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CFM-TMH Professional Series in Finance

Projects

0032114

Planning, Analysis, Selection, Financing, Implementation and Review

FIFTH EDITION

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Bangalore
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Third reprint 2003
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This edition can be exported from India only by the publishers, Tata McGraw-Hill Publishing Company Limited

ISBN 0-07-047359-5

Published by Tata McGraw-Hill Publishing Company Limited, 7 West Patel Nagar, New Delhi 110 008, typeset at Script Makers 19, A1-B DDA Market, Pashchim Vihar, New Delhi 110 063 and printed at Pashupati Printers, 1/429/16, Gali No. 1, Friends Colony, G.T. Road, Shahdara, Delhi 110 095

Cover Design: Cyber Creations

Cover: SDR Printers

To
Prashant & Pranav

Preface

With the publication of this edition, the book celebrates its 22nd anniversary. Its longevity may be attributed to the growing number of academics and practitioners who have repeatedly found it useful, relevant, and readable.

My effort has been to present to the readers a framework for evaluating capital expenditure proposals that has been developed by financial economists. Often, the ad hoc procedures and rules of thumb employed by businessmen and practitioners are not compatible with the principles advocated by financial economists. This book explains the rationale behind these principles and suggests ways and means to improve project appraisal and capital budgeting in practice.

The book spans the gamut of capital budgeting, defined in its broadest sense. Beginning with project planning, it culminates in the review of projects undertaken. In this respect, it is wider in coverage than any other books in the field.

The book focuses on explaining the analytical methods and techniques useful in different facets of capital budgeting. Numerous examples have been included to illustrate the methods and techniques. Where necessary, two or more examples in the ascending order of complexity have been included. Apart from analytical methods, the book discusses strategic, qualitative, and organisational considerations which impinge on capital budgeting decisions. It also describes and evaluates business practices in various areas.

Projects is primarily designed for two categories of readers—students and practitioners. Students of professional programmes (like MBA, CFM, CFA, ACA, and AICWA) and post graduate courses in Commerce, Finance, and Economics will benefit from this book. The book would prove a valuable reference to corporate policy makers who formulate and shape corporate investment strategies; to consultants and others who prepare project feasibility studies; to executives who have a say in the selection of projects and development

of the firm's capital budget; to officials of banks and financial institutions who evaluate projects as lenders and investors; and to those who are concerned with implementing as well as reviewing projects.

The key guidelines relevant to project planning, analysis, financing, and selection discussed in this book are:

- Develop a strategy that leads to sustainable competitive advantage.
- Sharpen the ability of the firm to identify promising investment opportunities.
- Formulate the project, taking into account the interrelationships among various aspects.
- Forecast realistically the incremental cash flows attributable to the project.
- Establish a hurdle rate that is consistent with the risk exposure of the project.
- Calculate the net present value of the project.
- Value the options embedded in the project.
- Blend judgment with analytical reasoning.

Changes in the Fifth Edition

This edition comes to you as a significant improvement over its predecessor. The key enhancements are.

Additions

New Chapters To broaden the scope of the book Part 5 has heen added. It covers financing and includes three chapters:

- Chapter 18: Financing of Projects
- Chapter 19: Financing Infrastructure Projects
- Chapter 20: Venture Capital

New Sections The following new sections have been added to update the content of the book:

- Section 1.2: Types of Capital Investments
- Section 1.8: Common Weaknesses in Capital Budgeting
- Section 2.5: Why Conglomerates Can Add Value in Emerging Markets
- Section 2.6: Investment in Capabilities
- Section 4.7: Market Planning
- Section 10.9: How Financial Institutions Calculate Cost of Capital
- Section 11.8: Managing Risk
- Section 11.11: How Financial Institutions Analyse Risk
- Section 12.1: Portfolio Related Risk Measures
- Section 13.6: International Capital Budgeting
- Section 16.7: Value of an Option to Abandon
- Section 16.9: Value of Natural Resource Options

- Section 17.1: Managerial Intuition and Judgment
- Section 23.5: Agency Problem

Revised Chapters While most of the chapters of the previous edition have undergone some change, the following chapters have been substantially revised:

Chapter 4: Market and Demand Analysis

Chapter 7: The Time Value of Money

Chapter 8: Investment Criteria

Chapter 9: Project Cash Flows

Chapter 10: The Cost of Capital

Chapter 11: Risk Analysis of Single Investments

Chapter 12: Risk Analysis: Firm Risk and Market Risk.

Chapter 16: Valuation of Real Options

Ancillary Materials

To enhance the utility of the book for students and instructors, the following ancillary materials are available.

- **Spreadsheet templates** Dr. V. Nagadevara of Indian Institute of Management, Bangalore developed the spreadsheet templates in Excel. They correlate with various concepts in the text and are meant to help students work through financial problems. These spreadsheet templates may be downloaded from www.tatamcgrawhill.com/digital_solutions/prasannachandra.
- **Solutions manual** The solutions manual contains solutions to end-of-chapter problems. The solutions can be accessed by instructors who adopt the book. They may contact Tata McGraw-Hill for assistance in accessing the solutions manual.

Organisation of the Book

Organised in terms of the broad phases of capital budgeting, this book is divided into seven parts:

Part 1 *Planning* Consisting of chapters 1 through 3, Part 1 covers the planning phase of capital budgeting. Chapter 1 provides an overview of capital budgeting. Chapter 2 discusses the key criteria, models, and considerations that are helpful in articulating the resource allocation strategy of a firm. Chapter 3 looks at the ways and means of generating project ideas and screening them at a preliminary level.

Part 2 *Analysis* Chapters 4 through 6 focus on gathering and analysing the basic information about the project. Chapter 4 discusses the key steps involved in market and demand analysis. Chapter 5 dwells on the various facets of technical analysis.

Chapter 6 explains how financial estimates and projections relating to a project are developed.

Part 3 *Selection – I* The content relating to the selection phase is very extensive. It has thus been split into two parts, Selection –I (Part 3) and Selection – II (Part 4). Part 3 consists of chapters 7-11. Chapter 7 discusses the principles of *compounding discounting*. Chapter 8 covers extensively the various investment appraisal criteria. Chapter 9 shows how project cash flows are defined. Chapter 10 explains the concept and measurement of cost of capital. Finally, Chapter 11 expounds the techniques for measuring and evaluating the stand-alone risks of projects.

Part 4 *Selection – II* Concerned with more advanced techniques of selection or broader methodologies of evaluation, Part 4 consists of chapters 12-17. Chapter 12 discusses the risk of a project in terms of firm risk and market risk. Chapter 13 looks at how capital budgeting decisions may be made in certain special situations. Chapter 14 presents the methodology of social cost benefit analysis. Chapter 15 shows how the capital budget may be drawn up in face of constraints,using the technique of mathematical programming. Chapter 16 explains the key insights provided by the option pricing theory and how the same may be employed for valuing the options embedded in capital projects. Chapter 17 explores the qualitative, strategic, and organisational issues relating to capital budgeting.

Part 5 *Financing* Consisting of chapters 18 to 20, Part 5 discusses how projects may be financed. Chapter 18 discusses various sources of finance used for setting up a project. Chapter 19 focuses on financing of infrastructure projects. Chapter 20 explains the concept and practice of venture capital.

Part 6 *Implementation* Part 6 includes two chapters which look at the implementation of the selected projects. Chapter 21 discusses various aspects of project management. Chapter 22 explains how network techniques (PERT, CPM, and Network Cost System) may be employed for project planning, scheduling, and control.

Part 7 *Review* Chapter 23 discusses various issues involved in project review. It also covers the administrative aspects of capital budgeting.

I look forward to receiving suggestions from the readers for further improving the content of this book.

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Acknowledgements

I am indebted to my students and the participants of executive development programmes conducted by me for providing the stimulus for writing this book. They pointed out to me the need for a comprehensive book, akin to a manual, on managing capital expenditures.

In writing this book I have drawn on materials from a variety of disciplines that have a bearing on different facets of projects appraisal and capital budgeting. I owe a profound intellectual debt to numerous authors whose ideas and contributions have shaped my thinking on this subject.

I am grateful to Prof.G.Sabarinathan, Prof. Naganna, Prof. Padmini Srinivasan, and Shri Suman Saha for their valuable contributions to this book. Moreover, I am indebted to a number of practitioners who have generously shared their views with me and to Dr.Subrahmanyam, Deepa, and Chandrasekhar of Tata McGraw Hill for their keen interest in this book. I am thankful to Savita and Subhashini for their help in preparing the manuscript. My deepest gratitude is to my wife, Padma, for her unstinted support.

At places I have drawn on my articles published in *Indian Management, Chartered Accountant, Management Accountant, Decision, Chartered Financial Analyst* and *Lok Udyog*. I am grateful to the editors of these journals.

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Contents

Preface *vii*
Acknowledgements *xi*

Part I: Planning

1. Overview **3**

1.1 Capital Investments: Importance and Difficulties *4*
1.2 Types of Capital Investments *5*
1.3 Phases of Capital Budgeting *5*
1.4 Levels of Decision Making *9*
1.5 Facets of Project Analysis *9*
1.6 Feasibility Study: A Schematic Diagram *12*
1.7 Objectives of Capital Budgeting *12*
1.8 Common Weaknesses in Capital Budgeting *15*
Summary *17*
Questions *18*

2. Capital Allocation Framework **19**

2.1 Key Criteria *20*
2.2 Elementary Investment Options *21*
2.3 Portfolio Planning Models *24*
2.4 Strategic Position and Action Evaluation (Space) *27*
2.5 Diversification Debate *30*
2.6 Investment in Capabilities *37*
2.7 Strategic Planning and Capital Budgeting *39*
Summary *40*
Questions *41*

3. Generation and Screening of Project Ideas **43**

3.1 Generation of Ideas *44*
3.2 Monitoring The Environment *45*

3.3 Corporate Appraisal 47
3.4 Profit Potential of Industries: Porter Model 48
3.5 Scouting for Project Ideas 50
3.6 Preliminary Screening 53
3.7 Project Rating Index 55
3.8 Sources of Positive Net Present Value 56
3.9 On Being an Entrepreneur 58
Summary 60
Questions 61

Part II: Analysis

4. Market and Demand Analysis 65

4.1 Situational Analysis and Specification of Objectives 66
4.2 Collection of Secondary Information 67
4.3 Conduct of Market Survey 72
4.4 Characterisation of the Market 75
4.5 Demand Forecasting 77
4.6 Uncertainties in Demand Forecasting 89
4.7 Market Planning 91
Summary 95
Questions 96
Problems 97

5. Technical Analysis 98

5.1 Manufacturing Process/Technology 99
5.2 Technical Arrangements 100
5.3 Material Inputs and Utilities 101
5.4 Product Mix 102
5.5 Plant Capacity 103
5.6 Location and Site 105
5.7 Machineries and Equipment 107
5.8 Structures and Civil Works 109
5.9 Environmental Aspects 109
5.10 Project Charts and Layouts 110
5.11 Schedule of Project Implementation 111
5.12 Need for Considering Alternatives 112
Summary 113
Questions 114

6. Financial Estimates and Projections 116

6.1 Cost of Project 117
6.2 Means of Finance 121
6.3 Estimates of Sales and Production 123

6.4 Cost of Production 124
6.5 Working Capital Requirement and its Financing 127
6.6 Profitability Projections (or Estimates of Working Results) 129
6.7 Projected Cash Flow Statement 133
6.8 Projected Balance Sheet 135
6.9 Multi-Year Projections 137
Summary 139
Questions 141
Problems 142
Appendix 6A 145

Part III: Selection: Basic Techniques

7. The Time Value of Money 155

7.1 Time Lines and Notation 156
7.2 Future Value of a Single Amount 157
7.3 Present Value of a Single Amount 161
7.4 Future Value of an Annuity 163
7.5 Present Value of an Annuity 167
7.6 Intra-Year Compounding and Discounting 173
Summary 176
Questions 178
Problems 178
Appendix 7A 181

8. Investment Criteria 183

8.1 Net Present Value 184
8.2 Benefit Cost Ratio 193
8.3 Internal Rate of Return 194
8.4 Urgency 203
8.5 Payback Period 204
8.6 Accounting Rate of Return 207
8.7 Assessment of Various Methods 210
8.8 Investment Appraisal: Indian Practice 211
8.9 Investment Appraisal: International Practice 215
Summary 216
Questions 218
Problems 219

9. Project Cash Flows 223

9.1 Elements of the Cash Flow Stream 224
9.2 Basic Principles of Cash Flow Estimation 225

9.3 Cash Flow Illustrations 232
9.4 Cash Flows for a Replacement Project 235
9.5 Viewing a Project from Other Perspectives 238
9.6 How Financial Institutions and the Planning Commission Define Cash Flows 243
9.7 Biases in Cash Flow Estimation 245
Summary 247
Questions 249
Problems 249

10. The Cost of Capital **252**

10.1 Some Preliminaries 253
10.2 Cost of Debt and Preference 254
10.3 Cost of Equity 256
10.4 Determining the Proportions 260
10.5 Weighted Average Cost of Capital 261
10.6 Weighted Marginal Cost of Capital Schedule 262
10.7 Floatation Costs and the Cost of Capital 267
10.8 Cost of Capital in Practice 270
10.9 How Financial Institutions Calculate Cost of Capital 274
Summary 275
Questions 277
Problems 278
Appendix 10A 280
Appendix 10B 281

11. Risk Analysis of Single Investments **284**

11.1 Sources, Measures, and Perspectives on Risk 285
11.2 Sensitivity Analysis 288
11.3 Scenario Analysis 290
11.4 Break-Even Analysis 292
11.5 Hillier Model 294
11.6 Simulation Analysis 298
11.7 Decision Tree Analysis 307
11.8 Managing Risk 315
11.9 Project Selection Under Risk 317
11.10 Risk Analysis in Practice 322
11.11 How Financial Institutions Analyse Risk 325
Summary 327
Questions 329
Problems 330
Appendix 11A 334
Appendix 11B 336
Appendix 11C 340

Part IV: Selection: Advanced Techniques

12. Risk Analysis: Firm Risk and Market Risk 345

12.1 Portfolio Related Risk Measures *346*
12.2 Mean-Variance Portfolio Construction *347*
12.3 Portfolio Theory and Capital Budgeting *354*
12.4 Capital Asset Pricing Model *356*
12.5 Developing the Inputs Required for Applying CAPM *362*
12.6 Empirical Evidence on Capital Asset Pricing Model *369*
12.7 Capital Asset Pricing Model and Capital Budgeting *371*
Summary 375
Questions 378
Problems 378

13. Special Decision Situations 381

13.1 Choice Between Mutually Exclusive Projects of Unequal Life *381*
13.2 Optimal Timing *383*
13.3 Determination of Economic Life *384*
13.4 Interrelationship Between Investment and Financing Aspects *388*
13.5 Inflation and Capital Budgeting *394*
13.6 International Capital Budgeting *395*
Summary 398
Questions 399
Problems 399

14. Social Cost Benefit Analysis 403

14.1 Rationale for SCBA *404*
14.2 UNIDO Approach *405*
14.3 Net Benefit in Terms of Economic (Efficiency) Prices *406*
14.4 Measurement of the Impact on Distribution *417*
14.5 Savings Impact and its Value *417*
14.6 Income Distribution Impact *419*
14.7 Adjustment for Merit and Demerit Goods *421*
14.8 Little–Mirrlees Approach *422*
14.9 Shadow Prices *423*
14.10 SCBA By Financial Institutions *425*
14.11 Public Sector Investment Decisions in India *434*
Summary 438
Questions 441
Problems 442

15. Multiple Projects and Constraints 445

15.1 Constraints *446*

15.2 Method of Ranking *448*
15.3 Mathematical Programming Approach *450*
15.4 Linear Programming Model *451*
15.5 Integer Linear Programming Model *456*
15.6 Goal Programming Model *461*
Summary *466*
Questions *467*
Problems *468*

16. Valuation of Real Options 472

16.1 What are Options? *473*
16.2 Options and their Payoffs Just Before Expiration *474*
16.3 Factors Determining Option Values *479*
16.4 Binomial Model for Option Valuation *483*
16.5 Black and Scholes Model *486*
16.6 Value of an Option to Make a Follow on Investment *490*
16.7 Value of an Option to Abandon *492*
16.8 Value of a Vacant Land *494*
16.9 Value of Natural Resource Options *496*
16.10 Judgmental Assessment of Options *498*
Summary *500*
Questions *501*
Problems *502*

17. Judgmental, Behavioural, Strategic and Organisational Considerations 504

17.1 Managerial Intuition and Judgment *505*
17.2 Mission, Strategy, and Capital Budgeting *508*
17.3 Bridging the Gulf Between Strategic Planning and Financial Analysis *511*
17.4 Informational Asymmetry and Capital Budgeting *514*
17.5 Organisational Considerations *516*
Summary *518*
Questions *519*

Part V: Financing

18. Financing of Projects 523

18.1 Capital Structure *524*
18.2 Menu of Financing *528*
18.3 Equity Capital *530*
18.4 Preference Capital *536*
18.5 Internal Accruals *537*

18.6 Term Loans *538*
18.7 Debentures *545*
18.8 Working Capital Advance *550*
18.9 Miscellaneous Sources *553*
18.10 Raising Venture Capital *557*
18.11 Raising Capital in International Markets *558*
Summary *563*
Questions *565*

19. Financing Infrastructure Projects **567**

19.1 Typical Project Configuration *569*
19.2 Key Project Parties *570*
19.3 Project Contracts *571*
19.4 Financial Structure and Corporate Governance *574*
19.5 Financing a Power Project *574*
19.6 Financing Telecommunication Projects *580*
Summary *582*
Questions *582*

20. Venture Capital **583**

20.1 Vc Investors *584*
20.2 What is a VC Investment *584*
20.3 What Makes a VC Investment Different *585*
20.4 The VC Investment Appraisal Process and Management *586*
20.5 The Indian VC Industry *592*
20.6 Regulation of VC Industry in India *594*
20.7 Current Concerns of the Indian VC Industry *595*
20.8 How to Approach a VC Fund *596*
Summary *597*
Questions *599*

Part VI: Implementation

21. Project Management **603**

21.1 Forms of Project Organisation *604*
21.2 Project Planning *606*
21.3 Project Control *612*
21.4 Human Aspects of Project Management *616*
21.5 Pre-Requisites for Successful Project Implementation *620*
Summary *623*
Questions *625*
Problems *625*

22. **Network Techniques for Project Management** 626

22.1 Development of Project Network *627*
22.2 Time Estimation *630*
22.3 Determination of the Critical Path *633*
22.4 Scheduling when Resources are Limited *639*
22.5 Pert Model *646*
22.6 Cpm Model *651*
22.7 Network Cost System *657*
Summary 660
Questions 662
Problems 662

Part VII: Review

23. **Project Review and Administrative Aspects** 667

23.1 Control of In-Progress Projects *667*
23.2 Post-Completion Audits *668*
23.3 Abandonment Analysis *672*
23.4 Administrative Aspects of Capital Budgeting *677*
23.5 Agency Problem *683*
23.6 Evaluating the Capital Budgeting System of an Organisation *685*
Summary 686
Questions 687
Problems 688

Bibliography 689
Appendix A 694
Appendix B 703
Appendix C 725
Appendix D 737
Index 743

PART I

Planning

1. Overview
2. Capital Allocation Framework
3. Generation and Screening of Project Ideas

CHAPTER 1

Overview

A mini steel plant is considering building a new arc furnace; an insurance company is planning to install a computer system for information processing; the Government of India is thinking of an ambitious plan to link the Ganges and Cauvery rivers; Gautam, a graduate student, is planning to buy a moped. All these situations involve a capital expenditure decision. Essentially, each of them represent a scheme for investing resources which can be analysed and appraised reasonably independently. The basic characteristic of a capital expenditure (also referred to as a capital investment or capital project or just project) is that it typically involves a current outlay (or current and future outlays) of funds in the expectation of a stream of benefits extending far into the future.

This definition of a capital expenditure is not necessarily synonymous with how a capital expenditure is defined in accounting. A capital expenditure, from the accounting point of view, is an expenditure which is shown as an asset in the balance sheet. This asset, except in the case of a non-depreciable asset like land, is depreciated over its life. In accounting, the classification of an expenditure as a capital expenditure or a revenue expenditure is governed by certain conventions, by some provisions of law, and by the management's desire to enhance or depress reported profits. Often, outlays on research and development, major advertising campaigns, and reconditioning of plant and machinery may be treated as revenue expenditures for accounting purposes, even though they are expected to generate a stream of benefits in the future and, therefore, qualify for being capital expenditures.

This chapter provides a broad overview of the field of project appraisal and capital budgeting. It is divided into eight sections as follows:

- Capital investments: Importance and difficulties
- Types of capital investments
- Phases of capital budgeting
- Levels of decision making

- Facets of project analysis
- Feasibility study: A schematic diagram
- Objectives of capital budgeting
- Common weaknesses in capital budgeting

1.1 CAPITAL INVESTMENTS: IMPORTANCE AND DIFFICULTIES

Importance

Capital expenditure decisions often represent the most important decisions taken by a firm. Their importance stems from three inter-related reasons:

- *Long-Term Effects* The consequences of capital expenditure decisions extend far into the future. The scope of current manufacturing activities of a firm is governed largely by capital expenditures in the past. Likewise, current capital expenditure decisions provide the framework for future activities. Capital investment decisions have an enormous bearing on the basic character of a firm.
- *Irreversibility* The market for used capital equipment in general is ill-organised. Further, for some types of capital equipment, custom-made to meet specific requirements, the market may virtually be non-existent. Once such an equipment is acquired, reversal of decision may mean scrapping the capital equipment. Thus, a wrong capital investment decision often cannot be reversed without incurring a substantial loss.
- *Substantial Outlays* Capital expenditures usually involve substantial outlays. An integrated steel plant, for example, involves an outlay of several thousand million. Capital costs tend to increase with advanced technology.

Difficulties

While capital expenditure decisions are extremely important, they also pose difficulties which stem from three principal sources:

- *Measurement Problems* Identifying and measuring the costs and benefits of a capital expenditure proposal tends to be difficult. This is more so when a capital expenditure has a bearing on some other activities of the firm (like cutting into the sales of some existing product) or has some intangible consequences (like improving the morale of workers).
- *Uncertainty* A capital expenditure decision involves costs and benefits that extend far into the future. It is impossible to predict exactly what will happen in the future. Hence, there is usually a great deal of uncertainty characterising the costs and benefits of a capital expenditure decision.
- *Temporal Spread* The costs and benefits associated with a capital expenditure decision are spread out over a long period of time, usually 10–20 years for industrial projects

and 20–50 years for infrastructural projects. Such a temporal spread creates some problems in estimating discount rates and establishing equivalences.

1.2 TYPES OF CAPITAL INVESTMENTS

Capital investments may be classified in different ways. At the simplest level, capital investments may be classified as physical, monetary, or intangible. *Physical assets* are tangible investments like land, building, plant, machinery, vehicles, and computers. *Monetary assets* are financial claims against some parties. Deposits, bonds, and equity shares are examples of monetary assets. *Intangible assets* are not in the form of physical assets or financial claims. They represent outlays on research and development, training, market development, franchises, and so on that are expected to generate benefits over a period of time.

Capital investments may also be classified as strategic investments and tactical investments. A *strategic investment* is one that has a significant impact on the direction of the firm. Telco's decision to invest in a passenger car project may be regarded as a strategic investment. A *tactical investment* is meant to implement a current strategy as efficiently or as profitably as possible. An investment by Telco to replace an old machine to improve productivity represents a tactical investment.

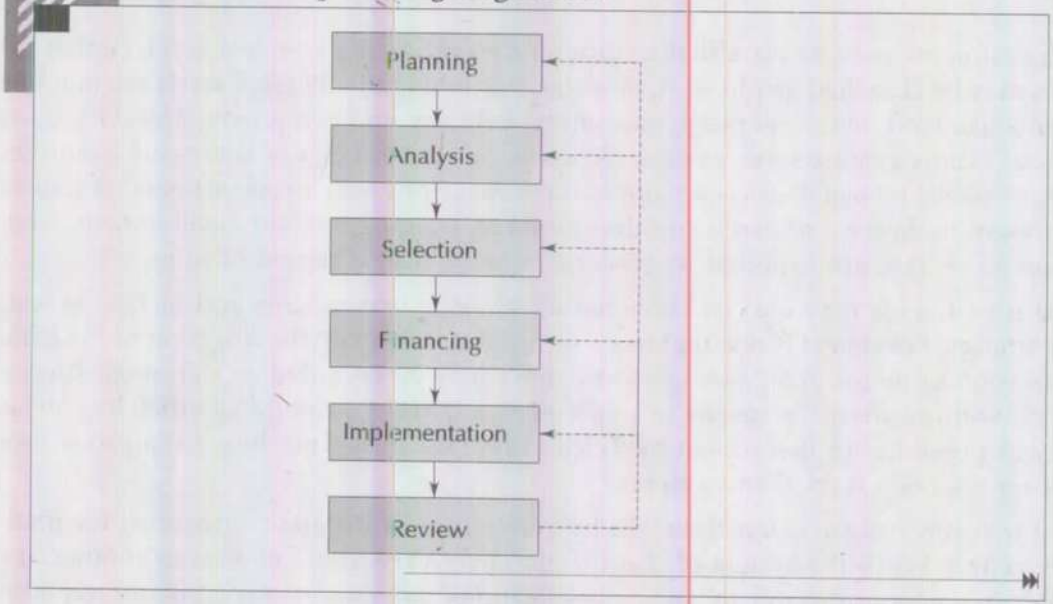
Capital investments are often classified by companies in different categories for planning and control. While the system of classification may vary from one firm to another, the following categories are found in most classifications: mandatory investments, replacement investments, expansion investments, diversification investments, R&D investments, and miscellaneous investments. A *mandatory investment* is a capital expenditure required to comply with statutory requirements. Examples of such investments are pollution control equipment, a fire fighting equipment, medical dispensary, and a créche in the factory. A *replacement investment* is meant to replace worn out equipment with new equipment to reduce operating costs, increase the yield, and improve quality. An *expansion investment* is meant to increase the capacity to cater to a growing demand. A *diversification investment* is aimed at producing new products or services or entering into new geographical areas. *R&D investments* are meant to develop new products and processes which would sharpen the technological edge of the firm. Finally, *miscellaneous investments* represent a catch-all category that includes items like interior decoration, recreational facilities, and landscaped gardens.

1.3 PHASES OF CAPITAL BUDGETING

Capital budgeting is a complex process which may be divided into six broad phases: planning, analysis, selection, financing, implementation, and review. Exhibit 1.1 portrays the

relationship among these phases. The sold arrows reflect the main sequence: planning precedes analysis; analysis precedes selection; and so on. The dashed arrows indicate that the phases of capital budgeting are not related in a simple, sequential manner. Instead, there are several feedback loops reflecting the iterative nature of the process.

Exhibit 1.1 *Capital Budgeting Process*



Planning

The planning phase of a firm's capital budgeting process is concerned with the articulation of its broad investment strategy and the generation and preliminary screening of project proposals. The investment strategy of the firm delineates the broad areas or types of investments the firm plans to undertake. This provides the framework which shapes, guides, and circumscribes the identification of individual project opportunities.

Once a project proposal is identified, it needs to be examined. To begin with, a preliminary project analysis is done. A prelude to the full blown feasibility study, this exercise is meant to assess (i) whether the project is prima facie worthwhile to justify a feasibility study and (ii) what aspects of the project are critical to its viability and hence warrant an in-depth investigation.

Analysis

If the preliminary screening suggests that the project is prima facie worthwhile, a detailed analysis of the marketing, technical, financial, economic, and ecological aspects is undertaken. The questions and issues raised in such a detailed analysis are described in the

following section. The focus of this phase of capital budgeting is on gathering, preparing, and summarising relevant information about various project proposals which are being considered for inclusion in the capital budget. Based on the information developed in this analysis, the stream of costs and benefits associated with the project can be defined.

Selection

Selection follows, and often overlaps, analysis. It addresses the question—Is the project worthwhile? A wide range of appraisal criteria have been suggested to judge the worthwhileness of a project. They are divided into two broad categories, viz., non-discounting criteria and discounting criteria. The principal non-discounting criteria are the payback period and the accounting rate of return. The key discounting criteria are the net present value, the internal rate of return, and the benefit cost ratio. The selection rules associated with these criteria are as follows:

Criterion	*Accept*	*Reject*
Payback period (*PBP*)	*PBP* < target period	*PBP* > target period
Accounting rate of return (*ARR*)	*ARR* > target rate	*ARR* < target rate
Net present value (*NPV*)	*NPV* > 0	*NPV* < 0
Internal rate of return (*IRR*)	*IRR* > cost of capital	*IRR* < cost of capital
Benefit cost ratio (*BCR*)	*BCR* > 1	*BCR* < 1

To apply the various appraisal criteria suitable cut-off values (hurdle rate, target rate, and cost of capital) have to be specified. These are essentially a function of the mix of financing and the level of project risk. While the former can be defined with relative ease, the latter truly tests the ability of the project evaluator. Indeed, despite a wide range of tools and techniques for risk analysis (sensitivity analysis, scenario analysis, Monte Carlo simulation, decision tree analysis, portfolio theory, capital asset pricing model, and so on), risk analysis remains the most intractable part of the project evaluation exercise.

Financing

Once a project is selected, suitable financing arrangements have to be made. The two broad sources of finance for a project are equity and debt. Equity (referred to as shareholders' funds on balance sheets in India) consists of paid-up capital, share premium, and retained earnings. Debt (referred to as loan funds on balance sheets in India) consists of term loans, debentures, and working capital advances.

Flexibility, risk, income, control, and taxes (referred to by the acronym FRICT) are the key business considerations that influence the capital structure (debt-equity ratio) decision and the choice of specific instruments of financing.

Implementation

The implementation phase for an industrial project, which involves setting up of manufacturing facilities, consists of several stages: (i) project and engineering designs, (ii) negotiations and contracting, (iii) construction, (iv) training, and (v) plant commissioning. What is done in these stages is briefly described below:

Stage	Concerned with
Project and engineering designs	Site probing and prospecting, preparation of blueprints, and plant designs, plant engineering, selection of specific machineries and equipment.
Negotiations and contracting	Negotiating and drawing up of legal contracts with respect to project financing, acquisition of technology, construction of building and civil works, provision of utilities, supply of machinery and equipment, marketing arrangements, etc.
Construction	Site preparation, construction of buildings and civil works, erection and installation of machinery and equipment.
Training	Training of engineers, technicians, and workers. (This can proceed simultaneously along with the construction work.)
Plant commissioning	Start up of the plant. (This is a brief but technically crucial stage in the project development cycle.)

Translating an investment proposal into a concrete project is a complex, time-consuming, and risk-fraught task. Delays in implementation, which are common, can lead to substantial cost overruns. For expeditious implementation at a reasonable cost, the following are helpful:

1. *Adequate Formulation of Projects* A major reason for the delay is inadequate formulation of projects. Put differently, if the necessary homework in terms of preliminary studies and comprehensive and detailed formulation of the project is not done, many surprises and shocks are likely to spring on the way. Hence, the need for adequate formulation of the project cannot be over-emphasised.
2. *Use of the Principle of Responsibility Accounting* Assigning specific responsibilities to project managers for completing the project within the defined time-frame and cost limits is helpful in expeditious execution and cost control.
3. *Use of Network Techniques* For project planning and control two basic techniques are available – PERT (Programme Evaluation Review Technique) and CPM (Critical Path Method). These techniques have, of late, merged and are being referred to by a common terminology, that is network techniques. With the help of these techniques, monitoring becomes easier.

Review

Once the project is commissioned, the review phase has to be set in motion. Performance review should be done periodically to compare actual performance with projected per-

formance. A feedback device, it is useful in several ways: (i) It throws light on how realistic were the assumptions underlying the project; (ii) It provides a documented log of experience that is highly valuable in future decision making; (iii) It suggests corrective action to be taken in the light of actual performance; (iv) It helps in uncovering judgmental biases; (v) It induces a desired caution among project sponsors.

1.4 LEVELS OF DECISION MAKING

In addition to looking at the various phases of capital budgeting, researchers have also examined different levels of decision making. Gordon, Miller, and Mintzberg[1], for example, defined three levels of decision making: operating, administrative, and strategic. The key characteristics of decisions at these levels are described below:

	Operating decisions	*Administrative decisions*	*Strategic decisions*
• *Where is the decision taken*	Lower level management	Middle level management	Top level management
• *How structured is the decision*	Routine	Semi-structured	Unstructured
• *What is the level of resource commitment*	Minor resource commitment	Moderate resource commitment	Major resource commitment
• *What is the time horizon*	Short-term	Medium-term	Long-term

The three levels (operating, administrative, and strategic) of decision making can be readily applied to capital budgeting decisions. Examples are given below:

Operating capital budgeting decision	: Minor office equipment
Administrative capital budgeting decision	: Balancing equipment
Strategic capital budgeting decision	: Diversification project

While the methods and techniques covered in this book are applicable to all levels of capital budgeting decisions, our discussion will mainly be oriented towards administrative and strategic capital budgeting decisions.

1.5 FACETS OF PROJECT ANALYSIS

The important facets of project analysis are:

- Market analysis
- Technical analysis

1. Gordon, L.A., Miller, D. and Mintzberg, H. *Normative Models of Managerial Decision-Making*, New York: National Association of Accountants, 1975.

- Financial analysis
- Economic analysis
- Ecological analysis

Market Analysis

Market analysis is concerned primarily with two questions:

- What would be the aggregate demand of the proposed product/service in the future?
- What would be the market share of the project under appraisal?

To answer the above questions, the market analyst requires a wide variety of information and appropriate forecasting methods. The kinds of information required are:

- Consumption trends in the past and the present consumption level
- Past and present supply position
- Production possibilities and constraints
- Imports and exports
- Structure of competition
- Cost structure
- Elasticity of demand
- Consumer behaviour, intentions, motivations, attitudes, preferences, and requirements
- Distribution channels and marketing policies in use
- Administrative, technical, and legal constraints

Technical Analysis

Analysis of the technical and engineering aspects of a project needs to be done continually when a project is formulated. Technical analysis seeks to determine whether the prerequisites for the successful commissioning of the project have been considered and reasonably good choices have been made with respect to location, size, process, etc. The important questions raised in technical analysis are:

- Whether the preliminary tests and studies have been done or provided for?
- Whether the availability of raw materials, power, and other inputs has been established?
- Whether the selected scale of operation is optimal?
- Whether the production process chosen is suitable?
- Whether the equipment and machines chosen are appropriate?
- Whether the auxiliary equipments and supplementary engineering works have been provided for?
- Whether provision has been made for the treatment of effluents?
- Whether the proposed layout of the site, buildings, and plant is sound?
- Whether work schedules have been realistically drawn up?

- Whether the technology proposed to be employed is appropriate from the social point of view?

Financial Analysis

Financial analysis seeks to ascertain whether the proposed project will be financially viable in the sense of being able to meet the burden of servicing debt and whether the proposed project will satisfy the return expectations of those who provide the capital. The aspects which have to be looked into while conducting financial analysis are:

- Investment outlay and cost of project
- Means of financing
- Cost of capital
- Projected profitability
- Break-even point
- Cash flows of the project
- Investment worthwhileness judged in terms of various criteria of merit
- Projected financial position
- Level of risk

Economic Analysis

Economic analysis, also referred to as social cost benefit analysis, is concerned with judging a project from the larger social point of view. In such an evaluation the focus is on the social costs and benefits of a project which may often be different from its monetary costs and benefits. The questions sought to be answered in social cost benefit analysis are:

- What are the direct economic benefits and costs of the project measured in terms of shadow (efficiency) prices and not in terms of market prices?
- What would be the impact of the project on the distribution of income in the society?
- What would be the impact of the project on the level of savings and investment in the society?
- What would be the contribution of the project towards the fulfillment of certain merit wants like self-sufficiency, employment, and social order?

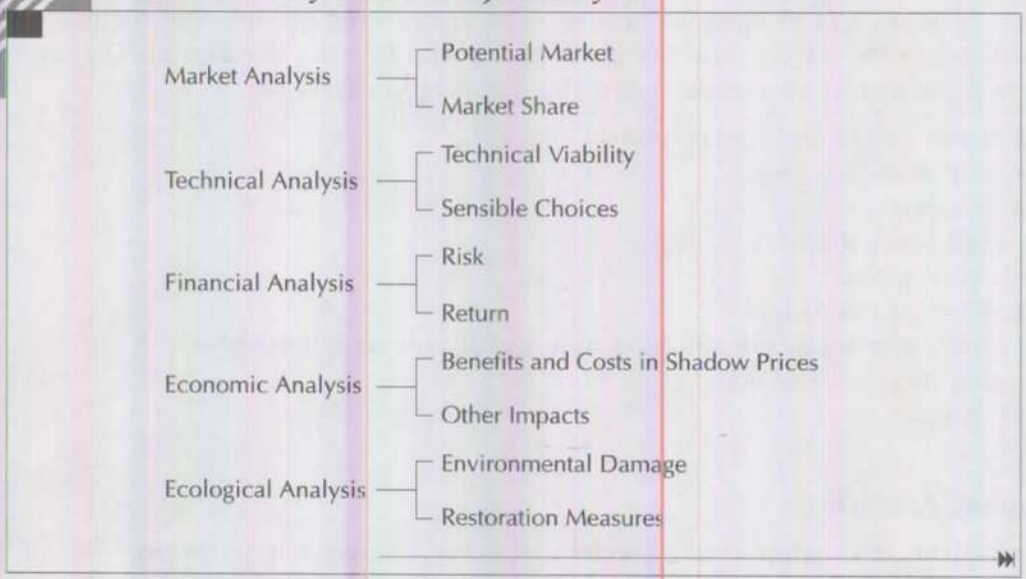
Ecological Analysis

In recent years, environmental concerns have assumed a great deal of significance—and rightly so. Ecological analysis should be done particularly for major projects which have significant ecological implications like power plants and irrigation schemes, and environment-polluting industries (like bulk drugs, chemicals, and leather processing). The key questions raised in ecological analysis are:

- What is the likely damage caused by the project to the environment?
- What is the cost of restoration measures required to ensure that the damage to the environment is contained within acceptable limits?

Exhibit 1.2 summarises the key issues considered in different types of analysis:

Exhibit 1.2 ***Key Issues in Project Analysis***



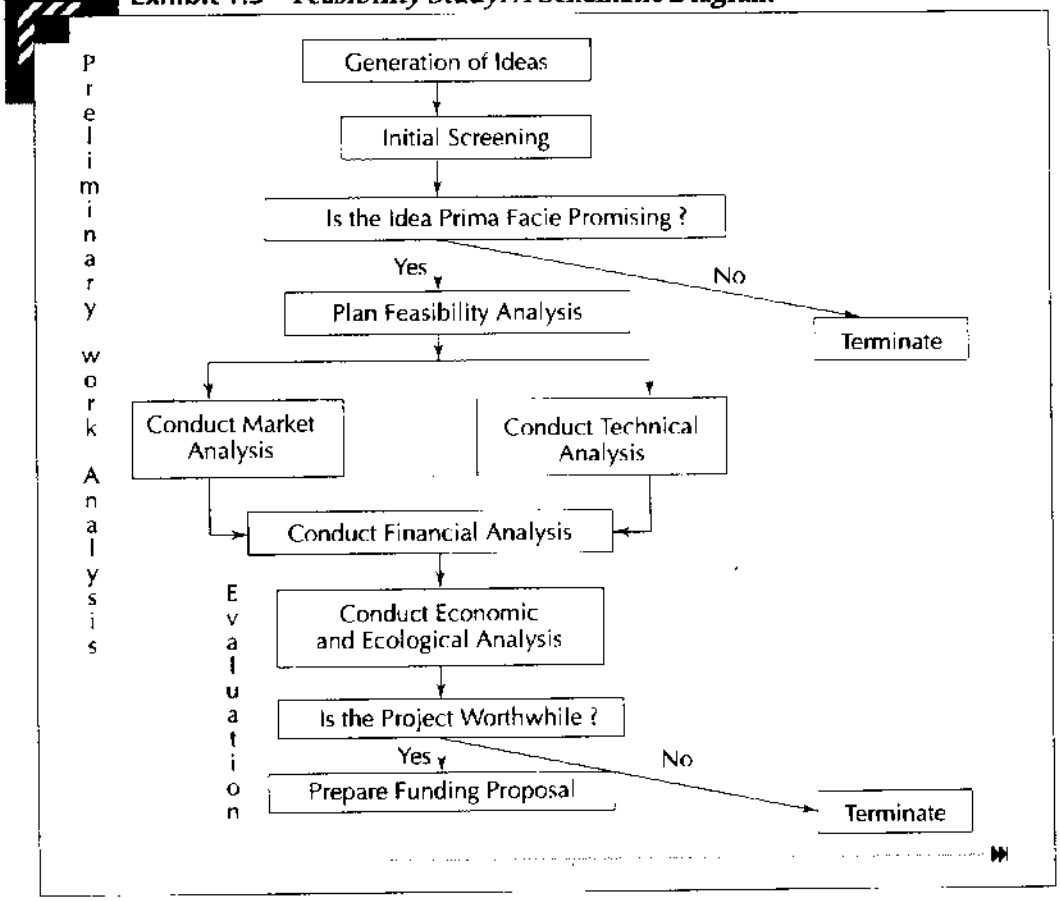
1.6 FEASIBILITY STUDY: A SCHEMATIC DIAGRAM

We have looked at the six broad phases of capital budgeting and examined the key facets of project analysis. The feasibility study is concerned with the first four phases of capital budgeting, viz., planning, analysis, selection (evaluation), and financing, and involves market, technical, financial, economic, and ecological analysis. The schematic diagram of the feasibility study is shown in Exhibit 1.3.

1.7 OBJECTIVES OF CAPITAL BUDGETING

Financial theory, in general, rests on the premise that the goal of financial management (which subsumes investment decision making) should be to maximise the present wealth of the firm's equity shareholders. For a firm whose equity shares are actively traded on the stock market, the wealth of the equity shareholders is reflected in the market value of the equity shares. Hence, the goal of financial management for such firms should be to maximise the market value of equity shares.

Exhibit 1.3 ***Feasibility Study: A Schematic Diagram***



The pursuit of the welfare of equity shareholders is justified on the grounds that it contributes to an efficient allocation of capital in the economy. The bases for allocation of savings in the economy are expected return and risk. Since equity share prices are based on expected return and risk, efforts to maximise equity share prices would result in an efficient allocation of resources. Another justification may be provided for the goal of shareholder wealth maximisation. Equity shareholders provide the venture (risk) capital required to start a business firm and appoint the management of the firm indirectly through the board of directors. Hence, it behooves on corporate managements to promote the welfare of equity shareholders.

What about a public sector firm the equity stock of which, being fully owned by the government, is not traded on the stock market? In such a case, the goal of financial management should be to maximise the present value of the stream of equity returns. Of course, in determining the present value of the stream of equity returns, an appropriate

discount rate has to be applied. A similar observation may be made with respect to other companies whose equity shares are either not traded or very poorly traded.

Alternatives

Are there other goals, besides the goal of maximising shareholder wealth, and expressing the shareholders' viewpoint? Several alternatives have been suggested: maximisation of profit, maximisation of earnings per share, maximisation of return on equity (defined as equity earnings/net worth).

Maximisation of profit is not as inclusive a goal as maximisation of shareholder wealth. It suffers from several limitations. These are:

- Profit in absolute terms is not a proper guide to decision making. It should be expressed on a per share basis or related to investment.
- It leaves considerations of timing and duration undefined. There is no guide for comparing profit now with profit in the future or for comparing profit streams of different durations.
- It glosses over the factor of risk. It cannot, for example, discriminate between an investment project which generates a certain profit of Rs 50,000 and an investment project which has a variable profit outcome with an expected value of Rs 50,000.

The goals of maximisation of earnings per share and maximisation of return on equity do not suffer from the first limitation mentioned above. They, however, suffer from the other limitations and hence are not suitable.

In view of the shortcomings of the alternatives discussed above, maximisation of the wealth of equity shareholders (as reflected in the market value of equity) appears to be the most appropriate goal for financial decision making. Though the strict validity of this goal rests on certain rigid assumptions about capital markets, it can be reasonably defined as a guide for financial decision making under fairly plausible assumptions.

Other Concerns of the Business

Should firms solely act to further the shareholders' welfare? This does not seem to be the issue here. Firms may pursue or ought to pursue several other goals. Business firms seek to achieve a high rate of growth, enjoy a substantial market share, attain product and technological leadership, promote employee welfare, further customer satisfaction, support education and research, improve community life, and solve other societal problems. Some of these goals may, of course, be in consonance with the goal of shareholder wealth maximisation. For a rapid growth rate, a dominant market position, and a higher customer satisfaction may lead to increasing returns for equity shareholders. Even efforts toward solving societal problems may further the interest of shareholders in the long run by improving the image of the firm and strengthening its relationship with the environment. When these goals seem to

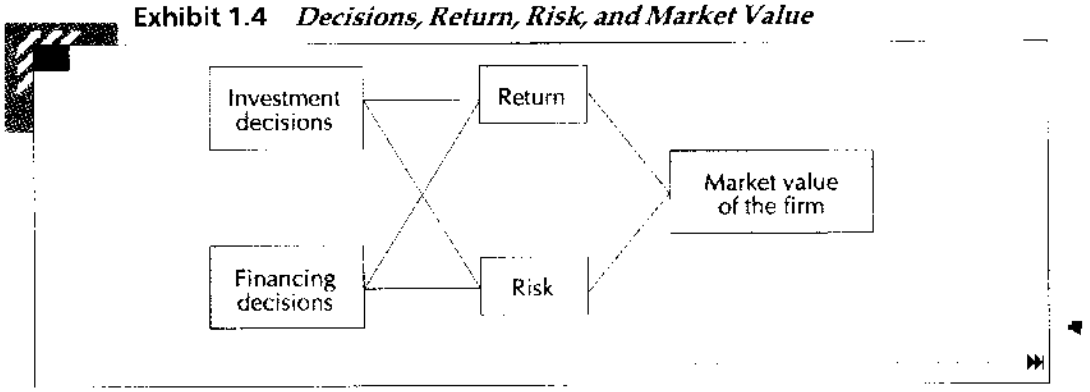
conflict with the goal of maximising the wealth of equity shareholders, it is helpful to know the cost of pursuing these goals. The trade-off has to be understood. It should be appreciated that the maximisation of the wealth of equity shareholders constitutes the principal guarantee for efficient allocation of resources in the economy and hence is to be regarded as the normative goal from the financial point of view.

Basic Considerations: Risk and Return

Suppose a firm is evaluating an investment proposal. What aspects are relevant from the financial angle? From the financial point of view the relevant dimensions are return and risk. Take another decision situation in which the firm is considering a financing proposal. The aspects along which such a proposal is examined are cost and risk. Since cost is the inverse of return, here too the basic dimensions are return and risk. In general, we find that these are the two basic dimensions of financial analysis.

What is the relationship between return, risk, and market value of equity? Higher the return, *ceteris paribus*, higher the market value; higher the risk, *ceteris paribus*, lower the market value. Exhibit 1.4 shows the schematic diagram of how decisions, return, risk, and market value are related.

Exhibit 1.4 ***Decisions, Return, Risk, and Market Value***



It may be emphasised that typically risk and return go hand in hand. This means that in a decision situation, an alternative which has a higher return tends to have a higher risk too. Likewise, an alternative which has a lower return tends to have a lower risk. In financial analysis, the trade-off between risk and return needs to be carefully analysed.

1.8 COMMON WEAKNESSES IN CAPITAL BUDGETING

A key factor that distinguishes value-creating firms from value-destroying firms is the quality of investment decisions, which, in turn, depends considerably on how sound is the

capital budgeting system of the firm. Unfortunately, the quality of investment decisions is often impaired due to various deficiencies in capital budgeting. The common weaknesses found in capital budgeting systems in practice are discussed below.

Poor Alignment between Strategy and Capital Budgeting Most companies seem to draw up a vision statement and a strategy to accomplish their goals. However, the capital budgeting system is often not well integrated with the strategy. For example, the strategy of a company may be to grow aggressively through new product introductions. Yet, the erosion of revenues of old products caused by the introduction of new products is viewed seriously in capital budgeting practice.

Deficiencies in Analytical Techniques Companies often employ flawed techniques and procedures. The commonly observed deficiencies are:

The Base Case is Poorly Identified For evaluating a project, the base case or the status quo scenario which reflects "what happens to the firm without the project" has to be specified. Obviously, the worse the base case, the more attractive the project looks. This may prompt project sponsors to portray a bleak base case scenario so that their pet proposals look attractive.

Risk is Treated Inadequately Capital projects are characterised by various risks which are assessed somewhat naively. A common practice is to develop low, medium, and high risk scenarios to gauge the range of future outcomes. Such simplistic characterisations are usually not enough for informed decision making.

Options are not Properly Evaluated When a firm undertakes a project it is likely to enjoy certain options in the future. It can expand its commitments; it can put the facilities to some other use; it can modify the scope of the project; it may truncate or even abandon the project prematurely. These options are often not properly assessed and captured in the capital budgeting analysis.

There is Lack of Uniformity in Assumptions In many multidivisional companies, project proposals coming from different divisions tend to make varying assumptions about economy growth rate, inflation rate, residual value, capital cost, and so on. Top management has to wrestle with non-uniform assumptions while evaluating capital investment proposals.

Side Effects are Ignored A project is likely to have important side effects. It may enhance the profitability of some of the existing activities of the firm because it has a complementary relationship with them; or, it may detract from the profitability of some of the existing activities of the firm because it has a competitive relationship with them. These side effects are not often considered properly during project evaluation.

No Linkage between Compensation and Financial Measures Companies often use discounted cash flow criteria like net present value *(NPV)* and internal rate of return *(IRR)*

for project selection, but link compensation to accounting measures like profit or average rate of return. In such a situation, managers may salute discounted cash flow criteria but walk in the direction of accounting measures.

A possible reason for such a misalignment is that *NPV* is a stock measure and not a flow measure. Further, it is a summary measure reflecting projected cash flows and not actual performance. To overcome this problem, a flow measure like economic value added *(EVA)*, which is linked to *NPV*, may be used instead of accounting measures like profit or average rate of return.

Reverse Financial Engineering Capital investment analysis is often afflicted by a subtle malaise in the form of reverse financial engineering. This involves twisting the figures and projections to fulfill certain criteria laid down by the firm.

Every project sponsor is keen to get his project included in the capital budget. So he is inclined to doctor the figures and dress up the proposal. For example, if the policy of the firm, stated or unstated, is to consider only those projects that have an *IRR* of more than 20 per cent or a payback period of less than five years, operating managers while submitting their project proposals will ensure that the financial estimates and projections are massaged to produce an *IRR* of more than 20 per cent or a payback period of less than 5 years. Thus, the quality of information used in capital budgeting is compromised.

Weak Integration between Capital Budgeting and Expense Budgeting Capital budgeting and expense budgeting are often done somewhat independently. For example, the projected profitability of a capital project may be based on the assumption that the firm would incur certain outlays on advertising and sales promotion. However, these outlays form part of the expense budget. Often, people approving the capital budget and the expense budget may not ensure consistency between the two. Even if the two budgets are developed in a mutually consistent manner, the pressure to perform in the short run may lead to a cutback in expense budgets. This may impair the performance of the capital budget and also induce skepticism about future capital investment proposals.

Inadequate Post-Audits The post-audit of a project involves comparison of its actual performance vis-à-vis its planned performance. It is meant to document the sources of discrepancy, provide useful feedback, facilitate continual improvement, and induce healthy caution among project sponsors. However, in many companies, post-audit is not handled properly. It often ends up as a policing device, leading to scepticism and distrust.

SUMMARY

- Essentially a capital project represents a scheme for investing resources that can be analysed and appraised reasonably independently.

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- The basic characteristic of a capital project is that it typically involves a current outlay (or current and future outlays) of funds in the expectation of a stream of benefits extending far into the future.
- Capital expenditure decisions often represent the most important decisions taken by a firm. Their importance stems from three inter-related reasons: long-term effects, irreversibility, and substantial outlays.
- While capital expenditure decisions are extremely important, they pose difficulties which stem from three principal sources: measurement problems, uncertainty, and temporal spread.
- Capital budgeting is a complex process which may be divided into six broad phases: planning, analysis, selection, financing, implementation, and review.
- One can look at capital budgeting decisions at three levels: operating, administrative, and strategic.
- The important facets of project analysis are: market analysis, technical analysis, financial analysis, economic analysis, and ecological analysis.
- Financial theory, in general, rests on the premise that the goal of financial management should be to maximise the present wealth of the firm's equity shareholders. Business firms may pursue other goals. When these other goals conflict with the goal of maximising the wealth of equity shareholders, the trade-off has to be understood.
- The common weaknesses found in capital budgeting systems in practice are: poor alignment between strategy and capital budgeting; deficiencies in analytical techniques; no linkage between compensation and financial measures; reverse financial engineering; weak integration between capital budgeting and expense budgeting; inadequate post-audits.

Questions

1. Why are capital expenditures often the most important decisions taken by a firm?
2. Explain the difficulties faced in capital expenditure decisions.
3. Discuss the five broad phases of capital budgeting.
4. Define the levels of decision making. What are their key characteristics?
5. What are the key questions raised in market analysis?
6. What are the important questions raised in technical analysis?
7. What aspects are looked into while conducting financial analysis?
8. What questions are sought to be answered in economic and ecological analysis?
9. Present a schematic diagram of the feasibility study.
10. What is the rationale for the goal of shareholder wealth maximisation?
11. Discuss the weaknesses found in capital budgeting systems in practice.

CHAPTER 2

Capital Allocation Framework

If you look at any organisation today what you see is mainly the result of capital allocation decisions made in the past. Its strategic assets, tangible or intangible, are traceable to the investment decisions of yesteryears. Hence, it isn't surprising that the key responsibility of the top management is concerned with capital allocation decisions. And this seems to be more so in large divisionalised companies (which are currently the norm), where a central concern of top management at the corporate head office is to allocate capital across strategic business units and manage the investment decision making activity in the entire group. As Mike Kaufman says: "The selection of the investment projects and the allocation of corporate capital to them are among top management's primary responsibilities to shareholders. A good corporate investment program can mean sustained growth; failure to invest wisely can impede growth or threaten company survival."

Capital budgeting is not the exclusive domain of financial analysts and accountants. Rather, it is a multifunctional task linked to a firm's overall strategy. As Richard Bower has said in his perceptive work *Managing the Resource Allocation Process* that the set of problems firms refer to as capital budgeting is "a task for general management rather than financial specialists."

Capital is scarce and hence must be allocated across competing claims very judiciously. The identification, evaluation, and selection of individual investment proposals is usually guided by a capital allocation framework, defined explicitly or implicitly by top management. The capital allocation framework of a firm spells out the kinds of businesses the firm

wants to be in, the strategy of the firm, the types of investments that make sense for the firm, the approach of the firm toward conglomerate diversification, so on and so forth.

This chapter explores certain analytical models, ideas, principles, and considerations that are useful in articulating a firm's capital allocation framework. It is divided into seven sections as follows:

- Key criteria
- Elementary investment options
- Portfolio planning models
- Strategic position and action evaluation
- Diversification debate
- Investment in capabilities
- Strategic planning and capital budgeting

2.1 KEY CRITERIA

The objective of maximising the wealth of shareholders is reflected, at the operational level, in three key criteria: profitability, risk, and growth.

Profitability The principal driving force for business activity, profitability reflects the relationship between profit and investment. While there are numerous ways of measuring profitability, return on equity is one of the most widely used. It is defined as:

$$\frac{\text{Profit after tax}}{\text{Net worth}}$$

In our present discussion, we will employ this measure.

Risk The search for profitable activities almost invariably entails risk. It reflects variability: How much do individual outcomes deviate from the expected value? A simple measure of variability is the *range* of possible outcomes, which is simply the difference between highest and lowest outcomes. For our present purposes, we will define risk in terms of the range of return on equity, our chosen measure of profitability.

Growth Business firms actively pursue and achieve growth over a period of time. This is manifested in the increase of revenues, assets, net worth, profits, dividends, and so on. To reflect the growth of a variable, the measure commonly employed is the compound rate of growth. We will look at the compound rate of growth of profit after tax.

It must be emphasised that the three criteria described above, viz., profitability, risk, and growth capture all facets of business performance. In addition, conceptually they are independent of each other. This point may be illustrated with the help of Exhibit 2.1 which

provides information on equity (net worth), profit after tax, dividends, and return on equity for three different pairs of firms over a period of a few years.

Panel 1 of Exhibit 2.1 shows the comparative picture of two firms, A and B. Looking at this panel, we find that A and B are identical with respect to average profitability (return on equity) and growth (compound rate of growth of profit after tax) but dissimilar in terms of risk (range of return on equity). Panel 2 depicts the comparative picture for two firms, C and D. Looking at this panel, we find that C and D are identical with respect to growth and risk but dissimilar in terms of profitability. Panel 3 displays the comparative picture for two firms, E and F. Looking at this panel we find that E and F are identical with respect to average profitability and risk, but different in terms of growth.

2.2 ELEMENTARY INVESTMENT OPTIONS

The building blocks of the corporate resource allocation strategy are the following elementary investment options:

- Replacement and modernisation
- Capacity expansion
- Vertical integration
- Concentric diversification
- Conglomerate diversification
- Divestment

Replacement and Modernisation

Often regarded as an integral part of the 'base level' capital expenditure programme, replacement and modernisation investments are meant to maintain (as well as augment) the production capacity of the firm, improve quality, and reduce costs. Without such investments, which are undertaken more or less routinely by well-managed firms, the competitive strength of the firm in its existing line of business can be significantly impaired. Indeed, if such investments are neglected, the very existence of the firm can be jeopardised. This has happened in the case of a large number of textile and other units in India.

Capacity Expansion

When a company anticipates growth in the market size of its product range or an increase in the market share enjoyed by it in its product range, expansion of the capacity of the existing product range would have great appeal. Such an expansion offers several advantages: familiarity with technology, production methods, and market conditions; lower capital costs due to the existence of surplus capacity in certain sections of the factory; reduction in unit

Exhibit 2.1 *Profitability, Growth, and Risk*

Panel 1

	A				B			
	Yr 1	*Yr 2*	*Yr 3*	*Yr 4*	*Yr 1*	*Yr 2*	*Yr 3*	*Yr 4*
Equity	100	100	100	100	100	100	100	100
Profit after tax	20	20	20	20	20	30	10	20
Dividends	20	20	20	20	20	30	10	20
Return on equity	20%	20%	20%	20%	20%	30%	10%	20%
Average profitability		: 20%			Average profitability		: 20%	
Growth		: 0%			Growth		: 0%	
Risk		: 0%			Risk		: 20%	

Panel 2

	C				D			
	Yr 1	*Yr 2*	*Yr 3*	*Yr 4*	*Yr 1*	*Yr 2*	*Yr 3*	*Yr 4*
Equity	100	100	100	100	100	100	100	100
Profit after tax	30	30	30	30	20	20	20	20
Dividends	30	30	30	30	20	20	20	20
Return on equity	30%	30%	30%	30%	20%	20%	20%	20%
Average profitability		: 30%			Average profitability		: 20%	
Growth		: 0%			Growth		: 0%	
Risk		: 0%			Risk		: 0%	

Panel 3

	E				F			
	Yr 1	*Yr 2*	*Yr 3*	*Yr 4*	*Yr 1*	*Yr 2*	*Yr 3*	*Yr 4*
Equity	100	120	144	172.8	100	100	100	100
Profit after tax	40	48	57.6	69.12	40	40	40	40
Dividends	20	24	28.8	34.56	40	40	40	40
Return on equity	40%	40%	40%	40%	40%	40%	40%	40%
Average profitability		: 40%			Average profitability		: 40%	
Growth		: 20%			Growth		: 0%	
Risk		: 0%			Risk		: 0%	

overhead costs because of larger volume of production. These advantages, however, should be weighed against the possibility of market saturation and risk of excessive dependence on the existing product range.

Vertical Integration

Vertical integration may be of two types: backward integration and forward integration. Backward integration involves the manufacture of raw materials and components required for the existing operations of the company. For example, Reliance Industries Limited set up a unit for the manufacture of polyester filament yarn required for its textile units.

Forward integration involves the manufacture of products which use the existing products of the company as the input. For example, Bharat Forge Company set up an automotive axles unit which uses its forgings as input. Vertical integration, backward or forward, provides greater stability to the existing as well as proposed operations, brings about better coordination between the supplying and consuming units, and enhances the market power of the combined entity.

Concentric Diversification

Many companies seek to widen their product range by adding related products. For example, a soap manufacturer may enter the field of detergents; a scooter producer may add motorcycles to its product line; a truck manufacturer may go in for passenger cars. The advantages of such diversification, referred to as concentric diversification or allied diversification, are: (i) The company may economise in the procurement of raw materials. (ii) Certain common manufacturing facilities may be better utilised. (iii) All products may benefit from the market image of the company. (iv) A common distribution network may be employed.

Conglomerate Diversification

Conglomerate diversification involves investment in fields unrelated to the existing line of business. For example, when an engineering company like Larsen and Toubro invests in shipping it is a case of conglomerate diversification. The principal motivations underlying conglomerate diversification are to (i) overcome the limited growth opportunities in the existing line of business, and (ii) reduce the overall risk exposure of the firm. Many firms in India in the last two decades or so have resorted to conglomerate diversification.

Divestment

Divestment is the opposite of investment. It involves termination or liquidation of the plant or even a division of a firm. The disposal of the Chembur plant of Union Carbide to Oswal Agro is an example of divestment. The motivations for divestment may be varied: low (or even negative) profitability, declining market share, difficulty in managing, or incompatibility with corporate strategy.

Exhibit 2.2 summarises the principal motivations underlying various elementary investment strategies and their likely outcomes in terms of profitability, growth, and risk. Typically, firms pursue a combined investment strategy which reflects two or more elementary investment strategies. For example, the firm may resort to capacity expansion along with allied diversification, or it may pursue the course of vertical integration with conglomerate diversification, or it may follow the path of concentric diversification, conglomerate diversification and vertical integration simultaneously, or it may adopt any other combination investment strategy.

Exhibit 2.2 *Elementary Investment Strategies, Principal Motivations, and Likely Outcomes*

Investment Strategy	Principal Motivations	Likely Outcomes		
		Profitability	Growth	Risk
Replacement and modernisation	– Quality improvement – Cost reduction – Maintenance (and enhancement) of competitive power	High	Moderate	Low
Capacity expansion	– Ability to serve a growing market – Familiarity with technology and market – Cost leadership	High	Moderate	Moderate
Vertical integration	– Greater stability for existing and proposed operations – Greater market power	High	Moderate	Moderate
Concentric diversification	– Improves utilisation of resources	High	Moderate	Moderate
Conglomerate diversification	– Limited scope in the present business	Moderate	High	Low
Divestment	– Inadequate profit – Poor strategy	High	Low	Low

2.3 PORTFOLIO PLANNING MODELS

To guide the process of strategic planning and resource allocation, several portfolio planning tools have been developed. Two such tools, highly relevant in the context of our present discussion, are:

- BCG Product Portfolio Matrix
- General Electric's Stoplight Matrix

BCG Product Portfolio Matrix

A tool for strategic (product) planning and resource allocation, the Boston Consulting Group (BCG) product portfolio matrix analyses products on the basis of (a) relative market share and (b) industry growth rate. The BCG matrix, shown in Exhibit 2.3, classifies products into four broad categories as follows:

Exhibit 2.3 ***BCG Product Portfolio Matrix***

Industry Growth Rate	*Relative Market Share*	
	High	Low
High	Stars	Question marks
Low	Cash cows	Dogs

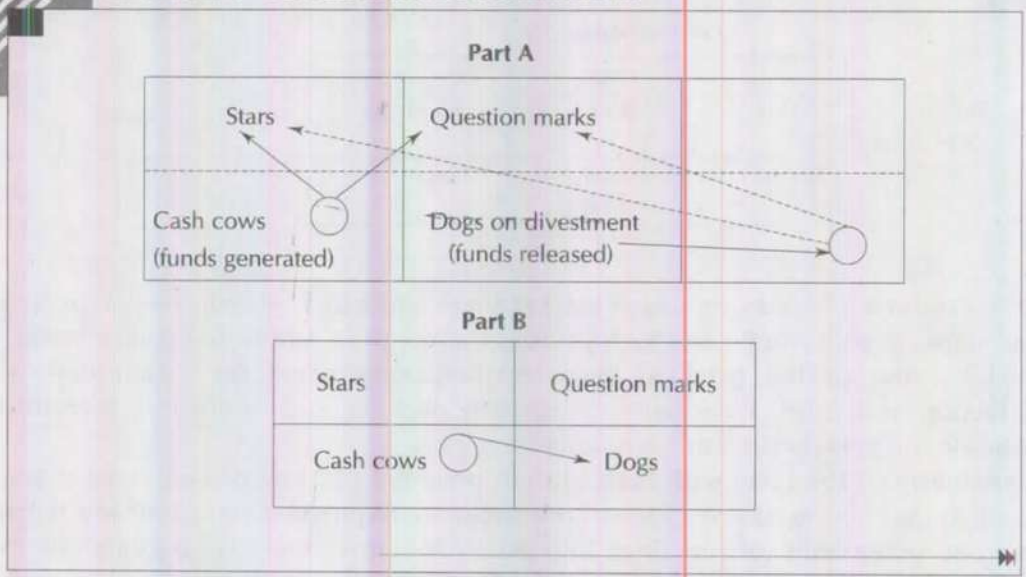
- *Stars* Products which enjoy a high market share and a high growth rate are referred to as stars. Though they earn high profits, they require additional commitment of funds because of the need to make further investments for expanding their production and sales. Eventually, as growth declines and additional investment needs diminish, stars become cash cows.
- *Question marks* Products with high growth potential but low present market share are called question marks. Additional resources are required to improve their market share and potentially convert them into stars. Of course, there is no guarantee that this would happen—that is why they are called 'question marks'.
- *Cash cows* Products which enjoy a relatively high market share but low growth potential are called cash cows. They generate substantial profits and cash flows but their investment requirements are modest. The cash surpluses provided by them are available for use elsewhere in the business.
- *Dogs* Products with low market share and limited growth potential are referred to as dogs. Since the prospects for such products are bleak, it is advisable to phase them out rather than continue with them.

From the above description, it is broadly clear that cash cows generate funds and dogs, if divested, release funds. On the other hand, stars and question marks require further commitment of funds. Hence, the suggested pattern of resource allocation should be as shown in Part A of Exhibit 2.4. Conscious efforts should be made to avoid the pattern of resource allocation depicted in Part B of Exhibit 2.4. Some firms unwittingly adopt this pattern which leads to the neglect of stars and question marks and to the misdirection of surplus funds generated by cash cows into futile efforts to revive dogs.

General Electric's Stoplight Matrix

The General Electric Company of US is widely respected for the sophistication, maturity, and quality of its planning systems. The matrix developed by this company for guiding resource allocation is called the General Electric's Stoplight Matrix. It calls for analysing

Exhibit 2.4 ***Pattern of Resource Allocation***



various products (or services) of the firm in terms of two key issues:

Business strength How strong is the firm vis-à-vis its competitors?

Industry attractiveness What is the attractiveness or potential of the industry?

The commitment of funds to various products is guided by how they are rated in terms of the above two dimensions. As shown in Exhibit 2.5, products which are favourably placed justify substantial commitment of funds. Products which are unfavourably placed call for divestment, and products which are placed in between qualify for modest investment.

Exhibit 2.5 ***General Electric's Stoplight Matrix***

Industry Attractiveness	Business Strength: *Strong*	*Average*	*Weak*
High	Invest	Invest	Hold
Medium	Invest	Hold	Divest
Low	Hold	Divest	Divest

Evaluation

Though widely used, portfolio planning models, like the BCG matrix, tend to oversimplify the analysis of alternatives. For example, issues become more complex if the matrix is expanded to cover the possibilities of moderate market share and moderate potential market growth rate. Likewise, if factors other than profit returns and investment requirements are considered, greater complications arise. Notwithstanding these limitations, the basic idea of classifying products in terms of market share and potential market growth rate is very powerful. It helps the management in asking the right questions and examining relevant strategies.

2.4 STRATEGIC POSITION AND ACTION EVALUATION (SPACE)

SPACE is an approach to hammer out an appropriate strategic posture for a firm and its individual businesses. An extension of the two-dimensional portfolio analysis, SPACE involves a consideration of four dimensions:

- Company's competitive advantage
- Company's financial strength
- Industry strength
- Environmental stability

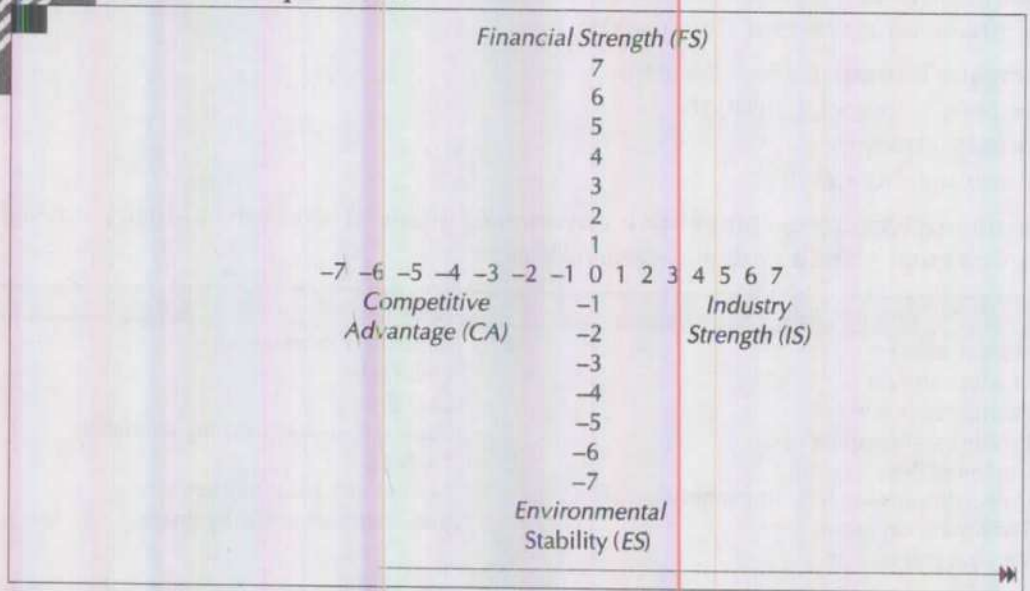
The factors determining competitive advantage, financial strength, industry strength, and environmental stability are shown as follows:

Company's competitive advantage	*Company's financial strength*
Market share	Return on investment
Product quality	Leverage
Product life cycle	Liquidity
Product replacement cycle	Capital required / capital available
Customer loyalty	Cash flow
Competition's capacity utilisation	Ease of exit from market
Technological know-how	Risk involved in the business
Vertical integration	
Industry strength	***Environmental stability***
Growth potential	Technological changes
Profit potential	Rate of inflation
Financial stability	Demand variability
Technological know-how	Price range of competing products
Resource utilisation	Barriers to entry into market
Capacity intensity	Competitive pressure
Ease of entry into market	Price elasticity of demand
Productivity, capacity utilisation	

To apply the SPACE approach to a firm, the following procedure may be followed:

1. Numerically assess the firm on the factors which have a bearing on the four dimensions. The scale of assessment for the factors relating to the dimensions of *company's financial strength* and *industry strength* may be 0 to 7, with 0 reflecting the most unfavourable assessment and 7 the most favourable. However, the scale of assessment for the factors relating to the dimensions of *environmental stability* and *company's competitive advantage* may be 0 to –7, with 0 reflecting the most favourable assessment and –7 the most unfavourable.
2. Average the numerical values assigned for various factors relating to a given dimension to get the numerical score for the dimension.
3. Plot the scores for the four dimensions on the axes of the SPACE chart. The SPACE chart is shown in Exhibit 2.6.
4. Connect the scores so plotted to get a four-sided polygon, reflecting the size and direction of the assessment.

Exhibit 2.6 *Space Chart*



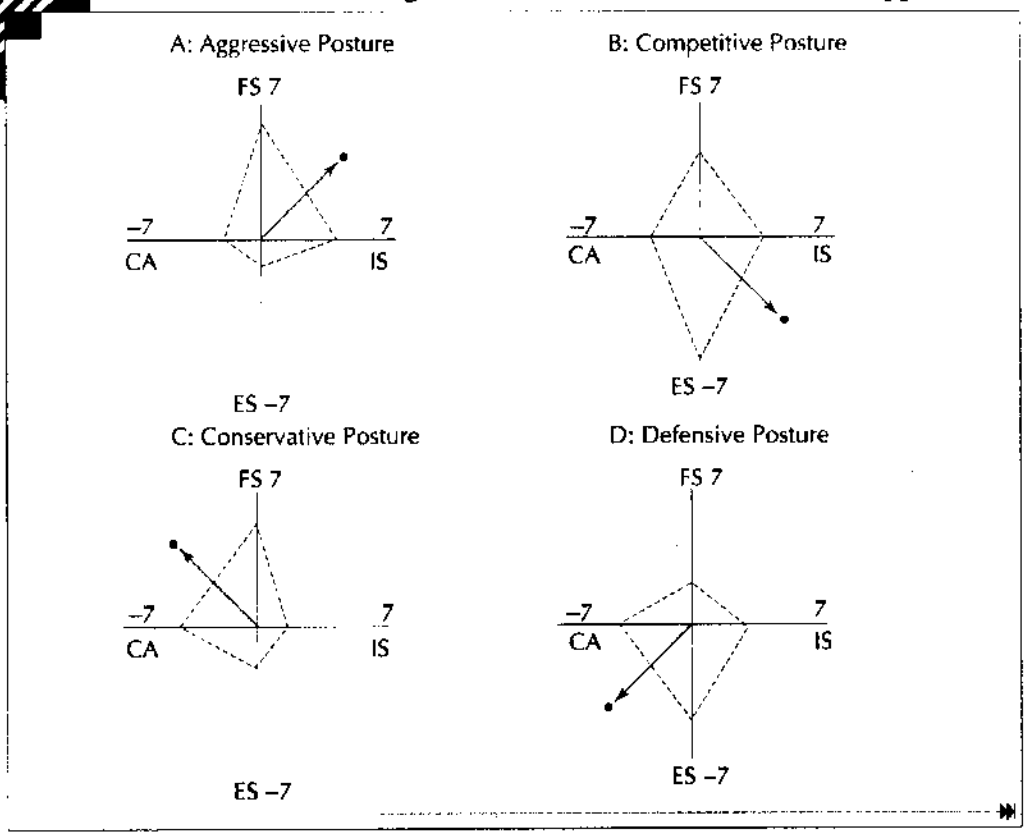
Strategic Postures

The basic strategic postures associated with the SPACE approach, illustrated graphically in Exhibit 2.7, are as follows:

Aggressive Posture This is appropriate for a company which (i) enjoys a competitive advantage and considerable financial strength and (ii) belongs to an attractive industry that operates in a relatively stable environment. An aggressive posture means that the firm

must fully exploit opportunities available to it, seriously look for acquisition possibilities in its own or related industries, concentrate resources to maintain its competitive edge, and enhance its market share. The aggressive posture is similar to the generic strategy of *overall cost leadership* suggested by Michael Porter.

Exhibit 2.7 ***Basic Strategies Postures Associated with SPACE Approach***



Competitive Posture This is suitable for a company which (i) enjoys a competitive advantage but has limited financial strength, and (ii) belongs to an attractive industry operating in a relatively unstable environment. The key planks of the competitive posture are as follows: maintain and enhance competitive advantage by product improvement and differentiation, widen the product line, improve marketing effectiveness, and augment financial resources. There is a great deal of commonality between the competitive posture described here and the generic strategy of *product differentiation* suggested by Michael Porter.

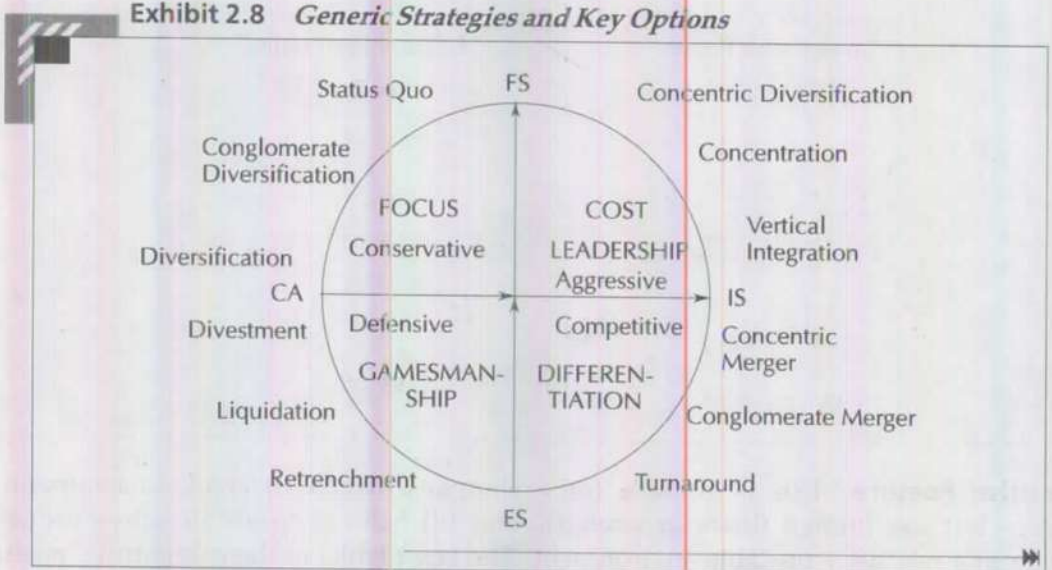
Conservative Posture This is appropriate for a company which (i) enjoys financial strength but has limited competitive advantage, and (ii) belongs to a not-so-attractive industry operating in a relatively stable environment. A conservative posture calls for the following

actions: prune non-performing products, reduce costs, improve productivity, develop new products, and access more profitable markets. The conservative posture described here is somewhat similar to the generic strategy of *focus* suggested by Michael Porter.

Defensive Posture This is suitable for a company which (i) lacks competitive advantage as well as financial strength, and (ii) belongs to a not-so-attractive industry operating in an unstable environment. A defensive posture involves the following actions: discontinue unviable products, control costs aggressively, monitor cash flows strictly, reduce capacity, and postpone or limit investments. The defensive posture so defined may be likened to gamesmanship which calls for employing manoeuvres to keep the company afloat, check the onslaught of competition, and eventually facilitate withdrawal or exit.

The generic strategies and the key options (which have important resource allocation implications) associated with them are shown in Exhibit 2.8. This is drawn from the book *Strategic Management—A Methodological Approach* by A.J. Rowe, R.O. Mason, and K.E. Dickel (Reading, Massachusetts, Addison-Wesley Publishing Company, 1986).

Exhibit 2.8 ***Generic Strategies and Key Options***



2.5 DIVERSIFICATION DEBATE

Conglomerate diversification, which involves diversification into unrelated areas, is very common in India. Here are some examples:

Company	*Field of diversification*
Metal Box	Ball bearings

Company	*Field of diversification*
Larsen & Toubro	Shipping
ITC	Hotel
Escorts	Dry dock
WIPRO	Computers
Bharat Vijay Mills	Syntex tanks
Oswal Agro	Petrochemicals

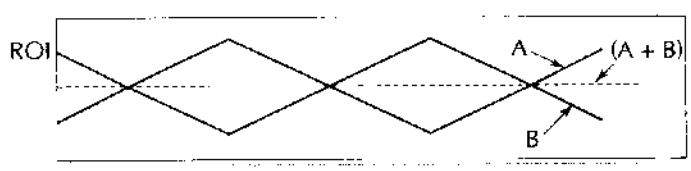
Despite its popularity, conglomerate diversification is considered to be a highly controversial investment strategy. This section examines various facets of conglomerate diversification.

Pros and Cons of Conglomerate Diversification

The proponents of conglomerate diversification argue that it helps a company in reducing its overall risk exposure. As most of the businesses are characterised by cyclicality it is desirable that there are at least two to three distinct lines of business in a firm's portfolio. As someone put it vividly "If you have three legs to your firm, you enjoy a reasonable degree of stability". This is simply another way of saying that don't put all your eggs in the same basket. The risk-reduction benefit of conglomerate diversification is depicted pictorially in Exhibit 2.9. This exhibit shows the behaviour of ROI (return on investment, which is simply profit divided by investment) for (i) business A, (ii) business B (whose ROI is perfectly negatively correlated with that of business A), and (iii) a portfolio consisting of A and B with equal weightages for them.

Another advantage claimed for conglomerate diversification is that it expands opportunities for growth. If the opportunities in the existing business are limited because of some kind of saturation, it is natural to look at other businesses where growth opportunities exist. Typically, such opportunities are more in newly emerging industries and hence there may be a justification to diversify into these fields which may be very different from the firm's existing businesses. While the prospects of succeeding in the new line of business are often uncertain, the immense potential acts as an irresistible bait. It naturally allures firms which have strong growth-orientation. Such firms continually look for opportunities to 'widen their options' in a dynamic industrial environment.

Exhibit 2.9 ***Diversification and Risk Reduction***



Though a good device for reducing risk exposure and widening growth possibilities, conglomerate diversification more often than not tends to dampen average profitability. Michael Gort[1] who conducted a study for the National Bureau of Economic Research in the US found that unrelated diversification is not positively correlated with profitability. In their classic work, Peters and Waterman[2] argued that organisations which stick very close to their original business outperform others and organisations which diversify into unrelated areas tend to underperform others. Echoing a similar view, Richard Rumelt in a widely quoted research study[3] reached the following conclusion "Companies which branch out somewhat yet stick very close to their central skill, outperform all others."

International Experience in Conglomerate Diversification

In the 1960s and 1970s, the wave of diversification swept the industrial world in the western countries. During this period the proportion of Fortune 500 companies which were diversified or outright conglomerates increased from 50 percent to 80 percent. Likewise, in the US, this proportion went up from 40 percent to 60 percent. The factors which seemed responsible for this swing in favour of diversification were:

- A desire to add second and third legs to one's company to overcome cyclical fluctuations.
- The argument of the Boston Consulting group that no company was safe unless it had a portfolio consisting of at least three different kinds of businesses.
- An inexorable desire of many companies to gradually get out of certain industries and move into newer ones.
- Existence of role models like Harold Geneen who presided over a gigantic corporate conglomerate.
- Influence of Theodore Levitt's doctrine that a company should redefine its business in a broad sense.

Back to Basics What happened in the 1980s? The experience of most of the companies which pursued the strategy of diversification in the 1960s and 1970s was that while they succeeded in related (or allied) diversification, they failed in unrelated (or conglomerate) diversification. Guided by this experience, many companies, particularly from the beginning of the 1980s, began shedding their once-coveted activities. Thirty three large US companies sold off by the middle of the1980s, more than one-half of their diversifications

1. Gort, Michael, *Diversification and Integration in American Industry*, Princeton, New Jersey: Princeton University Press, 1962.
2. Peters, Thomas J. and Robert H. Waterman, Jr. *In Search of Excellence: Lessons from America's Best-run Companies*, New York: Harper and Row, 1982.
3. Rumelt, R.P., *Strategy, Structure and Economic Performance*, Boston: Harvard Business School, 1974.

(via the takeover route) made between 1950 and 1980. Many companies seemed to be pursuing the strategy of going "back to basics". Here are some examples:

- United Biscuits dropped its fast food restaurants to concentrate on biscuits and food products.
- British Petroleum sold its world coal interests to concentrate on oil.
- Exxon divested Zilog, the last remnant of its decade long abortive attempt to expand in electronics.

Why Conglomerates Can Add Value in Emerging Markets

In western economies, corporate strategists have argued from the 1980s that the days of conglomerate companies are over and have preached the virtues of core competence and focus. Many conglomerates created in the 1960s and 1970s have been dismantled and restructured. By and large these initiatives have significantly enhanced corporate performance.

Management consultants and foreign investors have been persuading diversified business groups in emerging markets to imitate the practice of Western companies, reduce the scope of their activities, and focus on a few core businesses. Many Indian business groups have begun restructuring their business portfolio in conformity with this advice.

Khanna and Palepu[4], however, believe that while focus makes eminent sense in the West, conglomerates may have certain advantages in emerging markets which are characterised by many institutional shortcomings.

What are the institutional weaknesses in the emerging markets? How can conglomeration help in overcoming these shortcomings? The following discussion addresses these issues:

Product Markets Buyers and sellers in the emerging markets suffer from informational handicaps because of the following reasons: (a) The infrastructure for communication (postal services and telecommunication services) are often underdeveloped. (b) There are no reliable mechanisms in the form of independent consumer research outfits and governmental agencies to verify the claims of sellers. (c) Consumers do not have satisfactory redressal mechanisms when a product fails on its promises.

Due to lack of information, companies have to incur substantial costs for establishing credible brands. In such an environment, a conglomerate with a good track record has a natural advantage. As Tarun Khanna and Krishna Palepu argue: "A conglomerate with a reputation for quality products and services can use its group name to enter new businesses, even if those businesses are completely unrelated to its current lines." The cost incurred by a group to build a brand can be spread across multiple lines of business. Of

4. Khanna, Tarun and Krishna Palepu "Why Focused Strategies May Be Wrong for Emerging Markets" *Harvard Business Review*, July—August 1997.

course the group will have strong incentive not to spoil its brand quality in any business as it can have a negative impact on other businesses as well.

Capital Markets Capital markets in developing countries are underdeveloped in several ways: (a) Venture capital mechanisms are weak and inadequate. (b) The regulatory apparatus is deficient. (c) The quality of financial reporting is poor. (d) The community of investment analysts is small and not so well trained. (e) Financial press is often not very objective and professional.

In such an environment where investors may be reluctant to provide capital to new ventures, diversified groups with a good track record have an advantage as they can inspire confidence in investors. They enjoy superior ability to raise capital and this gives them a great edge over smaller companies. As Khanna and Palepu say: "Investors trust groups to evaluate new opportunities and to exercise an auditing and supervisory function. The groups thus become the conduit for large amounts of investment in their capital starved countries".

Labour Markets The major deficiencies characterising the labour markets in developing countries are: (a) There is often a shortage of well trained people. (b) Rigid laws prevent companies from retrenching manpower.

A conglomerate group can overcome problems by instituting training programmes to develop human capital, by shifting manpower from declining ventures to growing businesses, and by allocating scarce talent to units where it can be used optimally.

Regulation Despite liberalisation initiatives in recent years, governmental regulation over business activity is fairly extensive in developing countries. Often regulatory provisions give considerable discretion to bureaucrats.

A diversified conglomerate seems to have an advantage in coping with such a regulatory environment. As Khanna and Palepu say: "Diversified groups can add value by acting as intermediaries when their individual companies or foreign partners need to deal with regulatory bureaucracy. Experience and connections give conglomerates an advantage. The larger the company, the easier is it to carry the cost of maintaining government relationship."

Contract Enforcement Developing countries often lack effective contract enforcement mechanisms. Judicial processes are inordinately slow, and may be vitiated or capricious. As a consequence, companies may not be able to resolve disputes satisfactorily through the normal legal channel.

In such an environment, conglomerates who have built a reputation have an edge. As Khanna and Palepu argue: "In such situations, conglomerates can leverage reputations established... Because the misdeeds of one company in a group will damage the prospects of the others, all the group companies have credibility when they promise to honour their agreements with any single partner."

Compulsions for Conglomerate Diversification in India

Over the last two decades or so, a large number of companies in India have invested substantially in areas different from their traditional lines of business. The factors responsible for large scale moves in unrelated areas appear to be as follows:

- Restriction in growth in the existing line of business, often arising from governmental refusal to expansion proposals.
- Vulnerability to changes in governmental policies with respect to imports, duties, pricing, and reservations.
- Opening up of newer areas of investments in the wake of liberalisation.
- Cyclicality of the main line of business leading to wide fluctuations in sales and profits from year to year.
- Bandwagon mentality which has been induced by years of close regulation of industrial activity.
- Desire to avail of tax incentives mainly in the form of investment allowance and large initial depreciation write-offs.
- A self-image of venturesomeness and versatility prodding companies to prove themselves in newer fields.
- A need to widen future options by entering newly emerging industries where the potential seems enormous.

How to Reduce the Risks in Diversification

Diversification like other major business decisions, involves uncertainty. To reduce the risk of diversification, it has to be approached systematically and rationally. Markides[5] argues that the risk of diversification can be mitigated if managers ask the following questions:

What can our company do better than any of its competitors in its current market? Diversification is often based on a vague definition of business rather than on a systematic evaluation of what distinguishes a company from its competitors. By identifying what it excels at a company can improve the prospects of its success in new markets. As Markides says: "When facing the decision to diversify, however, managers need to think not about what their company does not but about what it does better than its competitors. In one sense, pinpointing strategic assets is a market driven approach to business definition." Put differently, the diversification decision has to be made on the basis of strategic assets like excellent distribution capabilities, or superior technical know-how, or talented and motivated manpower.

What strategic assets do we need in order to succeed in the new market? If a company excels in one market it does not mean that its success is assured in a new and related

5. Markides, Constantinos C., "To Diversify or not to Diversify," *Harvard Business Review*, November–December, 1997.

market. Managers evaluating a diversification proposal must ascertain whether their company has all the strategic assets required to gain a competitive advantage in the new market. As Markides says: "Although the question seems straightforward enough my research suggests that many companies make a fatal error. They assume that having some of the necessary strategic assets is sufficient to move forward with diversification. In reality a company usually must have all of them."

Can we catch up to or leapfrog competitors at their own game? A company need not despair if it lacks some critical strategic asset. It can perhaps buy what it lacks, or develop it or even render it redundant by altering the rules of competition. As an example, Markides cites the history of Sharp Corporation. To diversify into the field of television, Sharp licensed the television technology from RCA; to enter the business of microwave, Sharp acquired the technology by working with Litton; to enter the electronic calculator business, Sharp bought the technology from Rockwell.

Will diversification break up strategic assets that need to be kept together? Often companies employ their proven strategic assets in a new market and yet flounder. This generally happens because strategic assets that need to reinforce each other for producing results are separated. As Markides says: "Many companies introduce their time-tested strategic asset in a new market and still fail. That is because they have separated strategic assets that rely on one another for their effectiveness and hence are not able to function alone."

Will we be simply a player in the new market or will we emerge a winner? Competitors are likely to out-manoeuvre a diversifying company. They may imitate, or purchase, or even render unnecessary strategic assets on which the diversifying company may be betting heavily. As Markides says: "A company's competitive advantage will be short lived, and diversification will fail, if competitors in the new industry can imitate the company's move quickly and cheaply, purchase the necessary strategic assets in the open market, or find an effective substitute for them."

What can our company learn by diversifying, and are we sufficiently organised to learn it? Smart companies derive valuable lessons from their diversification initiatives. They use new businesses to improve existing businesses, to serve as launching pads for other business forays, and to enhance organisational efficiency. As Markides says: "Forward thinking managers not only will be concerned with success in new markets, but, like good chess players, also will be thinking two or three moves ahead."

Guidelines for Conglomerate Diversification

Conglomerate diversification, in general, dampens profitability and in some cases jeopardises the existence of the firm as it happened in the case of Metal Box. Yet there are many compulsions and inducements in India prompting companies to pursue the path of conglomerate diversification. Since it involves a journey into a relatively unfamiliar terrain

it should be viewed with circumspection. Here are some practical guidelines in this respect:

1. If you lack financial sinews to sustain the new project during the 'learning period', avoid grandiose diversification projects.
2. Realistically examine whether you have the critical skills and resources to succeed in the new line of business.
3. Ensure that the diversification project has a good fit in terms of technology and market with the existing business.
4. Try to be the first or a very early entrant in the field you are diversifying into. This will protect you from serious competitive threat in the initial years.
5. Where possible adopt the following sequence: marketing—substantial sub-contracting—full blown manufacturing.
6. Seek partnership of other firms in areas where you are vulnerable or competitively weak.
7. If the failure of the new project can threaten the company's existence, float a separate company to handle the new project.
8. Remember that meaningful conglomerate diversification represents the greatest challenge to corporate vision and leadership.
9. Guard against bandwagon mentality and empire-building tendencies.

Emerging Scenario in India

Historically most business groups in India diversified into a number of sectors, thanks to various inducements, compulsions and temptations. The heightening competition from the mid-1990s has forced many business houses to review and restructure their business portfolios. Given the benefits of diversification in an emerging market, the existence of shallow markets, and the obstacles in the way of selling and purchasing companies, it is unlikely that Indian firms will fully embrace the 'focus' model which has gained currency in the Western world from the early 1980s onward. Barring exceptions like Bajaj Auto, Asian Paints, and Ranbaxy Laboratories, most of the other companies will perhaps shed peripheral businesses, and focus on a few areas. This is reflected in the following views:

> **Harsh Goenka:** "My view is that we are all moving towards moderate focus: that is, a sizeable presence in four to six sectors. Not a vast array, but not just one or two."
>
> **B.K.Modi:** "One cannot achieve any kind of global size in a single product or sector; our markets are not big enough. You also run the risk of being swamped by global competition in a single sector."

2.6 INVESTMENT IN CAPABILITIES

Empirical evidence suggests that companies that perform well have organisational capabilities that enable them to exploit opportunities. What are these organisational capabilities? As Baldwin and Clark[6] say: "Organisational capabilities are combinations of

6. Baldwin, Carliss Y. and Clark, Kim. B. "Capabilities and Capital Investment: New Perspectives on Capital Budgeting," *Journal of Applied Corporate Finance*.

human skills, organisational procedures and routines, physical assets, and the systems of information and incentives that improve performance along particular dimensions. Such capabilities are indeed organisational assets."

They mention five specific capabilities which are briefly described below:

External Integration Capability This is the ability of the firm to link its understanding of customers with engineering design to develop improved products. As Baldwin and Clark say: "Companies with this capability develop products that match customers expectations down to the smallest details. The products not only satisfy customers but often surprise and delight them."

Internal Integration Capability Internal integration makes a company faster and more efficient in performing various functions like new product development, prototyping, facilities engineering, and capacity expansion. Without internal integration delays occur and costs mount. As Baldwin and Clark say: "In the absence of such internal integration, actions and decisions are taken first by the upstream functions and then by the downstream functions using the upstream group output. Typically the joint product will require two or more cycles of problem-solving to remedy the initial failures of coordination."

Flexibility Flexibility refers to the ability of the firm to do a variety of things and to respond quickly to changes. As Baldwin and Clark say: "Flexibility comes in many forms. A company may have the capability to manufacture a wide range of products and change its mix on short notice. It may have the ability to respond to changes in volume, or it may have the ability to introduce new products rapidly and efficiently."

The Capacity to Experiment Continuous improvement, a process referred to as *Kaizen* in Japanese, is often the key factor that drives productivity gains. Continuous improvement emanates from organisational learning which in turn requires experimentation. A firm's capacity to experiment depends on the investments it makes in developing knowledge, disseminating knowledge, and adopting the same in practice.

The Capacity to Cannibalise Cannibalisation involves introducing a new product that cuts into the sales of the existing products. An old rule of resource allocation prohibits cannibalisation because it seems to hurt the interest of the firm at least in the short run. However, many established firms have found that their disinclination to cannibalise provided opportunities to other companies to introduce new products. Hence it is imperative for a company to develop its capacity to cannibalise. Since cannibalisation is naturally resisted by the established hierarchy, the capacity to cannibalise has to be consciously developed.

Capabilities improve the value of a firm's investment. More specifically, external integration diminishes product risk; internal integration raises the probability of finding opportunities and lowers the cost of exploiting them; flexibility widens the options available to the firm to meet contingencies; the capacity to experiment brings about systematic improvements which reduce the cost over time; and the capacity to cannibalise enables a company to maintain its market position by warding off potential competitors.

Characteristics of Capabilities—Building Investments

Investments required to build capabilities have certain special characteristics. These are:

- Many of the outlays required are on things like common language and communication, human training and skill development, and support services. These are not ordinarily regarded as capital expenditure in many firms.
- Investments required to build a capability range widely in scale and scope.
- While costs of building capabilities are visible and appear on someone's budget, the benefits are derived by the company as a whole and occur only after a time lag.

Due to these characteristics, investment in capabilities in most organisations is done outside the financial system of resource allocation. However, this is not a satisfactory arrangement. As Baldwin and Clark say: "Unfortunately overriding the formal resource allocation system creates as many problems as it solves. When top managers short-circuit the system they do little to encourage capabilities investments at lower levels in the organisation."

Allocating Resources to Build Capabilities

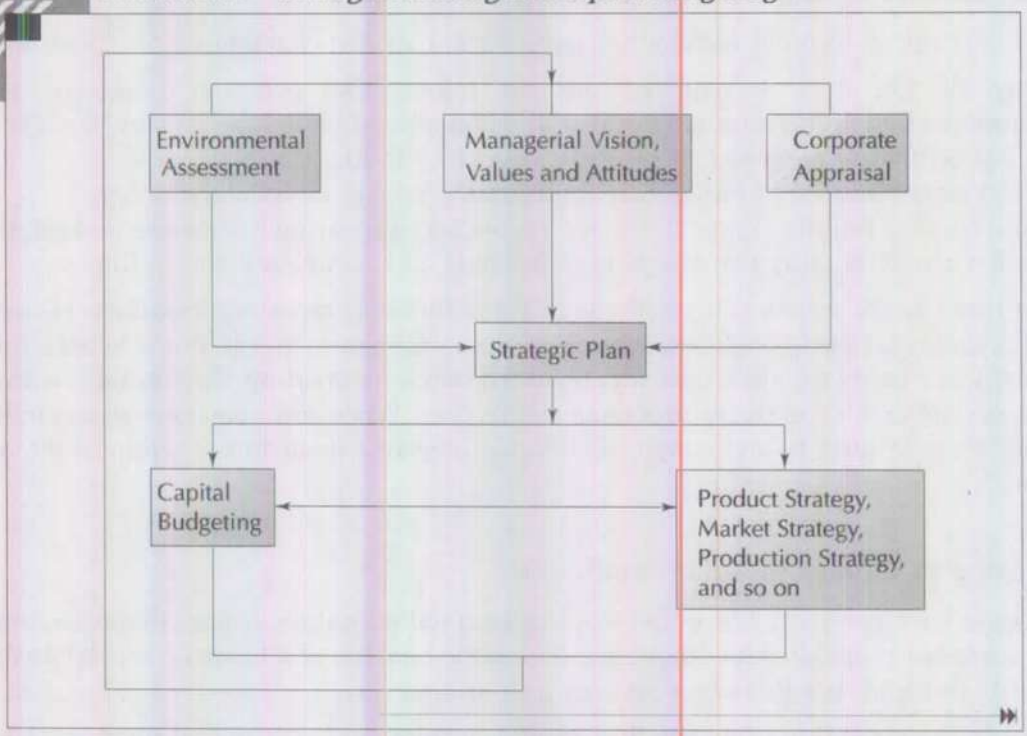
The challenge for a company lies in developing a capital allocation system that accommodates investment in capabilities without sacrificing the benefits of a formal financial analysis. Towards this end, the following actions are required:

- Identify the capabilities that the firm should develop and ensure that there is a firm organisational commitment to them.
- Develop a capital budget for capabilities and a proper system of authorisation and accounting for expenditures relating to capabilities.
- Translate the desired capabilities into appropriate goals and rewards that are clearly understood and used by people throughout the organisation.
- Link compensation of managers to improvements in speed, quality, and flexibility, which are the outcomes of capabilities.

2.7 STRATEGIC PLANNING AND CAPITAL BUDGETING

Capital expenditures, particularly the major ones, are supposed to subserve the strategy of the firm. Hence, the relationship between strategic planning and capital budgeting must be properly recognised. Exhibit 2.10 presents a way of defining this relationship. As emphasised in this exhibit, capital budgeting should be squarely related to corporate strategy.

Exhibit 2.10 *Strategic Planning and Capital Budgeting*



SUMMARY

- The resource allocation framework of the firm, which shapes, guides, and circumscribes individual project decisions, addresses two key issues: What should be the strategic posture of the firm? What pattern of resource allocation subserves the chosen strategic posture?
- Investment decisions, like most other business decisions, are guided by three key criteria: profitability, risk, and growth.
- The building blocks of the corporate resource allocation strategy are: replacement and modernisation, capacity expansion, vertical integration, concentric diversification, conglomerate diversification, and divestment.
- To guide the process of strategic planning and resource allocation, several portfolio planning tools have been developed. Two such tools are: (a) the BCG Product Portfolio Matrix, and (b) the General Electric Stoplight Matrix.
- The BCG Product Portfolio Matrix analyses products on the basis of (a) relative market share, and (b) industry growth rate. It classifies products into four broad categories, viz., stars, questions marks, cash cows, and dogs.
- The General Electric Stoplight Matrix calls for analysing various products of the firm in terms of two key dimensions: business strength and industry attractiveness.

- SPACE is an approach to hammer out an appropriate strategic posture for a firm and its individual businesses. An extension of the two-dimensional portfolio analysis, SPACE involves a consideration of four dimensions: company's competitive advantage, company's financial strength, industry strength, and environmental stability.
- Conglomerate diversification, which involves diversification into unrelated areas, is a very popular but highly controversial investment strategy. Though a good device for reducing risk exposure and widening growth possibilities, conglomerate diversification more often than not tends to dampen average profitability.
- In Western economies, corporate strategists have argued from the 1980s that the days of conglomerates are over and have preached the virtues of core competence and focus. Many conglomerates created in the 1960s and 1970s have been dismantled and restructured. By and large these initiatives have significantly enhanced corporate performance. Tarun Khanna and Krishna Palepu, however, believe that while focus makes eminent sense in the West, conglomerates may have certain advantages in emerging markets which are characterised by many institutional shortcomings.
- Empirical evidence suggests that companies that perform well have organisational capabilities that enable them to exploit opportunities. According to Baldwin and Clark there are five specific organisational capabilities: external integration capability; internal integration capability; flexibility; capacity to experiment; and capacity to cannibalise.
- The challenge for a company lies in developing a capital allocation system that accommodates investment in capabilities without sacrificing the benefits of a formal financial analysis.
- Capital expenditures, particularly the major ones, are supposed to subserve the strategy of the firm. Hence, the relationship between strategic planning and capital budgeting must be properly recognised.

Questions

1. Discuss the criteria of profitability, risk, and growth.
2. List and describe the various elementary investment strategies.
3. Explain the nature of the following portfolio planning tools: (a) BCG Product Portfolio Matrix, and (b) General Electric Stoplight Matrix.
4. Explain the procedure to be followed while applying the SPACE approach to a firm.
5. Discuss the basic postures associated with the SPACE approach.
6. What are the pros and cons of conglomerate diversification?
7. What has been the international experience in conglomerate diversification?

8. How can conglomeration help in overcoming the institutional weaknesses in the emerging markets?
9. What are the compulsions for conglomerate diversification in India?
10. How can the risks of diversification be reduced?
11. What guidelines should be borne in mind while pursuing the path of conglomerate diversification?
12. Discuss the organisational capabilities that enable firms to exploit opportunities.
13. What should be done to develop a capital allocation system that accommodates investment in capabilities?
14. Define the linkage between strategic planning and capital budgeting.

CHAPTER 3

Generation and Screening of Project Ideas

The search for promising project ideas is the first step towards establishing a successful venture. As the traditional adage goes, the key to success lies in getting into the right business at the right time. While this advice is simple, its accomplishment is difficult because good business opportunities tend to be elusive. Identification of such opportunities requires imagination, sensitivity to environmental changes, and realistic assessment of what the firm can do. The task is partly structured, partly unstructured; partly dependent on convergent thinking, partly dependent on divergent thinking; partly requiring objective analysis of quantifiable factors, partly requiring subjective evaluation of qualitative factors; partly amenable to control, partly dependent on fortuitous circumstances.

Identification is often the outcome of a triggering process rather than an analytical exercise. While the notion of identification is simple, it is difficult to develop methods or procedures for accomplishing it as there is no well defined theory to guide this task. And as Gordon and Pinches observed: "These difficulties become more severe as one moves up the hierarchy of organisational decision-making levels because of the relative uniqueness (non-routineness) of higher level decisions as compared to lower level decisions."[1]

With this note of caution, this chapter discusses certain broad considerations and guidelines helpful in the generation and screening of project ideas. The objective is to identify

1. Gordon, Lawrence A. and George E. Pinches, *Improving Capital Budgeting: A Decision Support System Approach*, Reading, Massachusetts: Addison-Wesley Publishing Co., 1984, p. 36.

investment opportunities which are *prima facie* feasible and promising and which merit further examination and appraisal. The discussion is divided into nine sections as follows:

- Generation of ideas
- Monitoring the environment
- Corporate appraisal
- Profit potential of industries: Porter model
- Scouting for project ideas
- Preliminary screening
- Project rating index
- Sources of positive net present value
- On being an entrepreneur

3.1 GENERATION OF IDEAS

Barring truly new ideas which are based on significant technological breakthroughs, most of the project ideas involve combining existing fields of technology or offering variants of present products or services. The typical route may be described as follows: Someone with specialised technical knowledge or marketing expertise or some other competence feels that he can offer a product or service which can cater to a presently unmet need or serve a market where demand exceeds supply or effectively compete with similar products or services because of certain favourable features like better quality or lower prices. His ideas are endorsed by his associates who encourage him and even show willingness to collaborate with him on the proposal. Finally he receives support from financial institutions and banks that approve his project and show readiness to finance it.

Stimulating the Flow of Ideas

Often firms adopt a somewhat casual and haphazard approach to the generation of project ideas. To stimulate the flow of ideas, the following are helpful:

SWOT Analysis SWOT is an acronym for strengths, weaknesses, opportunities, and threats. SWOT analysis represents a conscious, deliberate, and systematic effort by an organisation to identify opportunities that can be profitably exploited by it. Periodic SWOT analysis facilitates the generation of ideas.

Clear Articulation of Objectives The operational objectives of a firm may be one or more of the following:

- Cost reduction
- Productivity improvement
- Increase in capacity utilisation
- Improvement in contribution margin
- Expansion into promising fields

A clear articulation and prioritisation of objectives helps in channelising the efforts of employees and prods them to think more imaginatively.

Fostering a Conducive Climate To tap the creativity of people and to harness their entrepreneurial urges, a conducive organisational climate has to be fostered. Two conspicuous examples of organisations which have been exceptionally successful in tapping the creativity of employees are the Bell Telephone Laboratory and the 3 M Corporation. While the former has succeeded in harnessing creativity by providing an unconstrained environment the latter has effectively nurtured the entrepreneurial urges of its employees. At a more mundane level, many organisations (Hindustan Lever is a prominent example in India) have successfully used suggestion schemes to motivate employees to think more creatively.

3.2 MONITORING THE ENVIRONMENT

Basically a promising investment idea enables a firm (or entrepreneur) to exploit opportunities in the environment by drawing on its competitive strengths. Hence, the firm must systematically monitor the environment and assess its competitive abilities. For purposes of monitoring, the business environment may be divided into six broad sectors, as shown in Exhibit 3.1. The important aspects studied in monitoring the key sectors of the environment are as follows:

Economic Sector

- State of the economy
- Overall rate of growth
- Growth rate of primary, secondary, and tertiary sectors
- Cyclical fluctuations
- Linkage with the world economy
- Trade surplus/deficits
- Balance of payment situation

Governmental Sector

- Industrial policy
- Government programmes and projects
- Tax framework
- Subsidies, incentives, and concessions
- Import and export policies
- Financing norms
- Lending conditions of financial institutions and commercial banks

Technological Sector

- Emergence of new technologies
- Access to technical know-how, foreign as well as indigenous
- Receptiveness on the part of industry

Socio-demographic Sector

- Population trends
- Age shifts in population
- Income distribution
- Educational profile
- Employment of women
- Attitudes toward consumption and investment

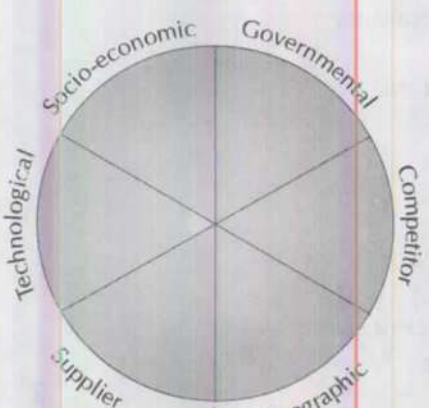
Competition Sector

- Number of firms in the industry and the market share of the top few (four or five)
- Degree of homogeneity and differentiation among products
- Entry barriers
- Comparison with substitutes in terms of quality, price, appeal, and functional performance
- Marketing policies and practices

Supplier Sector

- Availability and cost of raw materials and sub-assemblies

Exhibit 3.1 ***Business Environment***



- Availability and cost of energy
- Availability and cost of money

3.3 CORPORATE APPRAISAL

A realistic appraisal of corporate strengths and weaknesses is essential for identifying investment opportunities which can be profitably exploited. The broad areas of corporate appraisal and the important aspects to be considered under them are as follows:

Marketing and Distribution

- Market image
- Product line
- Market share
- Distribution network
- Customer loyalty
- Marketing and distribution costs

Production and Operations

- Condition and capacity of plant and machinery
- Availability of raw materials, sub-assemblies, and power
- Degree of vertical integration
- Locational advantage
- Cost structure

Research and Development

- Research capabilities of the firm
- Track record of new product developments
- Laboratories and testing facilities
- Coordination between research and operations

Corporate Resources and Personnel

- Corporate image
- Clout with governmental and regulatory agencies
- Dynamism of top management
- Competence and commitment of employees
- State of industrial relations

Finance and Accounting

- Financial leverage and borrowing capacity
- Cost of capital
- Tax situation
- Relations with shareholders and creditors
- Accounting and control system
- Cash flows and liquidity

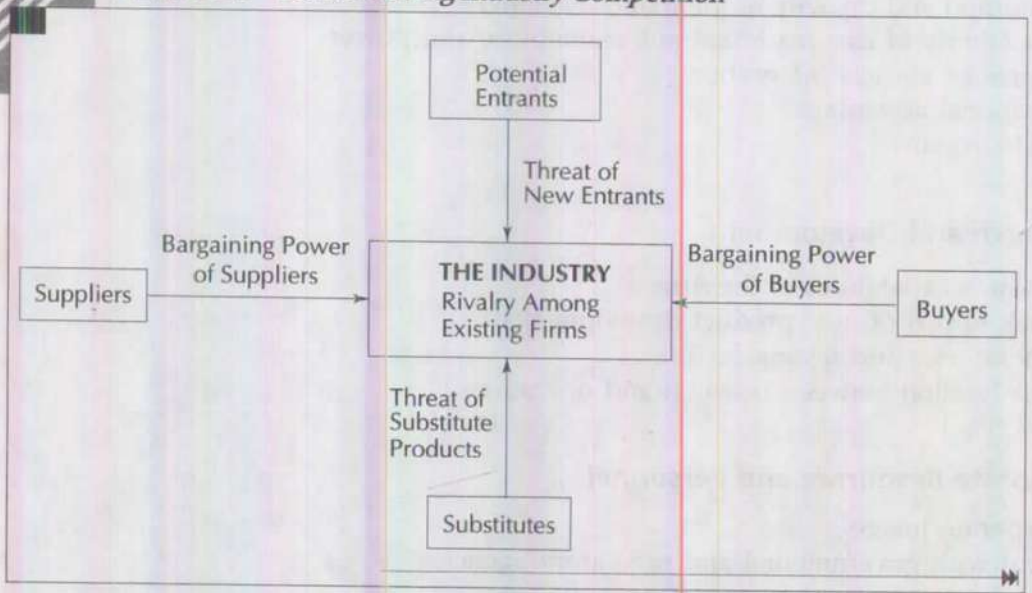
3.4 PROFIT POTENTIAL OF INDUSTRIES : PORTER MODEL

Michael Porter[2] has argued that the profit potential of an industry depends on the combined strength of the following five basic competitive forces:

- Threat of new entrants
- Rivalry among existing firms
- Pressure from substitute products
- Bargaining power of buyers
- Bargaining power of sellers

Exhibit 3.2 diagrammatically shows the forces that drive competition and determine industry profit potential.

Exhibit 3.2 *Forces Driving Industry Competition*



2. Porter, Michael E.,*Competitive Strategy: Techniques for Analysing Industries and Competitors*, The Free Press, 1980.

Threat of New Entrants

New entrants add capacity, inflate costs, push prices down, and reduce profitability. Hence, if an industry faces the threat of new entrants, its profit potential would be limited. The threat from new entrants is low if the entry barriers confer an advantage on existing firms and deter new entrants. Entry barriers are high when:

- The new entrants have to invest substantial resources to enter the industry.
- Economies of scale are enjoyed by the industry.
- Existing firms control the distribution channels, benefit from product differentiation in the form of brand image and customer loyalty, and enjoy some kind of proprietary experience curve.
- Switching costs—these are essentially one-time costs of switching from the products of one supplier to another—are high.
- The government policy limits or even prevents new entrants.

Rivalry between Existing Firms

Firms in an industry compete on the basis of price, quality, promotion, service, warranties, and so on. Generally, a firm's attempts to improve its competitive position provoke retaliatory action from others. If the rivalry between the firms in an industry is strong, competitive moves and countermoves dampen the average profitability of the industry. The intensity of rivalry in an industry tends to be high when:

- The number of competitors in the industry is large.
- At least a few firms are relatively balanced and capable of engaging in a sustained competitive battle.
- The industry growth is sluggish, prodding firms to strive for a higher market share.
- The level of fixed costs is high, generating strong pressures for all firms to achieve a higher capacity utilisation level.
- There is chronic over capacity in the industry.
- The industry's product is regarded as a commodity or near-commodity, stimulating strong price and service competition.
- The industry confronts high exit barriers.

Pressure from Substitute Products

In a way, all firms in an industry face competition from industries producing substitute products. Performing the same function as the original product, substitute products may limit the profit potential of the industry by imposing a ceiling on the prices that can be charged by the firms in the industry. The threat from substitute products is high when:

- The price-performance trade off offered by the substitute products is attractive.
- The switching costs for prospective buyers are minimal.

- The substitute products are being produced by industries earning superior profits.

Bargaining Power of Buyers

Buyers are a competitive force. They can bargain for price cut, ask for superior quality and better service, and induce rivalry among competitors. If they are powerful, they can depress the profitability of the supplier industry. The bargaining power of a buyer group is high when:

- Its purchases are large relative to the sales of the seller.
- Its switching costs are low.
- It poses a strong threat of backward integration.

Bargaining Power of Suppliers

Suppliers, like buyers, can exert a competitive force in an industry as they can raise prices, lower quality, and curtail the range of free services that they provide. Powerful suppliers can hurt the profitability of the buyer industry. Suppliers have strong bargaining power when:

- Few suppliers dominate and the supplier group is more concentrated than the buyer group.
- There are hardly any viable substitutes for the products supplied.
- The switching costs for the buyers are high.
- Suppliers do present a real threat of forward integration.

3.5 SCOUTING FOR PROJECT IDEAS

Good project ideas—the key to success—are elusive. So a wide variety of sources should be tapped to identify them. Here are some suggestions in this regard.

Analyse the Performance of Existing Industries A study of existing industries in terms of their profitability and capacity utilisation can indicate promising investment opportunities—opportunities which are profitable and relatively risk-free. An examination of capacity utilisation of various industries provides information about the potential for further investment. Such a study becomes more useful if it is done regionwise, particularly for products which have high transportation costs.

Examine the Inputs and Outputs of Various Industries An analysis of the inputs required for various industries may throw up project ideas. Opportunities exist when (i) materials, purchased parts, or supplies are presently being procured from distant sources with attendant time lag and transportation cost, and (ii) several firms produce internally some components/parts which can be supplied at a lower cost by a single manufacturer who can

enjoy economies of scale. Similarly, a study of the output of the existing industries may reveal opportunities for adding value through further processing of the main outputs, by-products, as well as waste products. (Remember that one person's trash can be another person's treasure.)

Review Import and Exports An analysis of import statistics for a period of five to seven years is helpful in understanding the trend of imports of various goods and the potential for import substitution. Indigenous manufacture of goods currently imported is advantageous for several reasons: (i) it improves the balance of payments situation, (ii) it generates employment, and (iii) it provides a market for the supporting industries and services. Likewise, an examination of export statistics is useful in learning about the export possibilities of various products.

Study Plan Outlays and Governmental Guidelines The government plays a very important role in our economy. Its proposed outlays in different sectors provide useful pointers toward investment opportunities. They indicate the potential demand for goods and services required by different sectors.

A very valuable source of information to estimate the scope for further investment is the *Guidelines to Industries* published annually by the Department of Industrial Development, Government of India. This publication provides information about the structure and location, production performance, licensed and installed capacity, exports, and future scope of various industries.

While the governmental projections are often a good starting point, they must be viewed with some caution. Often they are not well-grounded. It is helpful to remember the words of Alvin Hanson: " No one reading the plans can fail to be impressed by the frequent unrealism of these assumptions. So much appears to be contingent on the realisation of the unrealisable."

Look at the Suggestions of Financial Institutions and Developmental Agencies In a bid to promote development of industries in their respective states, state financial corporations, state industrial development corporations, and other developmental bodies conduct studies, prepare feasibility reports, and offer suggestions to potential entrepreneurs. The suggestions of these agencies are helpful in identifying promising projects.

Investigate Local Materials and Resources A search for project ideas may begin with an investigation into local resources and skills. Various ways of adding value to locally available materials may be examined. Similarly, the skills of local artisans may suggest products that may be profitably produced and marketed.

The National Council of Applied Economic Research (NCAER) and other bodies publish surveys of various regions showing the potential of industrial development in various regions. These surveys assess the resources (human and material), infrastructural facilities, and markets for various products.

Analyse Economic and Social Trends A study of economic and social trends is helpful in projecting demand for various goods and services. Changing economic conditions and consumer preferences provide new business opportunities. For example, a greater awareness of the value of time is dawning on the public. Hence, the demand for time-saving products like prepared food items, ovens, and powered vehicles has been increasing. Another change that can be seen is the increasing desire for leisure and recreational activities. This has caused a growth in the market for recreational products and services.

Study New Technological Developments There is a large network of research laboratories in India under the umbrella of the Council of Scientific and Industrial Research and other bodies. New products or new processes and technologies for existing products developed by research laboratories may be examined for profitable commercialisation.

Draw Clues from Consumption Abroad Entrepreneurs willing to take higher risks may identify projects for the manufacture of products or supply of services which are new to the country but extensively used abroad. Automatic vending machines, entertainment parks, pre-fabricated houses, and fast food restaurants are examples of projects belonging to this category.

Explore the Possibility of Reviving Sick Units Industrial sickness is rampant in the country. There are innumerable units which have been characterised as sick. These units are either closed or face the prospect of closure. A significant proportion of sick units, however, can be nursed back to health by sound management, infusion of further capital, and provision of complementary inputs. Hence, there is a fairly good scope for investment in this area. Such investments typically have a shorter gestation period because one does not have to begin from scratch. Indeed, in many cases marginal efforts would suffice to revive such units.

Identify Unfulfilled Psychological Needs For well-established, multi-brand product groups like bathing soap, detergents, cosmetics, and toothpaste, the question to be asked is not whether there is an opportunity to manufacture something to satisfy an actual physical need but whether there are certain psychological needs of the consumers which are presently unfulfilled. To find out whether such an opportunity exists, the technique of spectrum analysis is useful. This analysis is done in the following manner: (i) Important factors influencing brand choice are identified. (ii) Existing brands in the market are positioned on a continuum in respect of the factors identified in step (i). (iii) Gaps which exist in relation to consumer psychological needs are identified.

Attend Trade Fairs National and international trade fairs provide an excellent opportunity to get to know about new products and developments.

Stimulate Creativity for Generating New Product Ideas New product ideas may be generated by thinking along the following lines: Modification, Rearrangement, Reversal, Magnification, Reduction, Substitution, Adaptation and Combination.

Hope that the Chance Factor will Favour You[3] Identification of investment opportunity may be influenced by the chance factor. Two examples may be given here.

- Nrupendar Rao and KVK Raju on a visit to the Bokaro Steel Plant learnt that the steel plant was about to lose a 60,000 tonne order for hot rolled coils from a subsidiary of General Motors mainly because of sub-standard packaging. General Motors had then suggested to Bokaro managers that they use Signode packaging systems. This incident led to a plan to set up an industry to cater to packaging needs.
- Joseph Kamoo, while working in Zurich, once witnessed two Muslims almost come to blows over the correct direction to face while offering their prayers. Triggered by this incident, Kamoo thought of manufacturing a Mecca-finder.

3.6 PRELIMINARY SCREENING

By using the suggestions made in the preceding section, it is possible to develop a long list of project ideas. Some kind of preliminary screening is required to eliminate ideas which *prima facie* are not promising. For this purpose, the following aspects may be looked into:

- Compatibility with the promoter
- Consistency with governmental priorities
- Availability of inputs
- Adequacy of market
- Reasonableness of cost
- Acceptability of risk level

Compatibility with the Promoter

The idea must be compatible with the interest, personality, and resources of the entrepreneur. According to Murphy, a real opportunity has three characteristics: (i) It fits the personality of the entrepreneur—it squares with his abilities, training, and proclivities. (ii) It is accessible to him. (iii) It offers him the prospect of rapid growth and high return on the invested capital.

Consistency with Governmental Priorities

The project idea must be feasible given the national goals and governmental regulatory framework. The questions to be raised in this context are:

- Is the project consistent with national goals and priorities?
- Are there any environmental effects contrary to governmental regulations?
- Can the foreign exchange requirements of the project be easily accommodated?

3. This suggestion is made in a semi-humorous vein.

- Will there be any difficulty in obtaining the licence for the project?

Availability of Inputs

The resources and inputs required for the project must be reasonably assured. To assess this, the following questions need to be answered:

- Are the capital requirements of the project within manageable limits?
- Can the technical know-how required for the project be obtained?
- Are the raw materials required for the project available domestically at a reasonable cost? If the raw materials have to be imported, will there be problems?
- Is the power supply for the project reasonably obtainable from external sources and captive power sources?

It may be noted here that Indian business has been traditionally faced with (i) shortages of certain inputs like power, foreign exchange, and important raw materials, and (ii) fluctuating supplies of agricultural raw materials like cotton, jute and oil seeds.

Of course, in recent times the situation has improved in some ways (i) power generation has increased significantly, (ii) foreign exchange is now available more easily, and (iii) supplies of certain basic industrial raw materials have been augmented substantially. However, the supply situation of power, coal, and transport facilities still leaves much to be desired.

Adequacy of the Market

The size of the present market must offer the prospect of adequate sales volume. Further, there should be a potential for growth and a reasonable return on investment. To judge the adequacy of the market the following factors have to be examined:

- Total present domestic market
- Competitors and their market shares
- Export markets
- Quality-price profile of the product vis-à-vis competitive products
- Sales and distribution system
- Projected increase in consumption
- Barriers to the entry of new units
- Economic, social, and demographic trends favourable to increased consumption
- Patent protection

It may be emphasised here that barring recessionary aberrations, the demand for most of the products in India has been growing secularly. This trend will continue because of the low levels of per capita consumption in India. Fortunately, from the point of view of entrepreneurs, the Indian economy unlike most developed, western economies, is not a "share shift" economy wherein the growth in demand for a product is likely to be at the expense of the demand for others.

Reasonableness of Cost

The cost structure of the proposed project must enable it to realise an acceptable profit with a price. The following should be examined in this regard:

- Cost of material inputs
- Labour costs
- Factory overheads
- General administration expenses
- Selling and distribution costs
- Service costs
- Economies of scale

Acceptability of Risk Level

The desirability of a project is critically dependent on the risk characterising it. In the assessment of risk—a difficult task, indeed—the following factors should be considered:

- Vulnerability to business cycles
- Technological changes
- Competition from substitutes
- Competition from imports
- Governmental control over price and distribution[4]

3.7 PROJECT RATING INDEX

When a firm evaluates a large number of project ideas regularly, it may be helpful to streamline the process of preliminary screening. For this purpose, a preliminary evaluation may be translated into a project rating index. The steps involved in determining the project rating index are as follows:

4. It may be noted here that operational controls have been imposed from time to time on business firms in India. These controls, concerned mainly with production, distribution, price and exports, have been applied to a wide range of industries: steel, aluminium, paper, cement, fertilisers, tyres, trucks, automobiles, pharmaceuticals, textiles, bicycles, sugar, and vanaspati. The present approach of the government—it may be noted that the history of controls imposed by the government reveals a varied and chequered pattern—appears to have three main features: (i) The government is not as control-conscious as it was in the past. This is evident from the relaxation—total or partial—of several controls in recent years. (ii) The government seems to favour partial control. In many cases a part of production is being reserved to be supplied to certain sectors at a fixed, concessional price and the remaining is allowed to be sold at the market price. (iii) In price fixation, the government has shown a better responsiveness to inflationary forces.

- Identify factors relevant for project rating.
- Assign weights to these factors (the weights are supposed to reflect their relative importance).
- Rate the project proposal on various factors, using a suitable rating scale. (Typically a 5-point scale or a 7-point scale is used for this purpose.)
- For each factor, multiply the factor rating with the factor weight to get the factor score.
- Add all the factor scores to get the overall project rating index.

Exhibit 3.3 illustrates the determination of the project rating index. Once the project rating index is determined, it is compared with a pre-determined hurdle value to judge whether the project is *prima facie* worthwhile or not.

Exhibit 3.3 ***Construction of a Rating Index***

Factor	Factor Weight	Rating					Factor Score
		VG 5	G 4	A 3	P 2	VP 1	
Input availability	0.25			✓			0.75
Technical know-how	0.10		✓				0.40
Reasonableness of cost	0.05		✓				0.20
Adequacy of market	0.15	✓					0.75
Complementary relationship with other products	0.05		✓				0.20
Stability	0.10		✓				0.40
Dependence on firm's strength	0.20	✓					1.00
Consistency with governmental priorities	0.10			✓			0.30
						Rating Index	4.00

3.8 SOURCES OF POSITIVE NET PRESENT VALUE

It is often taken for granted that there is an abundance of positive *NPV* projects which can be identified rather easily. However, note that choosing positive *NPV* projects is akin to selecting under-valued securities using fundamental analysis. The latter is possible if there are imperfections in the financial market that cause a discrepancy between security prices and their equilibrium values (intrinsic values). Likewise, imperfections in real markets (product and factor markets) lead to entry barriers which cause positive *NPV*s. Hence, an understanding of entry barriers is helpful in identifying positive *NPV* projects.

It appears that there are six main entry barriers that result in positive *NPV* projects which are as follows:

- Economies of scale
- Product differentiation
- Cost advantage
- Marketing reach
- Technological edge
- Government policy

Economies of Scale Economies of scale means that an increase in the scale of production, marketing, or distribution results in a decline in the cost per unit. When substantial economies of scale are present, the existing firms are likely to be large in size. The more pronounced the economies of scale, the greater the cost advantage of the existing firms.

In order to exploit the economies of scale, new entrants require a substantial investment in plant and machinery, research and development, and market development. Such capital needs serve as an entry barrier. The greater the capital requirement, the higher the barrier to entry. This seems to be especially true in industries like petroleum refining, mineral extraction, iron and steel, and aluminium.

Product Differentiation A firm can create an entry barrier by successfully differentiating its products from those of its rivals. The basis for differentiation may be one or more of the following:

- Effective advertising and superior marketing
- Exceptional service
- Innovative product features
- High quality and dependability

Cost Advantage If a firm can enjoy cost advantage vis-à-vis its competitors, it can be reasonably assured of earning superior returns. Cost advantage may stem from one or more of the following:

- Accumulated experience and comparative edge on the learning curve
- Monopolistic access to low cost materials
- A favourable location
- More effective cost control and cost reduction

Marketing Reach A penetrating marketing reach is an important source of competitive advantage. Two examples illustrate this:

- Avon Products markets its products through a worldwide network of 1,300,000 independent sales representatives. Avon's competitors find it almost impossible to replicate this. Thanks to such a nonpareil marketing network, Avon has been able to earn superior returns in a highly competitive industry.

- The breadth and depth of Hindustan Lever's distribution network is miles ahead of its competitors. Such a marketing reach has contributed to the superior returns earned by Hindustan Lever.

Technological Edge Technological superiority enables a firm to enjoy excellent returns. Firms like IBM and Xerox earned superior returns over extended periods of time due to *inter alia*, the technological edge they had over their rivals. On the Indian scene, firms like Dr. Reddy's Laboratory and Hero Honda have substantially outperformed their competitors because of their technological strength.

Government Policy A government policy which shelters a firm from the onslaught of competition enables it to earn superior returns. Government policies that create entry barriers, partial or absolute, include the following:

- Restrictive licensing
- Import restrictions
- High tariff walls
- Environmental controls
- Special tax reliefs

A number of firms in India benefited substantially from restrictive government policies which offered considerable protection to them from potential competition, domestic as well as foreign, for many years. The liberalisation measures of recent years have, of course, dismantled, partly or substantially, entry barriers stemming from earlier government policies. Remember that what the government can give, it can also take away.

3.9 ON BEING AN ENTREPRENEUR

Many persons have an entrepreneurial urge to set up their own project and be on their own. Hence, it may not be out of place here to discuss the questions every entrepreneur must answer and the qualities and traits of a successful entrepreneur.

The Questions Every Entrepreneur Must Answer

According to Amar Bhide[5] the following are the questions that every entrepreneur must answer:

(i) Are my goals well defined?
- Personal aspirations
- Business sustainability and size
- Tolerance for risk

5. Bhide, Amar. "The Questions Every Entrepreneur Must Answer", *Harvard Business Review*, 1996.

(ii) Do I have the right strategy?
- Clear definition
- Profitability and potential for growth
- Durability
- Rate of growth

(iii) Can I execute the strategy?
- Resources
- Organisational infrastructure
- The founder's role

Qualities and Traits of a Successful Entrepreneur

What qualities and traits are required to be a successful entrepreneur? While it is difficult to answer this question definitively, it appears that a successful entrepreneur has the following qualities and traits:

- Willingness to make sacrifices
- Leadership
- Decisiveness
- Confidence in the project
- Marketing orientation
- Strong ego

Willingness to Make Sacrifices A new venture is often plagued with numerous difficulties and unanticipated problems. To nurture it in such an inhospitable environment, the entrepreneur has to be prepared to sacrifice his time, energy, and resources. He must be willing to struggle, sacrificing personal comforts and conveniences, against seemingly endless odds. An entrepreneurial job is not like a typical nine-to-five executive job. It tends to be far more demanding, requiring total commitment—and sometimes, even obsessive preoccupation—on the part of the entrepreneur.

Leadership Successful entrepreneurs generally have strong leadership qualities. They are able to inspire ordinary persons to accomplish great feats. Even though outwardly they may show bizarre signs (they may be whimsical, timid, or even cantankerous) they are able to fire people with their zeal. They have the flair for galvanising their team to successfully cope with the challenges and frustrations inherent in a new venture.

Decisiveness A fledgling enterprise has to accomplish many things in an atmosphere of uncertainty. Numerous decisions have to be taken in quick succession on the basis of limited information. The firm does not have a history to fall back on or a well-organised data base to rely upon. Unless the entrepreneur is decisive by nature, he would not be able to cope with the enormous burden of decision making. If he procrastinates, he may court disaster. If he dilly-dallies, he may miss valuable opportunities. The fluid situation of a

new enterprise calls not only for an ability to decide quickly but also an ability to revise the decisions to adapt the enterprise to an environment in which it has not established proper moorings.

Confidence in the Project An entrepreneur should have unbounded faith in his project. This helps him in instilling confidence in suppliers, creditors, customers, employees, and others. Without unflinching conviction in the project, it would be difficult for the entrepreneur to withstand the failures and frustrations that form the new venture diet.

Marketing Orientation A strong marketing orientation is critical to a new venture. An entrepreneur who is skillful in exploiting market opportunities has the best chance of success. Irrespective of the professional guise he wears (whether it be that of an engineer, inventor, production technologist, accountant, or any other), the entrepreneur must have marketing talent. Edwin Land of Polaroid is widely recognised as an ideal example of disguised marketing talent. Land, an engineering genius, had superior marketing skills and perhaps this was the most critical factor in the outstanding success of Polaroid. Land could inspire the technical and financial world, thanks to his marketing abilities. If an entrepreneur lacks marketing skills, he must find a partner who can remedy this deficiency. Otherwise the venture will be severely handicapped because of its inability to exploit the marketing opportunities.

Strong Ego Setting up a new enterprise is like riding an emotional roller coaster. There are days which bring jubilation and there are days which cause despondency, as the enterprise is buffeted by environmental forces, which tend to have a strong influence on the nascent venture. The entrepreneur needs a strong ego to bear with such ups and downs. To endure periods of adversity and to maintain a proper perspective when events cast a shadow over the enterprise, the entrepreneur needs a strong identity and self-image.

SUMMARY

- Identification of promising investment opportunities requires imagination, sensitivity to environmental changes, and a realistic assessment of what the firm can do.
- To stimulate the flow of investment ideas, the following are helpful: (i) SWOT analysis, (ii) clear articulation of objectives, and (iii) conducive climate.
- The business environment, which needs to be monitored regularly to identify investment opportunities, may be divided into six broad sectors: economic sector, government sector, technological sector, socio-demographic sector, competition sector, and supplier sector.
- A realistic appraisal of corporate strengths and weaknesses is essential for identifying investment opportunities which can be profitably exploited. The broad areas of corporate appraisal are: market and distribution, production and operations, research and development, corporate resources and personnel, and finance and accounting.

- According to Michael Porter the profit potential of an industry depends on the combined strength of the following five basic competitive forces (i) threat of new entrants, (ii) rivalry among existing firms, (iii) pressure from substitute products, (iv) bargaining power of buyers, and (v) bargaining power of sellers.
- Good project ideas—the key to success—are elusive. So a wide variety of sources should be tapped to identify them. Here are some suggestions in this regard: analyse the performance of existing industries, examine the inputs and outputs of various industries, review imports and exports, study plan outlays and governmental guidelines, look at the suggestions of financial institutions and developmental agencies, investigate local materials and resources, analyse economic and social trends, study new technological developments, draw clues from consumption abroad, explore the possibility of reviving sick units, identify unfulfilled psychological needs, attend trade fairs, stimulate creativity for generating new product ideas, and hope that the chance factor will favour you.
- By using the above suggestions, it is possible to develop a long list of project ideas. For the preliminary screening of these ideas, the following aspects may be looked into: compatibility with the promoter, consistency with governmental priorities, availability of inputs, adequacy of market, reasonableness of cost, and acceptability of risk level. When a firm evaluates a large number of project ideas regularly, it may he helpful to streamline the process of preliminary screening by employing a project rating index.
- It appears that there are six main entry barriers which result in positive *NPV* projects: economies of scale, product differentiation, cost advantage, marketing reach, technological edge, and government policy.
- Every entrepreneur must answer the following questions: Are my goals well defined? Do I have the right strategy? Can I execute the strategy?
- It appears that a successful entrepreneur has the following qualities and traits: willingness to make sacrifices, leadership, decisiveness, confidence in the project, marketing orientation, and a strong ego.

Questions

1. **What can a firm do to stimulate the flow of project ideas?**
2. **Describe briefly the aspects of a business environment that need to be monitored as well as the dimensions along which a firm may appraise its strengths and weaknesses for identifying investment opportunities.**
3. **Discuss suggestions helpful in scouting for project ideas.**
4. **What key issues would you examine in a preliminary screening exercise?**
5. **Discuss how a project rating index may be developed.**
6. **What qualities and traits are required to be a successful entrepreneur?**
7. **Discuss the sources of positive *NPV*.**

PART II

Analysis

4. Market and Demand Analysis
5. Technical Analysis
6. Financial Estimates and Projections

CHAPTER 4

Market and Demand Analysis

In most cases, the first step in project analysis is to estimate the potential size of the market for the product proposed to be manufactured (or service planned to be offered) and get an idea about the market share that is likely to be captured. Put differently, market and demand analysis is concerned with two broad issues: What is the likely aggregate demand for the product/service? What share of the market will the proposed project enjoy?

These are very important, yet difficult, questions in project analysis. Intelligent and meaningful answers to them call for an in-depth study and assessment of various factors like patterns of consumption growth, income and price elasticity of demand, composition of market, nature of competition, availability of substitutes, reach of distribution channels, so on and so forth. Yet, in many cases project feasibility studies seem to make a short shrift of market and demand analysis. It is not uncommon to find cursory statements like "the market is attractive" or "the demand is expected to exceed supply" as substitutes for a thorough market and demand analysis in project evaluation exercises.

Given the importance of market and demand analysis, it should be carried out in an orderly and systematic manner. The key steps involved in market and demand analysis are depicted in Exhibit 4.1. This chapter discusses these steps. It is organised into seven sections as follows:

- Situational analysis and specification of objectives
- Collection of secondary information
- Conduct of market survey
- Characterisation of the market
- Demand forecasting
- Uncertainties in demand forecasting
- Market planning

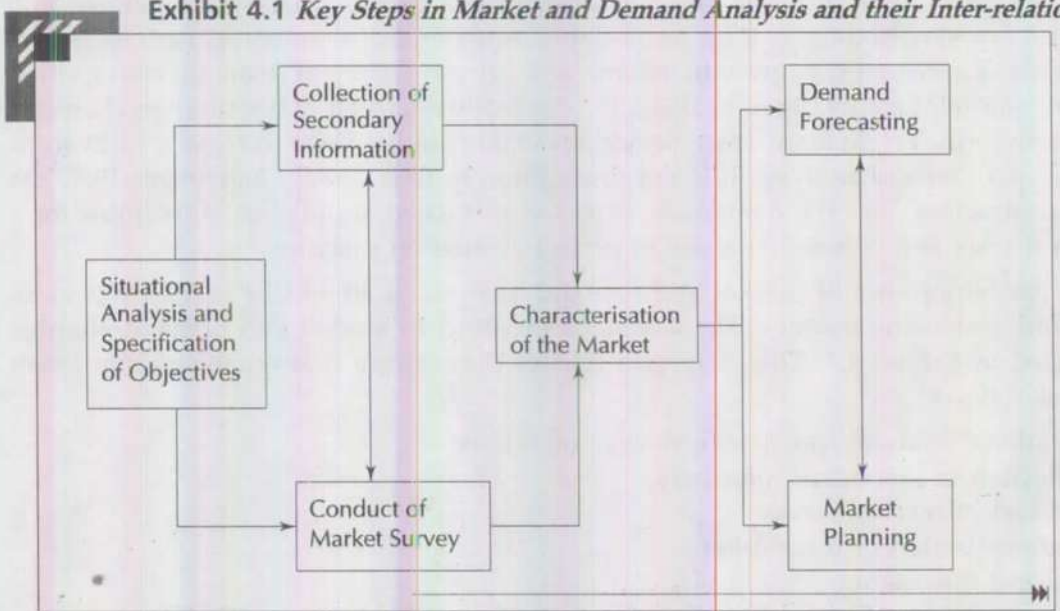
4.1 SITUATIONAL ANALYSIS AND SPECIFICATION OF OBJECTIVES

In order to get a "feel" of the relationship between the product and its market, the project analyst may informally talk to customers, competitors, middlemen, and others in the industry. Wherever possible, he may look at the experience of the company to learn about the preferences and purchasing power of customers, actions and strategies of competitors, and practices of the middlemen.

If such a situational analysis generates enough data to measure the market and get a reliable handle over projected demand and revenues, a formal study need not be carried out, particularly when cost and time considerations so suggest. In most cases, of course, a formal study of the market and demand is warranted. To carry out such a study, it is necessary to spell out its objectives clearly and comprehensively. Often this means that the intuitive and informal goals that guide situational analysis need to be expanded and articulated with greater clarity. A helpful approach to spell out objectives is to structure them in the form of questions. Of course, in doing so, always bear in mind how the information generated will be relevant in forecasting the overall market demand and in assessing the share of the market that the project will capture. This will ensure that questions not relevant to the market and demand analysis will not be asked unnecessarily.

To illustrate, suppose that a small but technologically competent firm has developed an improved air cooler based on a new principle that appears to offer several advantages over the conventional air cooler. The chief executive of the firm needs information about

Exhibit 4.1 ***Key Steps in Market and Demand Analysis and their Inter-relationships***



where and how to market the new air cooler. The objectives of the market and demand analysis in this case may be to answer the following questions:

- Who are the buyers of air coolers?
- What is the total current demand for air coolers?
- How is the demand distributed temporally (pattern of sales over the year) and geographically?
- What is the break-up of demand for air coolers of different sizes?
- What price will the customers be willing to pay for the improved air cooler?
- How can potential customers be convinced about the superiority of the new cooler?
- What price and warranty will ensure its acceptance?
- What channels of distribution are most suited for the air cooler? What trade margins will induce distributors to carry it?
- What are the prospects of immediate sales?

4.2 COLLECTION OF SECONDARY INFORMATION

In order to answer the questions listed while delineating the objectives of the market study, information may be obtained from secondary and/or primary sources. Secondary information is information that has been gathered in some other context and is already available. Primary information, on the other hand, represents information that is collected for the first time to meet the specific purpose on hand. Secondary information provides the base and the starting point for the market and demand analysis. It indicates what is known and often provides leads and cues for gathering primary information required for further analysis. This section looks at secondary information and the following at primary information.

General Sources of Secondary Information

The important sources of secondary information useful for market and demand analysis in India are mentioned below:

Census of India A decennial publication of the Government of India, it provides, *inter alia*, information on population, demographic characteristics, household size and composition, and maps.

National Sample Survey Reports Issued from time to time by the Cabinet Secretariat, Government of India, these reports present information on various economic and social aspects like patterns of consumption, distribution of households by the size of consumer expenditure, distribution of industries, and characteristics of the economically active population. The information presented in these reports is obtained from a nationally representative sample by the interview method.

Plan Reports Issued by the Planning Commission usually at the beginning, middle and end of the five-year plans, these reports and documents provide a wealth of information on plan proposals, physical and financial targets, actual outlays, accomplishments, etc.

Statistical Abstract of the Indian Union An annual publication of the Central Statistical Organisation, it provides, *inter alia*, demographic information, estimates of national income, and agricultural and industrial statistics.

India Year Book An annual publication of the Ministry of Information and Broadcasting, it provides a wide range of information on economic and other aspects.

Statistical Year Book An annual publication of the United Nations, it provides world statistics relating to various aspects like population, demography, gross domestic publication, industrial production, international trade, etc.

Economic Survey An annual publication of the Ministry of Finance, it provides the latest data on industrial production, wholesale prices, consumer prices, exports, agricultural production, national income, etc.

Guidelines to Industries This is an annual publication of the Ministry of Industrial Development.

Annual Survey of Industries An annual publication of the Central Statistical Organisation, it contains information on various aspects of industry: number of units and statewise distribution, average number of working days, employment, materials consumption, quantity of products, etc.

Annual Reports of the Development Wing, Ministry of Commerce and Industry An annual publication, it gives a detailed review of industries under the purview of the wing. It also provides information about new items manufactured for the first time in India and the list of protected industries.

Annual Bulletin of Statistics of Exports and Imports An annual publication of the Ministry of Commerce, it provides data on imports and exports for a very large number of items and as per international classification.

Techno-Economic Surveys The National Council of Applied Economic Research has conducted and published techno-economic surveys for various states.

Industry Potential Surveys The Industrial Development Bank of India in consortium with other financial institutions has conducted and published industrial potential surveys for several backward areas.

The Stock Exchange Directory This directory, published by the Bombay Stock Exchange, provides a ten-year picture of performance and financial statements for all listed compa-

nies and other important companies. It contains very valuable information for comparative analysis. It is periodically updated.

Monthly Studies of Production of Selected Industries A monthly publication of the Central Statistical Organisation, it provides all-India data on production, number of units installed, capacity, state-wise break-up, stock level, etc., for several selected industries.

Monthly Bulletin of Reserve Bank of India This provides information on production indices, prices, balance of payment position, exchange rates, etc.

Publications of Advertising Agencies The leading advertising agencies like Clarion, McCann and Thompson have published test markets, marketing rating indices of towns of India, consumer index of markets, and other studies which throw valuable light on Indian markets.

Other Publications Among other publications, a mention may be made of the following: (i) Weekly bulletin of Industrial Licences, Import Licences and Export Licences (published by the Government of India); (ii) Studies of the State Trading Corporation; (iii) Commodity reports and other studies of the Indian Institute of Foreign Trade; (iv) Studies and reports of export promotion councils and commodity boards; and (v) Annual Report on Currency and Finance (issued by the Reserve Bank of India).

Industry Specific Sources of Secondary Information

The important industry-specific sources of secondary information are given in Exhibit 4.2.

Evaluation of Secondary Information

While secondary information is available economically and readily (provided the market analyst is able to locate it), its reliability, accuracy, and relevance for the purpose under consideration must be carefully examined. The market analyst should seek to know:

- Who gathered the information? What was the objective?
- When was the information gathered? When was it published?
- How representative was the period for which the information was gathered?
- Have the terms in the study been carefully and unambiguously defined?
- What was the target population?
- How was the sample chosen?
- How representative was the sample?
- How satisfactory was the process of information gathering?
- What was the degree of sampling bias and non-response bias in the information gathered?
- What was the degree of misrepresentation by respondents?

Exhibit 4.2 ***Some Important Industry-Specific Sources of Secondary Information***

Industry	*Title*	*Publisher*
Automobiles	*Annual Reports of Association of Indian Automobile Manufacturers*	Indian Automobile Manufacturers Association, Army and Navy Bldg., Mahatma Gandhi Road, Mumbai 23
	Automobile Ancillary Industry (Yearly)	All India Automobile and Ancillary Industries Association, 80, Dr Annie Besant Road, Mumbai 18
Chemicals (including Fertilisers, Drugs and Pharmaceuticals)	*Fertiliser Statistics*	Fertiliser Association of India, JN University, New Delhi 57
	Annual Reports of Organisation of Pharmaceutical Producers of India	Organisation of Pharmaceutical Producers of India, Cook's Building, DN Road, Mumbai 1
	Indian Drugs and Pharmaceutical Industries	Chary Publications, 18B, Bharucha Marg, Mumbai 43
	Chemical Age of India	Technical Press Publications, 5 Convent Street, Mumbai 1
Electrical and Electronics	*Annual Electric Power Survey of India*	Central Electricity Authority, Government of India
	Annual Report of Indian Electrical Manufacturers Association	Indian Electrical Manufacturers Association, Hakad Chambers, Dr A. Besant Road, Mumbai 18
	Electric India (Fortnightly)	Indian Electrical Manufacturers Association, Hakad Chambers, Dr A. Besant Road, Mumbai 18
	Electronic Digest	All India Radio and Electronics Association, Sukh Sagar, NS Patkar Marg, Mumbai 7
	Electronics Information and Planning (Monthly)	Information, Planning and Analysis Group of Electronics Commission, New Delhi
Industrial Machinery	*Build Machine-Build India*	Directorate General of Technical Development, Chary Publications, 18B, Bharucha Marg, Mumbai 43
	Textile Machinery Accessories and Stores Journal	
	Annual Report of Indian Machine Tool Manufacturers Association	Indian Machine Tool Manufacturers Association, 82 Jolly Maker Chambers, No. 2, 225 Nariman Point, Mumbai 21
Metallurgical	*Iron and Steel Control Bulletin* (Quarterly)	Ministry of Steel and Mines
	Steel Furnace (Monthly)	Steel Furnace Association of India, 3/D, Vandana, 11 Tolstoy Marg, New Delhi 1
	Annual Reports of Steel Wire Manufacturers Association of India	Steel Wire Manufacturers Association of India, 6 N. Subhas Road, Kolkata 1

	Minerals and Metals Review	Asian Industry and Information Services (P) Ltd., Kolkata
	Annual Reports of Steel Re-rolling Mills Association	Steel Re-rolling Mills Association, C-50, Anand Niketan, New Delhi 23
Textiles	*Indian Textile Bulletin*	Textile Commissioner, Bombay
	Silk and Rayon Industries of India	Silk and Art Silk Mills Research Association, Dr A. Besant Road, Mumbai 18
	Wool and Woollens of India	Indian Woollen Mills Federation, Churchgate Chambers, 4 New Marine Lines, Mumbai 20
	Man-made Fibres	Association of Man-made Fibre Industry, 78 Veer Nariman Road, Mumbai 20
	Synthetic Fibres	Association of Synthetic Fibre Industry, Raj Mahal, 84 Veer Nariman Road, Mumbai 20
	Jute Chronicle	Indian Jute Mills Association, Royal Exchange, 9 N Subhas Road, Kolkata 1
	Monthly Summary of Jute and Gunny Statistics	Indian Jute Mills Association, Royal Exchange, 9 N Subhas Road, Kolkata 1
	Annual Reports of Indian Cotton Mills Federation	Indian Cotton Mills Federation, 34, P.D. Mello Road, Wadi Bunder, Mumbai 9
Other Industries	*Cement*	Cement Manufacturers Association, Express Building, Opp. Churchgate Rly Station, Mumbai 20
	Glass Udyog	All India Glass Manufacturers Federation 812, ND House, Barakhamba Road, New Delhi 1
	Hotel Guide-India	Federation of Hotel and Restaurant Association of India, 503/56, Nehru Place, New Delhi 24
	Indian Packaging Directory	Indian Institute of Packaging, E-2, Marol Industrial Estate, Mumbai 93
	Packaging India (Quarterly)	Indian Institute of Packaging, E-2, Marol Industrial Estate, Mumbai 93
	Rubber India	All India Rubber Industries Associataion, Navjivan Society Building, Lamington Road, Mumbai 8
	Statistics of Marine Products Exports	Marine Products Export Development Authority, M.Gandhi Road, Cochin 16
	Yearbook of Fishery Statistics	FAO, United Nations Organisation

- How accurately was the information edited, tabulated, and analysed?
- Was statistical analysis properly applied?

4.3 CONDUCT OF MARKET SURVEY

Secondary information, though useful, often does not provide a comprehensive basis for market and demand analysis. It needs to be supplemented with primary information gathered through a market survey, specific to the project being appraised.

The market survey may be a census survey or a sample survey. In a census survey, the entire population is covered. (The word 'population' is used here in a particular sense. It refers to the totality of all units under consideration in a specific study. Examples: All industries using milling machines, all readers of the *Economic Times*) *Census surveys* are employed principally for intermediate goods and investment goods when such goods are used by a small number of firms. In other cases a census survey is prohibitively costly and may also be infeasible. For example, it would be inordinately expensive—in fact almost impossible—to cover every user of Lifebuoy or every person in the income bracket Rs 10,000—15,000.

Due to the above mentioned limitations of the census survey, the market survey, in practice, is typically a *sample survey*. In such a survey a sample of population is contacted or observed and relevant information is gathered. On the basis of such information, inferences about the population may be drawn.

The information sought in a market survey may relate to one or more of the following:

- Total demand and rate of growth of demand
- Demand in different segments of the market
- Income and price elasticities of demand
- Motives for buying
- Purchasing plans and intentions
- Satisfaction with existing products
- Unsatisfied needs
- Attitudes toward various products
- Distributive trade practices and preferences
- Socio-economic characteristics of buyers

Steps in a Sample Survey

Typically, a sample survey consists of the following steps:

Define the Target Population In defining the target population the important terms should be carefully and unambiguously defined. The target population may be divided into

various segments which may have differing characteristics. For example, all television owners may be divided into three to four income brackets.

Select the Sampling Scheme and Sample Size There are several sampling schemes: simple random sampling, cluster sampling, sequential sampling, stratified sampling, systematic sampling, and non-probability sampling. Each scheme has its advantages and limitations. The sample size, other things being equal, has a bearing on the reliability of the estimates—the larger the sample size, the greater the reliability.

Develop the Questionnaire The questionnaire is the principal instrument for eliciting information from the sample of respondents. The effectiveness of the questionnaire as a device for eliciting the desired information depends on its length, the types of questions, and the wording of the questions. Developing the questionnaire requires a thorough understanding of the product/service and its usage, imagination, insights into human behaviour, appreciation of subtle linguistic nuances, and familiarity with the tools of descriptive and inferential statistics to be used later for analysis. It also requires knowledge of psychological scaling techniques if the same are employed for obtaining information relating to attitudes, motivations, and psychological traits. Industry and trade market surveys, in comparison to consumer surveys, generally involve more technical and specialised questions.

Since the quality of the questionnaire has an important bearing on the results of the market survey, the questionnaire should be tried out in a pilot survey and modified in the light of problems/difficulties noted.

Recruit and Train the Field Investigators Recruiting and training of field investigators must be planned well since it can be time consuming. Great care must be taken in recruiting the right kind of investigators and imparting the proper kind of training to them. Investigators involved in industry and trade market surveys need intimate knowledge of the product and technical background, particularly for products based on sophisticated technologies.

Obtain Information as per the Questionnaire from the Sample of Respondents Respondents may be interviewed personally, telephonically, or by mail for obtaining information. Personal interviews ensure a high rate of response. They are, however, expensive and likely to result in biased responses because of the presence of the interviewer. Mail surveys by snail mail or e-mail are economical and evoke fairly candid responses. The response rate, however, is often low. Telephonic interviews, common in western countries, have very limited applicability in India because telephone tariffs are high and telephone connections few.

Scrutinise the Information Gathered Information gathered should be thoroughly scrutinised to eliminate data which is internally inconsistent and which is of dubious validity. For example, a respondent with a high income and large family may say that he lives in a one room tenement. Such information, probably inaccurate, should be deleted. Sometimes data inconsistencies may be revealed only after some analysis.

Analyse and Interpret the Information Information gathered in the survey needs to be analysed and interpreted with care and imagination. After tabulating it as per a plan of analysis, suitable statistical investigation may be conducted, wherever possible and necessary. For purposes of statistical analysis, a variety of methods are available. These may be divided into two broad categories: parametric methods and non-parametric methods. Parametric methods assume that the variable or attribute under study conforms to some known distribution. Non-parametric methods do not presuppose any particular distribution.

Results of the data based on the sample survey will have to be extrapolated to the target population. For this purpose, appropriate inflationary factors, based on the ratio of the size of the target population to the size of the sample studies, will have to be used.

The statistical analysis of data should be directed by a person who has a good background in statistics as well as economics.

It may be emphasised that the results of the market survey can be vitiated by: (i) non-representativeness of the sample, (ii) imprecision and inadequacies in the questions, (iii) failure of the respondents to comprehend the questions, (iv) deliberate distortions in the answers given by the respondents, (v) inept handling of the interviews by the investigators, (vi) cheating on the part of the investigators, (vii) slip-shod scrutiny of data, and (viii) incorrect and inappropriate analysis and interpretation of data.

Some Problems

A market researcher in India has to contend with the following problems:

Heterogeneity of the Country Since it is impossible to cover all the states in an all India survey, the country has to be divided into broad territories going beyond the state boundaries. However, the heterogeneity of the country makes the task difficult. Presently, the research agencies divide the country in a way they think is appropriate. This causes problems in comparing the findings of different research agencies.

Multiplicity of Languages Related to the above difficulty is the problem of multiplicity of languages confronted by a research agency interested in conducting an all India survey.

Design of Questionnaire Scaling techniques, commonly recommended in marketing research literature, involve a 5-point scale or a 7-point scale. Such refined scales are not easily amenable to translation in regional languages. More important, they are often not comprehensible to a vast majority of respondents who may lack the education and sophistication to understand them. Hence when refined scaling techniques are used, answers tend to be erratic and inconsistent. It is perhaps desirable to rely more on open-ended questions and less on pre-coded questions on definite scales.

4.4 CHARACTERISATION OF THE MARKET

Based on the information gathered from secondary sources and through the market survey, the market for the product/service may be described in terms of the following:

- Effective demand in the past and present
- Breakdown of demand
- Price
- Methods of distribution and sales promotion
- Consumers
- Supply and competition
- Government policy

Effective Demand in the Past and Present

To gauge the effective demand in the past and present, the starting point typically is apparent consumption which is defined as:

Production + Imports – Exports – Changes in stock level

The figure of apparent consumption has to be adjusted for consumption of the product by the producers and the effect of abnormal factors. The consumption series, after such adjustments, may be obtained for several years.

In a competitive market, effective demand and apparent consumption are equal. However, in most of the developing countries, where competitive markets do not exist for a variety of products due to exchange restrictions and controls on production and distribution, the figure of apparent consumption may have to be adjusted for market imperfections. Admittedly, this is often a difficult task.

Breakdown of Demand

To get a deeper insight into the nature of demand, the aggregate (total) market demand may be broken down into demand for different segments of the market. Market segments may be defined by (i) nature of product, (ii) consumer group, and (iii) geographical division.

Nature of Product One generic name often subsumes many different products: steel covers sections, rolled products, and various semi-finished products; commercial vehicles, cover trucks and buses of various capacities; so on and so forth.

Consumer Groups Consumers of a product may be divided into industrial consumers and domestic consumers. Industrial consumers may be sub-divided industry-wise. Domestic consumers may be further divided into different income groups.

Geographical Division A geographical breakdown of consumers is helpful, particularly for products which have a small value-to-weight relationship and for products which require regular, efficient after-sales service.

Why is segmental analysis required? Segmental information is helpful because the nature of demand tends to vary from one segment to another. The demand from consumers in high income brackets may not be sensitive to price variations whereas the demand from consumers in low income brackets may be very sensitive to price variations and different marketing strategies may be appropriate for different market segments.

Price

Price statistics must be gathered along with statistics pertaining to physical quantities. It may be helpful to distinguish the following types of prices: (i) manufacturer's price quoted as FOB (free on board) price or CIF (cost, insurance, and freight) price, (ii) landed price for imported goods, (iii) average wholesale price, and (iv) average retail price.

Methods of Distribution and Sales Promotion

The method of distribution may vary with the nature of the product. Capital goods, industrial raw materials or intermediates, and consumer products tend to have different distribution channels. Likewise, methods used for sales promotion (advertising, discounts, gift schemes, etc.) may vary from product to product.

The methods of distribution and sales promotion employed presently and their rationale must be specified. Such a study may explain certain patterns of consumption and highlight the difficulties that may be encountered in marketing the proposed products.

Consumers

Consumers may be characterised along two dimensions as follows:

Demographic and sociological	*Attitudinal*
Age	Preferences
Sex	Intentions
Income	Habits
Profession	Attitudes
Residence	Responses
Social background	

Supply and Competition

It is necessary to know the existing sources of supply and whether they are foreign or domestic. For domestic sources of supply, information along the following lines may be gathered: location, present production capacity, planned expansion, capacity utilisation level, bottlenecks in production, and cost structure.

Competition from substitutes and near-substitutes should be specified because almost any product may be replaced by some other product as a result of relative changes in price, quality, availability, promotional effort, and so on.

Government Policy

The role of the government in influencing the demand and market for a product may be significant. Governmental plans, policies, and legislations, which have a bearing on the market and demand of the product under examination should be spelt out. These are reflected in: production targets in national plans, import and export trade controls, import duties, export incentives, excise duties, sales tax, industrial licensing, preferential purchases, credit controls, financial regulations, and subsidies/penalties of various kinds.

4.5 DEMAND FORECASTING

After gathering information about various aspects of the market and demand from primary and secondary sources, an attempt may be made to estimate future demand. A wide range of forecasting methods is available to the market analyst. These may be classified in three categories as shown in Exhibit 4.3. The methods listed in this exhibit are described in some detail below:

Exhibit 4.3 ***Methods of Demand Forecasting***

I **Qualitative Methods** These methods rely essentially on the judgment of experts to translate qualitative information into quantitative estimates. The important qualitative methods are:
- Jury of executive method
- Delphi method

II **Time Series Projection Methods** These methods generate forecasts on the basis of an analysis of the historical time series. The important time series projection methods are:
- Trend projection method
- Exponential smoothing method
- Moving average method

III **Causal Methods** More analytical than the preceding methods, causal methods seek to develop forecasts on the basis of cause–effect relationships specified in an explicit, quantitative manner. The important causal methods are:
- Chain ratio method
- Consumption level method
- End use method
- Leading indicator method
- Econometric method

Jury of Executive Opinion Method

This method, which is very popular in practice, involves soliciting the opinions of a group of managers on expected future sales and combining them into a sales estimate.

The *advantages* of this method are: (i) It is an expeditious method for developing a demand forecast. (ii) It permits a variety of factors like economic climate, competitive environment, consumer preferences, technological developments, and so on, to be included in the subjective estimates provided by the experts. (iii) It has immense appeal to managers who tend to prefer their judgment to mechanistic forecasting procedures.

The *disadvantages* of this method are: (i) The biases underlying subjective estimates cannot be unearthed easily. (ii) The reliability of this technique is questionable.

Delphi Method

This method is used for eliciting the opinions of a group of experts with the help of a mail survey. The steps involved in this method are:

1. A group of experts is sent a questionnaire by mail and asked to express their views.
2. The responses received from the experts are summarised without disclosing the identity of the experts, and sent back to the experts, along with a questionnaire meant to probe further the reasons for the extreme views expressed in the first round.
3. The process may be continued for one or more rounds till a reasonable agreement emerges in the view of the experts.

Delphi method appeals to many organisations for the following reasons: (i) It is intelligible to users. (ii) It seems to be more accurate and less expensive than the traditional face-to-face group meetings.

While the Delphi method is appealing, there are certain questions marks: What is the value of the expert opinion? What is the contribution of additional rounds and feedback to accuracy?

Trend Projection Method

The trend projection method involves (a) determining the trend of consumption by analysing past consumption statistics, and (b) projecting future consumption by extrapolating the trend.

When the trend projection method is used, the most commonly employed relationship is the linear relationship.

$$Y_t = a + bT \tag{4.1}$$

where Y_t = demand for year t
T = time variable
a = intercept of the relationship
b = slope of the relationship

To estimate the parameters a and b of the linear relationship, the least squares method is used. To illustrate the use of this method, the following demand data for a product will be used as shown in Exhibit 4.4.

Exhibit 4.4 ***Demand Data***

Year	Demand	Year	Demand
1988	10[1]	1995	20
1989	13	1996	22
1990	14	1997	23
1991	17	1998	22
1992	18	1999	24
1993	18	2000	24
1994	19	2001	25

For purposes of linear trend analysis, it is convenient to change the time axis as shown in Exhibit 4.5.

Exhibit 4.5 ***Change in Time Axis***

Actual Year	Year for Analysis	Actual Year	Year for Analysis
1988	0	1995	7
1989	1	1996	8
1990	2	1997	9
1991	3	1998	10
1992	4	1999	11
1993	5	2000	12
1994	6	2001	13

According to the least squares method, the linear relationship is chosen in such a manner that the sum of the squared deviations of the observations from the line is minimised. The parameters, a and b, of the linear relationship are estimated with the help of the following equations: [2]

1. In thousand units.
2. The equations for a and b are derived as follows. The sum of the squared deviations is

$$\Sigma(Y - a - bT)^2 \tag{1}$$

To minimise this with respect to a and b, the partial derivatives of this sum with respect to a and b are set equal to zero. This gives:

$$\frac{\partial}{\partial a}\Sigma(Y - a - bT)^2 = -2\,\Sigma(Y - a - bT) = 0 \tag{2}$$

$$\frac{\partial}{\partial b}\Sigma(Y - a - bT)^2 = -2\,T\,\Sigma(Y - a - bT) = 0 \tag{3}$$

From the above equations we get the following:

$$\Sigma Y = \Sigma(a + bT) \tag{4}$$

$$\Sigma TY = \Sigma(aT + bT^2) \tag{5}$$

Solving these two equations, referred to as normal equations, we get the values of a and b given in Eqns (4.2) and (4.3).

$$b = \frac{\Sigma TY - n\overline{T}\,\overline{Y}}{\Sigma T^2 - n\overline{T}^2} \tag{4.2}$$

$$a = \overline{Y} - b\,\overline{T} \tag{4.3}$$

The calculation of a and b, for our example, is shown in Exhibit 4.6. The least squares line is shown in Exhibit 4.7.

The *advantages* of the least squares method are: (i) It uses all the observations. (ii) The straight line is derived by an objective, statistical procedure. (iii) A measure of goodness of fit is available.

The *limitations* of the least squares method are: (i) The method is somewhat more complicated than the methods discussed earlier. (ii) The results of such an analysis are valid only when certain conditions are satisfied.

Exhibit 4.6 *Calculations in the Least Square Method*

T	Y	TY	T^2
0	10	0	0
1	13	13	1
2	14	28	4
3	17	51	9
4	18	72	16
5	18	90	25
6	19	114	36
7	20	140	49
8	22	176	64
9	23	207	81
10	22	220	100
11	24	264	121
12	24	288	144
13	25	325	169
$\Sigma T = 91$	$\Sigma Y = 269$	$\Sigma TY = 1998$	$\Sigma T^2 = 819$
$\overline{T} = 6.5$	$\overline{Y} = 19.21$		

$$b = \frac{\Sigma TY - n\overline{T}\,\overline{Y}}{\Sigma T^2 - n\overline{T}^2} = \frac{1998 - 1748.5}{819 - 591.5} = 1.097$$

$$a = \overline{Y} - b\,\overline{T} = 19.21 - 1.097 \times 6.5 = 12.08$$

where T = time

Y = demand

n = number of observations

$\overline{T}$ = mean of T

$\overline{Y}$ = mean of Y

a = intercept

b = slope

Apart from the linear relationship, the following relations are also used:

Exponential Relationship: $$Y_t = a\, e^{bt} \tag{4.4}$$

On logarithmic transformation this becomes:

$$\log Y_t = \log a + b\, t \tag{4.4a}$$

Polynomial Relationship: $$Y_t = a_0 + a_1\, t + a_2\, t^2 + \ldots + a_n\, t^n \tag{4.5}$$

A polynomial of the second degree is:

$$Y_t = a_0 + a_1\, t + a_2\, t^2 \tag{4.5a}$$

Cobb Douglas Relationship: $$Y_t = a\, t^b \tag{4.6}$$

On logarithmic transformation this becomes:

$$\log Y_t = \log a + b \log t \tag{4.6a}$$

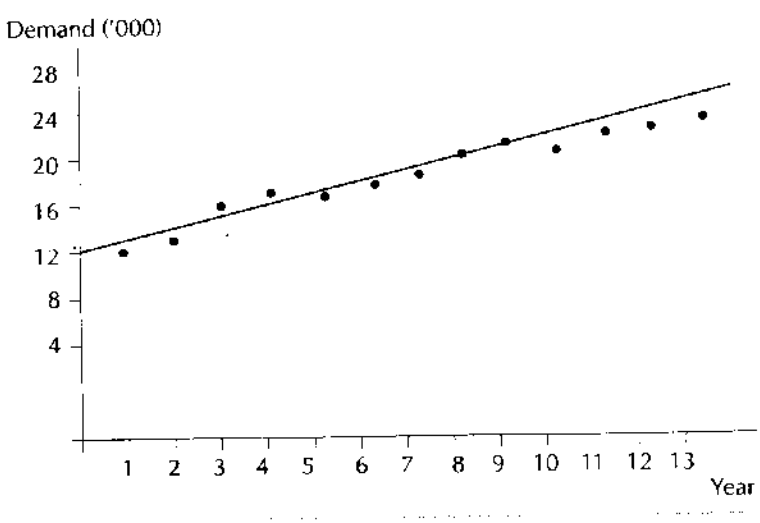
In the above equations Y_t represents demand for year t, t is the time variable, and a, b and a_i s are constants.

Exponential Smoothing Method

In exponential smoothing, forecasts are modified in the light of observed errors. If the forecast value for year t, F_t, is less than the actual value for year t, S_t, the forecast for the year $t+1$, F_{t+1}, is set higher than F_t. If $F_t > S_t$, F_{t+1} is set lower than F_t. In general

$$F_{t+1} = F_t + \alpha e_t \tag{4.7}$$

Exhibit 4.7 ***Least Squares Fitting***



where F_{t+1} = forecast for year $t + 1$

α = smoothing parameter (which lies between 0 and 1)

e_t = error in the forecast for year $t = S_t - F_t$

Exhibit 4.8 shows how the forecasts would be arrived at, given an initial forecast of $F_1 = 29$ and $\alpha = 0.2$. (The choice of these will be discussed later.)

Exhibit 4.9 shows the plot of the forecasts versus the data. The plot shows that the forecasts have the desirable property of being stable.

How should the first forecast (F_1) and the smoothing parameter (α) be chosen? A simple and reasonably satisfactory rule of thumb is to choose F_1 as the mean of the warm-up sample. (The warm-up sample consists of several observations preceding the period for which the forecasting exercise is begun.)

For choosing α, consider several values in the range of 0 to 1 and choose the value which minimises the MSE (mean squared error) in the warm-up period. The mean squared error is defined as

$$1/n = \Sigma(S_i - F_i)^2 \qquad (4.8)$$

where S_i = actual value of sales in period i

F_i = forecast value of sales in period i

n = number of periods in the "warm-up" sample

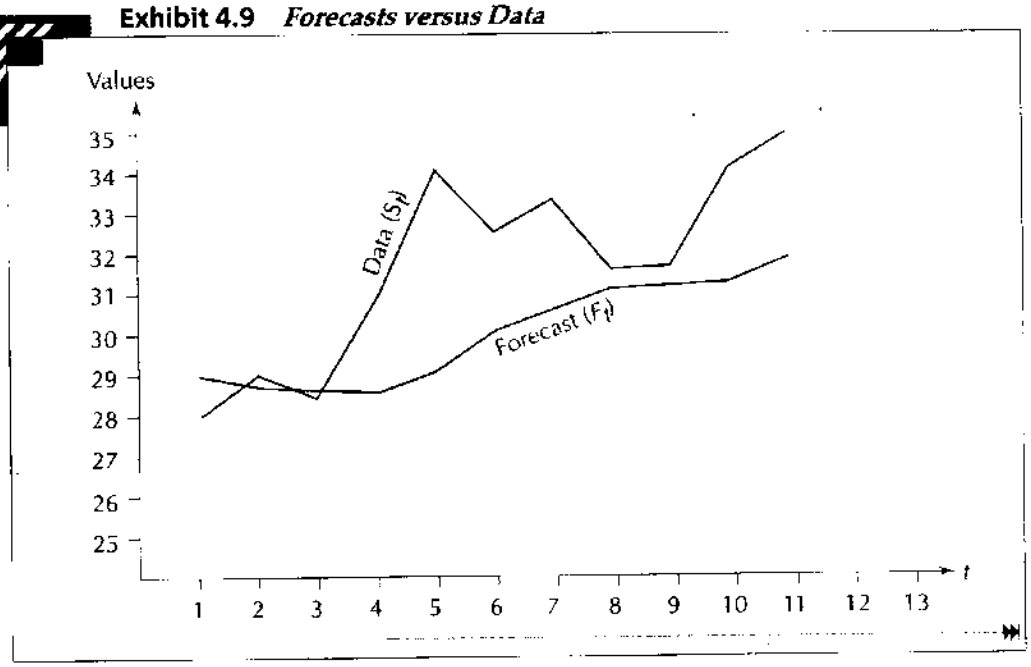
Exhibit 4.8 *Derivation of Forecasts*

t	Data (S_t)	Forecast (F_t)	Error ($e_t = S_t - F_t$)	Forecast for $t+1$ $F_{t+1} = F_{t+1} + \alpha e_t$
1	28.0	29.0	–1.0	$F_2 = 29.0 + 0.2\ (-1.0) = 28.8$
2	29.0	28.8	0.2	$F_3 = 28.8 + 0.2\ (0.2) = 28.8$
3	28.5	28.8	–0.3	$F_4 = 28.2 + 0.2\ (-0.3) = 28.7$
4	31.0	28.7	2.3	$F_5 = 28.7 + 0.2\ (2.3) = 29.2$
5	34.2	29.2	5.0	$F_6 = 29.2 + 0.2\ (5.0) = 30.2$
6	32.7	30.2	2.5	$F_7 = 30.2 + 0.2\ (2.5) = 30.7$
7	33.5	30.7	2.8	$F_8 = 30.7 + 0.2\ (2.8) = 31.3$
8	31.8	31.3	0.5	$F_9 = 31.3 + 0.2\ (0.5) = 31.4$
9	31.9	31.4	0.5	$F_{10} = 31.4 + 0.2\ (0.5) = 31.5$
10	34.3	31.5	2.8	$F_{11} = 31.5 + 0.2\ (2.8) = 32.1$
11	35.2	32.1	3.1	$F_{12} = 32.1 + 0.2\ (3.1) = 32.7$

Moving Average Method

As per the moving average method of sales forecasting, the forecast for the next period is equal to the average of the sales for several preceding periods.

Exhibit 4.9 *Forecasts versus Data*



In symbols,

$$F_{t+1} = \frac{S_t + S_{t-1} + \ldots + S_{t-n+1}}{n} \tag{4.9}$$

where F_{t+1} = forecast for the next period

S_t = sales for the current period

n = period over which averaging is done

To illustrate the use of the moving average technique, consider the following time series.

Year	*Sales*
1	28.0
2	29.0
3	28.5
4	31.0
5	34.2
6	32.7
7	33.5
8	31.8
9	31.9
10	34.3
11	35.2
12	36.0

If n is set equal to 4 (n has to be specified by the forecaster), the forecast for period 5 will be equal to

$$(28.0 + 29.0 + 28.5 + 31.0)/4 = 29.1$$

(It may be noted that if n is equal to 4, the first forecast can be made only for period 5.)

The forecast for period 6 is equal to

$$(S_5 + S_4 + S_3 + S_2) / 4 = (34.2 + 31.0 + 28.5 + 29.0)/4 = 30.7$$

Other forecasts follow as shown in Exhibit 4.10.

Exhibit 4.10 ***Forecasts***

t	Data S_t	Forecast F_t	Forecast for $t+1$ $F_{t+1} = (S_t + S_{t-1} + S_{t-2} + S_{t-3})/4$
1	28.0		
2	29.0		
3	28.5		
4	31.0		
			$F_5 = (28.0 + 29.0 + 28.5 + 31.0)/4 = 29.1$
5	34.2	29.1	$F_6 = (29.0 + 28.5 + 31.0 + 34.2)/4 = 30.7$
6	32.7	30.7	$F_7 = (28.5 + 31.0 + 34.2 + 32.7)/4 = 31.6$
7	33.5	31.6	$F_8 = (31.0 + 34.2 + 32.7 + 33.5)/4 = 32.9$
8	31.8	32.9	$F_9 = (34.2 + 32.7 + 33.5 + 31.8)/4 = 33.1$
9	31.9	33.1	$F_{10} = (32.7 + 33.5 + 31.8 + 31.9)/4 = 32.5$
10	34.3	32.5	$F_{11} = (33.5 + 31.8 + 31.9 + 34.3)/4 = 32.9$
11	35.2	32.9	$F_{12} = (31.8 + 31.9 + 34.3 + 35.2)/4 = 33.3$
12	36.0	33.3	

In the above illustration, we set n equal to 4. Why should not n be set equal to 3, 5, 6 or any other number? There seems to be no *a priori* way to determine n; it can best be arrived at by experimentation. Another issue may be raised. In Eq. (4.9), which is based on a simple arithmetic average, all preceding values of sales are weighted equally. Should the more recent data not be accorded higher weightage? For example, it may make more sense to assign weights of 0.1, 0.2, 0.3, and 0.4 to the years $t-3$, $t-2$, $t-1$, and t respectively. Here again experimentation seems to be the only way to decide the system of weights.

Chain Ratio Method

The potential sales of a product may be estimated by applying a series of factors to a measure of aggregate demand. For example, General Foods (US) estimated the potential sales for a new product, a freeze-fried instant coffee (Maxim), in the following manner:

- Total amount of coffee sales : 174.5 million units
- Proportion of coffee used at home : 0.835

- Coffee used at home : 145.7 million units
- Proportion of non-decaffeinated coffee used at home : 0.937
- Non-decaffeinated coffee used at home : 136.5 million units
- Proportion of instant coffee : 0.400
- Instant non-decaffeinated coffee used at home : 54.6 million units
- Estimated long-run market share for Maxim : 0.08
- Potential sales of Maxim : 4.37 million units

Another example of the chain ratio method may be given. Several years ago a firm planning to manufacture stainless steel blades in India tried to estimate its potential sales in the following manner:

- Adult male population in the country : 150 million
- Proportion of adult male population using shaving blades : 0.60
- Adult male population using shaving blades : 90 million
- Number of times in a year a person, who uses shaving blades, shaves : 100
- Total shavings done per year : 9,000 million
- Proportion of shavings done with stainless steel blades : 0.40
- Average number of shavings per stainless steel blade : 6
- Number of stainless steel blades used per year : 600 million
  (9000 million × 0.40)/6
- Proportion of the stainless steel blade market the firm could capture : 0.20
- Potential sales : 120 million

The chain ratio method uses a simple analytical approach to demand estimation. However, its reliability is critically dependent on the ratios and rates of usage used in the process of determining the sales potential. While some of these ratios and rates of usage may be based on objective proportions, others will have to be subjectively defined.

Consumption Level Method

Useful for a product which is directly consumed, this method estimates consumption level on the basis of elasticity coefficients, the important ones being the income elasticity of demand and the price elasticity of demand.

Income Elasticity of Demand The income elasticity of demand reflects the responsiveness of demand to variations in income. It is measured as follows:

$$E_I = \frac{Q_2 - Q_1}{I_2 - I_1} \times \frac{I_1 + I_2}{Q_2 + Q_1} \tag{4.10}$$

where E_I = income elasticity of demand

Q_1 = quantity demanded in the base year

Q_2 = quantity demanded in the following year

I_1 = income level in the base year

I_2 = income level in the following year.

Example The following information is available on quantity demanded and income level: $Q_1 = 50$, $Q_2 = 55$, $I_1 = 1{,}000$, and $I_2 = 1{,}020$. What is the income elasticity of demand? The income elasticity of demand is:

$$E_I = \frac{55-50}{1{,}020-1{,}000} \times \frac{1{,}000+1{,}020}{55+50} = 4.81$$

The information on income elasticity of demand along with projected income may be used to obtain a demand forecast. To illustrate, suppose the present per capita annual demand for paper is 1 kg and the present per capital annual income is Rs 18,200. The income elasticity of demand for paper is 2. The projected per capita annual income three years hence is expected to be 10 per cent higher (in real terms) than what it is now. The projected per capita demand for paper three years hence will be:

$$\begin{Bmatrix}\text{Present per}\\ \text{capita}\\ \text{demand}\end{Bmatrix}\left\{1+\begin{matrix}\text{Per capita}\\ \text{change in}\\ \text{income level}\end{matrix}\times\begin{matrix}\text{Income}\\ \text{elasticity}\\ \text{of demand}\end{matrix}\right\}$$

$$= (1)\ (1 + 0.10 \times 2) = 1.2 \text{ kg}$$

The aggregate demand projection for paper will simply be:

Projected per capita demand × Projected population

The income elasticity of demand differs from one product to another. Further, for a given product, it tends to vary from one income group to another and from one region to another. Hence, wherever possible, disaggregative analysis should be attempted.

Price Elasticity of Demand The price elasticity of demand measures the responsiveness of demand to variations in price. It is defined as:

$$E_p = \frac{Q_2 - Q_1}{P_2 - P_1} \times \frac{P_1 + P_2}{Q_2 + Q_1} \qquad (4.11)$$

where E_p = price elasticity of demand

Q_1 = quantity demanded in the base year

Q_2 = quantity demanded in the following year

P_1 = price per unit in the base year

P_2 = price per unit in the following year

Example The following information is available about a certain product: P_1= Rs 600, $Q_1 = 10{,}000$, P_2 = Rs 800, $Q_2 = 9{,}000$. What is the price elasticity of demand? The price elasticity of demand is:

$$E_p = \frac{9{,}000 - 10{,}000}{600 - 800} \times \frac{600 + 800}{9{,}000 + 10{,}000} = -0.37$$

The price elasticity of demand is a useful tool in demand analysis. The future volume of demand may be estimated on the basis of the price elasticity coefficient and expected price change. The price elasticity coefficient may also be used to study the impact of variable prices that may be obtained in future on the economic viability of the project. In using the price elasticity measure, however, the following considerations should be borne in mind: (i) The price elasticity coefficient is applicable to only small variations. (ii) The price elasticity measure is based on the assumption that the structure and behaviour remain constant.

End Use Method

Suitable for estimating the demand for intermediate products, the end use method, also referred to as the consumption coefficient method, involves the following steps:

1. Identify the possible uses of the product.
2. Define the consumption coefficient of the product for various uses.
3. Project the output levels for the consuming industries.
4. Derive the demand for the product.

This method may be illustrated with an example. A certain industrial chemical, Indchem, is used by four industries, Alpha, Beta, Gamma, and Kappa. The consumption coefficients for these industries, the projected output levels for these industries for the year *X*, and the projected demand for Indchem are shown in Exhibit 4.11.

Exhibit 4.11 ***Projected Demand for Indchem***

	Consumption Coefficient[3]	*Projected Output in year X*	*Projected Demand for Indchem in year X*
Alpha	2.0	10,000	20,000
Beta	1.2	15,000	18,000
Kappa	0.8	20,000	16,000
Gamma	0.5	30,000	15,000
		Total	69,000

As is clear from the foregoing discussion, the key inputs required for the application of the end use method are: (i) projected output levels of consuming industries (units), and (ii) consumption coefficients. However, it may be difficult to estimate the projected output levels of consuming industries (units). More importantly, the consumption coefficients may vary from one period to another in the wake of technological changes and improvements in the methods of manufacturing. Hence, the end use method should be used judiciously.

3. This is expressed in tonnes of Indchem required per unit of output of the consuming industry.

Leading Indicator Method

Leading indicators are variables which change ahead of other variables, the lagging variables. Hence, observed changes in leading indicators may be used to predict the changes in lagging variables. For example, the change in the level of urbanisation (a leading indicator) may be used to predict the change in the demand for air conditioners (a lagging variable).

Two basic steps are involved in using the leading indicator method: (i) First, identify the appropriate leading indicator(s). (ii) Second, establish the relationship between the leading indicator(s) and the variable to the forecast.

The principal merit of this method is that it does not require a forecast of an explanatory variable. Its limitations are that it may be difficult to find appropriate leading indicator(s) and the lead-lag relationship may not be stable over time.

Econometric Method

An econometric model is a mathematical representation of economic relationship(s) derived from economic theory. The primary objective of econometric analysis is to forecast the future behaviour of the economic variables incorporated in the model.

Two types of econometric models are employed: the single equation model and the simultaneous equation model. The single equation model assumes that one variable, the dependent variable (also referred to as the explained variable), is influenced by one or more independent variables (also referred to as the explanatory variables). In other words, one-way causality is postulated. An example of the single equation model is given below:

$$D_t = a_0 + a_1 P_t + a_2 N_t \tag{4.12}$$

where D_t = demand for a certain product in year t

P_t = price for the product in year t

N_t = income in year t

The simultaneous equation model portrays economic relationships in terms of two or more equations. Consider a highly simplified three equation econometric model of the Indian economy.

$$GNP_t = G_t + I_t + C_t \tag{4.13}$$

$$I_t = a_0 + a_1 GNP_t \tag{4.14}$$

$$C_t = b_0 + b_1 GNP_1 \tag{4.15}$$

where GNP_t = gross national product for year t

G_t = governmental purchases for year t

I_t = gross investment for year t

C_t = consumption for year t

In the above model, Eq. (4.13), is just a definitional equation which says that the gross national product is equal to the sum of government purchases, gross investment, and con-

sumption. Eq. (4.14) postulates that investment is a linear function of gross national product; Eq. (4.15) posits that consumption is a linear function of gross national product.

The construction and use of an econometric model involves four broad steps.

Specification This refers to the expression of an economic relationship in a mathematical form.

Estimation This involves the determination of the parameter values and other statistics by a suitable method such as the least squares method.

Verification This step is concerned with accepting or rejecting the specification as a reasonable approximation to the truth on the basis of the results of estimation.

Prediction This involves projection of the value of the explained variable(s).

The econometric method offers certain *advantages:* (i) The process of econometric analysis sharpens the understanding of complex cause–effect relationships. (ii) The econometric model provides a basis for testing assumptions and for judging how sensitive the results are to changes in assumptions.

The *limitations* of the econometric method are: (i) It is expensive and data-demanding. (ii) To forecast the behaviour of the dependent variable, one needs the projected values of the independent variable(s). The difficulty in obtaining these may be the main limiting factor in employing the econometric method for forecasting purposes.

4.6 UNCERTAINTIES IN DEMAND FORECASTING

Demand forecasts are subject to error and uncertainty which arise from three principal sources:

- Data about past and present market
- Methods of forecasting
- Environmental change

Data about Past and Present Markets

The analysis of past and present markets, which serves as the springboard for the projection exercise, may be vitiated by the following inadequacies of data:

Lack of Standardisation Data pertaining to market features like product, price, quantity, cost, income, etc. may not reflect uniform concepts and measures.

Few Observations Observations available to conduct meaningful analysis may not be enough.

Influence of Abnormal Factors Some of the observations may be influenced by abnormal factors like war or natural calamity.

Methods of Forecasting

Methods used for demand forecasting are characterised by the following limitations:

Inability to Handle Unquantifiable Factors Most of the forecasting methods, being quantitative in nature, cannot handle unquantifiable factors which sometimes can be of immense significance.

Unrealistic Assumptions Each forecasting method is based on certain assumptions. For example, the trend projection method is based on the 'mutually compensating effects' premise and the end use method is based on the constancy of technical coefficients. Uncertainty arises when the assumptions underlying the chosen method tend to be unrealistic and erroneous.

Excessive Data Requirement In general, the more advanced a method, the greater the data requirement. For example, to use an econometric model one has to forecast the future values of explanatory variables in order to project the explained variable. Clearly, predicting the future value of explanatory variables is a difficult and uncertain exercise.

Environmental Changes

The environment in which a business functions is characterised by numerous uncertainties. The important sources of uncertainty are mentioned below:

Technological Change This is a very important but hard-to-predict factor which influences business prospects. A technological advancement may create a new product which performs the same function more efficiently and economically, thereby cutting into the market for the existing product. For example, electronic watches are encroaching on the market for mechanical watches.

Shift in Governmental Policy In India, governmental regulation of business is extensive. Changes in governmental policy, which may be difficult to anticipate, could have a telling effect on the business environment: granting of licences to new companies, particularly foreign companies, may alter the market situation significantly; relaxation of price and distribution controls may widen the market considerably.

Developments on the International Scene Developments on the international scene may have a profound effect on industries. The most classic example of recent times is the OPEC price hike in the seventies which led to a near-stagnation in the Indian automobile industry for a few years.

Discovery of New Sources of Raw Material Discovery of new sources of raw materials, particularly hydrocarbons, can have a significant impact on the market situation of several products.

Vagaries of Monsoon Monsoon, which plays an important role in the Indian economy, is somewhat unpredictable. The behaviour of monsoon influences, directly or indirectly, the demand for a wide range of products.

Coping with Uncertainties

Given the uncertainties in demand forecasting, adequate efforts, along the following lines, may be made to cope with uncertainties.

- Conduct analysis with data based on uniform and standard definitions.
- In identifying trends, coefficients and relationships, ignore the abnormal or out-of-the-ordinary observations.
- Critically evaluate the assumptions of the forecasting methods and choose a method which is appropriate to the situation.
- Adjust the projections derived from quantitative analysis in the light of unquantifiable, but significant, influences.
- Monitor the environment imaginatively to identify important changes.
- Consider likely alternative scenarios and their impact on market and competition.
- Conduct sensitivity analysis to assess the impact on the size of demand for unfavourable and favourable variations of the determining factors from their most likely levels.

4.7 MARKET PLANNING[4]

A marketing plan usually has the following components:

- Current marketing situation
- Opportunity and issue analysis
- Objectives
- Marketing strategy
- Action programme

We will demonstrate the preparation of a marketing plan for a new product. ABC Limited already has a successful five-year old shampoo addressing the South and East markets in India. ABC now plans to launch a toilet soap named Alpha in the same geographical markets. ABC's current year sales are Rs 100 million. Its gross contribution margin is 18.4 percent and net profit margin is 4.4 percent. The gross and net margins have been roughly the same in the last 5 years. (*Note:* The company and the brands are fictitious. They are meant to illustrate the development of marketing plan.)

4. This section has been contributed by Dr Y. L. R. Murthy of the Indian Institute of Management, Bangalore. It has been adapted from Philip Kotler, *Marketing Management—Millenium Edition*, 2000 published by Prentice-Hall Inc.

Current Marketing Situation

This part of the marketing plan deals with the different dimensions of the current situation. It examines the market situation, competitive situation, distribution situation, and the macro-environment. In other words, it paints a pen-picture of the present.

Market Situation This deals with size, the growth, the consumer aspirations, and buying behaviour in the market under consideration. The toilet soap market has a size of about 5.5 lakh tons. There are three price-based segments in this market. The low-priced segment consists of Lifebuoy and Nirma Bath. The medium-priced segment has brands like Jai, Breeze, Santoor, and Hamam. The premium segment features soaps like Mysore Sandal, Pears, and Dove. The medium-priced segment is growing at the expense of the low-priced segment.

Competitive Situation This dwells on the major competitors, their objectives, strategies, strengths, etc. Alpha's important competitors are brands of Hindustan Lever (HLL) and Nirma. Lever's marketing prowess is well known. It has more than 50 percent share of the toilet soap market. Its objective would be retaining overall control of the market. It could use the profit from its successful soaps like Lux, Hamam, and Rexona to subsidise its new launches. Nirma, the other competitor, is a challenger and a price fighter. After struggling for 6 years it established its toilet soaps in the market. The competition from both these companies is formidable. Besides, there are other competitors like Godrej, Reckitt-Coleman, and Wipro to contend with.

Distribution Situation This compares the distribution capabilities of the competitors. There are an estimated 9 million retail outlets in the country. These are spread across 570,000 villages, besides towns and cities. Very few companies reach these outlets effectively. Hindustan Lever, Eveready, and ITC are the few companies that have made a name for themselves in distribution. Nirma, by contrast, is strong at the wholesale level. It retains the loyalty of trade by paying them very handsome margins. Recently it launched a brand called Nima to strengthen its retail presence. The questions before ABC are therefore (a) How many retail outlets should it aim to stock in? (b) What kind of margins should it be paying to its trade? (c) What special schemes can it offer trade, to keep them loyal to Alpha?

Macro-environment This describes the effect of social, political, economic, technological, and other external variables on the market. For instance, when there is an economic downturn, consumption moves towards low priced soaps. Most Indian population is young (as opposed to American, European, and Japanese which is middle aged). Therefore there is likely to be a demand for more fashionable and contemporary soaps. The liberalisation of the Indian economy may bring in cheap raw material. But it will also usher in stiff competition. Thus the macro environment also points to enhanced competition as the competitive situation does.

Opportunity and Issue Analysis

In this section a **SWOT** (Strength, Weakness, Opportunity, Threat analysis) is conducted for Alpha and the core issues before the product are identified. Alpha's **strength** is that its parent ABC has to its credit the successful launch of a shampoo in the current market. Its **weakness** is probably its limited resources. The **opportunity** for Alpha could be the growth witnessed in the medium-priced segment of the toilet soap market at the expense of the low-priced soaps. The **threat** might be the growing acceptance of new launches like Nima which are already exhausting the opportunities available in the market.

In light of this analysis, the issues before Alpha are:

- Given ABC's limited resources, should Alpha be marketed first in the South and then in the East or should it be launched simultaneously in both the markets.
- Given that its shampoo is already successful should ABC use a new brand name or should it extend its shampoo's brand name to the soap.

Objectives

Objectives have to be clear-cut, specific, and achievable. The following objectives have been set:

- Achieve break-even in three years for Alpha.
- Attain sales of Rs 20 million in the first year, Rs 80 million in the second, and Rs 120 million in the third.
- Achieve a top-of-mind recognition of 75 percent in the target segment for Alpha in the first year and 90 percent in the second.
- Reach 300,000 retail outlets in the first year, 900,000 in the second, and 1,500,000 in the third.

Marketing Strategy

The marketing strategy covers the following: target segment, positioning, product line, price, distribution, sales force, sales promotion, and advertising.

Target Segment The target segment from the point of view of income is middle class (as defined by NCAER). But the segment needs to be described more clearly in terms of its psychographics. This is to make the soap distinct from its competitors. For instance, Alpha could specifically target students or teenagers or entry level executives.

Positioning Positioning is how a product is placed in the mind of the customer. Having decided on targeting students, Alpha could be positioned as "romantic" or "rugged". Similarly, if entry level executives are targeted, the positioning could be "self confidence" or "daylong freshness". An important issue here is, as to which of the above positioning statements dovetail with the shampoo's positioning, if a brand extension is being attempted.

Product Line Would ABC like to launch a single variant or more than one variant? What fragrance goes with a "romantic" soap (lavender) and what fits if the positioning is "rugged" (cologne)?

Price Will Alpha be launched in the mid-price segment because the segment is growing? Whose pricing will it be closest to, ranging from Breeze at the lower end of this segment to Hamam at the higher end? Will the price decision change depending on whether the positioning is "romantic" or "rugged"?

Distribution Alpha may like to confine its distribution to important consumption centres in the South and East. It may drop out ineffective outlets, as mentioned.

Sales Force The sales force may be marginally increased. In fact, ABC is likely to press for an increase in the efficiency of its individual salesmen to boost sales.

Sales Promotion Direct consumer promotion is usually expensive because it covers thousands of individual consumers. As a small organisation ABC may like to promote dealers because their number is limited. It may aim at spending 60 percent of the promotion money on dealer schemes and the balance on consumer schemes. (A larger organisation may do the opposite.)

Advertising Unconventional and creative advertising options (balloons, advertising behind bus tickets, pamphlets in newspapers, hoarding in high visibility locations like bus stations, etc) may be allocated 60 percent of the budget. The balance goes into mainstream advertising like newspapers and TV. This is because main stream advertising is expensive and not affordable.

Action Programme

Action programmes operationalise the strategy. The following steps give an idea of how Alpha might like to roll out its marketing plan in the next one year.

Quarter 1 Alpha should attain a top-of-mind-awareness of 60 percent in the target segment. This is done by spending 60 percent of Alpha's advertising budget on unconventional media and the rest on conventional media as mentioned above. Alpha shall reach 100,000 retail outlets by ensuring that all the outlets that currently stock shampoo, stock the soap also.

Quarter 2 Alpha shall reach 200,000 retail outlets. This means doubling the number of outlets stocking Alpha. The outlets that are not stocking shampoo currently shall also be pursued aggressively. Alpha's turnover shall reach Rs 10 million by the second quarter. Display money and stock incentives shall be given to retailers to achieve the required turn over.

Quarter 3 Alpha shall reach 300,000 retail outlets. The aggressive drive for distribution started in the second quarter shall be continued. Top-of-mind awareness should reach 75 percent. Since what is being reached now is incremental audience, promotional programmes shall be more focused. 20 percent of the promotional budget is to be spent in this quarter.

Quarter 4 Alpha shall consolidate its position in 300,000 retail outlets. Dip-stick tests to be conducted on customer preferences to determine whether the strategies adopted have been successful.

Summary

- Given the importance of market and demand analysis, it should be carried out in an orderly and systematic manner. The key steps in such analysis are: (i) situational analysis and specification of objectives, (ii) collection of secondary information, (iii) conduct of market survey, (iv) characterisation of the market, (v) demand forecasting, and (vi) market planning.
- The project analyst may do an informal situational analysis which in turn may provide the basis for a formal study.
- For purposes of a market study, information may be obtained from secondary and/or primary sources.
- Secondary information is information that has been gathered in some other context and is already available. While secondary information is available economically, its reliability, accuracy, and relevance for the purpose under consideration must be carefully examined.
- Secondary information, thought useful, often does not provide a comprehensive basis for market and demand analysis. It needs to be supplemented with primary information gathered through a market survey, specific to the project being appraised, that is likely to be a sample survey.
- Typically, a sample survey consists of the following steps: (i) Define the target population. (ii) Select the sampling scheme and sample size. (iii) Develop the questionnaire. (iv) Scrutinise the information gathered. (vii) Analyse and interpret the information.
- Based on the information gathered from secondary sources and through market survey, the market for the product/service may be described in terms of the following: effective demand in the past and present; breakdown of demand; price; methods of distribution and sales promotion; consumers; supply and competition; and government policy.
- After gathering information about various aspects of the market and demand from primary and secondary sources, an attempt may be made to estimate future demand. A wide range of forecasting methods is available to the market analyst. These may be divided into three broad categories, viz., qualitative methods, time series projection methods, and causal methods.

- Qualitative methods rely essentially on the judgement of experts to translate qualitative information into quantitative estimates. The important qualitative methods are: jury of executive method and Delphi method.
- Time series projection methods generate forecasts on the basis of an analysis of the historical time series. The important time series projection methods are: trend projection method, exponential smoothing method, and moving average method.
- Causal methods seek to develop forecasts on the basis of cause–effect relationships specified in an explicit, quantitative manner. The important causal methods are: chain ratio method, consumption level method, end use method, leading indicator method, and econometric method.
- To enable the product to reach a desired level of market penetration, a suitable marketing plan, covering pricing, distribution, promotion, and service, needs to be developed.

Questions

1. Describe briefly the general sources of secondary information available in India.
2. List the important industry-specific sources of secondary information in India.
3. How would you evaluate secondary information.
4. Discuss the key steps in a sample survey.
5. How would you characterise the market.
6. What are the pros and cons of the jury of executive opinion method?
7. What steps are involved in the Delphi method?
8. What are the different kinds of relationship commonly used in the trend projection method?
9. Describe the exponential smoothing method.
10. Discuss the moving average method.
11. Give an example of the chain ratio method.
12. How is income elasticity of demand measured?
13. How is price elasticity of demand measured?
14. What steps are involved in the end use method?
15. Describe the leading indicator method.
16. What is an econometric model? What steps are involved in constructing an econometric method? What are the pros and cons of the econometric method?
17. Discuss the uncertainties in demand forecasting. How can one cope with these uncertainties?
18. Describe the aspects covered in market planning.

Problems

1. The sales of a certain product during a 14-year period have been as follows:

Period	Sales	Period	Sales
1	2,000	8	4,000
2	2,200	9	3,900
3	2,100	10	4,000
4	2,300	11	4,200
5	2,500	12	4,300
6	3,200	13	4,900
7	3,600	14	5,300

Find the least squares regression line for the data given.

2. For the data given in Problem 1 assume that the forecast for period 1 was 2,100. If α is equal to 0.3, derive the forecasts for the periods 2 to 14 using the exponential smoothing method.
3. For the data given in Problem 1, set n equal to 3 and develop forecasts for the periods 4 to 14 using the moving averages method.
4. The following information is available on quantity demanded and income level:
   $Q_1 = 60$, $Q_2 = 70$, $I_1 = 1000$ and $I_2 = 1200$. What is the income elasticity of demand?
5. The following information is available on price and quantity for a certain product:
   $P_1 =$ Rs 40, $Q_1 = 100{,}000$, $P_2 =$ Rs 50, $Q_2 = 95{,}000$. What is the price elasticity of demand?

CHAPTER 5

Technical Analysis

Analysis of technical and engineering aspects is done continually when a project is being examined and formulated. Other types of analysis are closely intertwined with technical analysis.

The broad purpose of technical analysis is (a) to ensure that the project is technically feasible in the sense that all the inputs required to set up the project are available, and (b) to facilitate the most optimal formulation of the project in terms of technology, size, location, and so on.

While technical analysis is essentially the preserve of the technical expert, the financial analyst participating in the project appraisal exercise should be able to raise basic issues relating to technical analysis using common sense and economic logic.

This chapter covers these issues very broadly. It is organised into twelve sections as follows:

- Manufacturing process/technology
- Technical arrangements
- Materials and inputs
- Product mix
- Plant capacity
- Location and site
- Machineries and equipments
- Structures and civil works
- Environmental aspects
- Project charts and layouts
- Project implementation schedule
- Need for considering alternatives

5.1 MANUFACTURING PROCESS/TECHNOLOGY

For manufacturing a product/service often two or more alternative technologies are available. For example:

- Steel can be made either by the Bessemer process or the open hearth process.
- Cement can be made either by the dry process or the wet process.
- Soda can be made by the electrolysis method or the chemical method.
- Paper, using bagasse as the raw material, can be manufactured by the kraft process or the soda process or the Simon Cusi process.
- Vinyl chloride can be manufactured by using one of the following reactions: acetylene on hydrochloric acid or ethylene on chlorine.
- Soap can be manufactured by the semi-boiled process or the fully boiled process.

Choice of Technology

The choice of technology is influenced by a variety of considerations:

- Plant capacity
- Principal inputs
- Investment outlay and production cost
- Use by other units
- Product mix
- Latest developments
- Ease of absorption

Plant Capacity Often, there is a close relationship between plant capacity and production technology. To meet a given capacity requirement perhaps only a certain production technology may be viable.

Principal Inputs The choice of technology depends on the principal inputs available for the project. In some cases, the raw materials available influence the technology chosen. For example, the quality of limestones determines whether the wet or dry process should be used for a cement plant.

Investment Outlay and Production Cost The effect of alternative technologies on investment outlay and production cost over a period of time should be carefully assessed.

Use by Other Units The technology adopted must be proven by successful use by other units, preferably in India.

Product Mix The technology chosen must be judged in terms of the total product-mix generated by it, including saleable by-products.

Latest Developments The technology adopted must be based on the latest developments in order to ensure that the likelihood of technological obsolescence in the near future, at least, is minimised.

Ease of Absorption The ease with which a particular technology can be absorbed can influence the choice of technology. Sometimes a high-level technology may be beyond the absorptive capacity of a developing country which may lack trained personnel to handle that technology.

Appropriateness of Technology

Appropriate technology refers to those methods of production which are suitable to local economic, social, and cultural conditions. In recent years, the debate about appropriate technology has been sparked off mainly by Schumacher and others. The advocates of appropriate technology urge that the technology should be evaluated in terms of the following questions:

- Whether the technology utilises local raw materials?
- Whether the technology utilises local man power?
- Whether the goods and services produced cater to the basic needs?
- Whether the technology protects ecological balance?
- Whether the technology is harmonious with social and cultural conditions?

5.2 TECHNICAL ARRANGEMENTS

Satisfactory arrangements must be made to obtain the technical know-how needed for the proposed manufacturing process. When collaboration is sought, *inter alia*, the following aspects of the agreement must be worked out in detail:

- The nature of support to be provided by the collaborators during the designing of the project, selection and procurement of equipment, installation and erection of the plant, operation and maintenance of the plant, and training of the project personnel.
- Process and performance guarantees in terms of plant capacity, product quality, and consumption of raw materials and utilities.
- The price of technology in terms of one-time licensing fee and periodic royalty fee.
- The continuing benefit of research and development work being done by the collaborator.
- The period of the collaboration agreement.
- The assistance to be provided and the restrictions to be imposed by the collaborator with respect to exports.
- The level of equity participation and the manner of sharing management control, especially if the technical collaboration is backed by financial collaboration.

- Assignment of the agreement by either side in case of change of ownership.
- Termination of the agreement or other remedies when either party fails to meet its obligation.
- Approach to be adopted in *force majeure* situations.

5.3 MATERIAL INPUTS AND UTILITIES

An important aspect of technical analysis is concerned with defining the materials and utilities required, specifying their properties in some detail, and setting up their supply programme. There is an intimate relationship between the study of materials and utilities and other aspects of project formulation, particularly those concerned with location, technology, and equipments.

Material inputs and utilities may be classified into four broad categories: (i) raw materials, (ii) processed industrial materials and components, (iii) auxiliary materials and factory supplies, and (iv) utilities.

Raw Materials

Raw materials (processed and/or semi-processed) may be classified into four types: (i) agricultural products, (ii) mineral products, (iii) livestock and forest products, and (iv) marine products.

Agricultural Products In studying agricultural products, the quality must first be examined. Then, an assessment of the quantities available, currently and potentially, is required. The questions that may be raised in this context are: What is the present marketable surplus? What is the present area under cultivation? What is the likely increase in yield per acre?

Mineral Products In assessing mineral raw materials, information is required on the quantum of exploitable deposits and the properties of the raw materials. The study should provide details of the location, size, and depth of the deposits and the viability of open cast or underground mining. In addition, information should be generated on the composition of the ore, level of impurities, need for beneficiation, and physical, chemical and other properties.

Livestock and Forest Products Secondary sources of data on livestock and forest products often do not provide a dependable basis for estimation. Hence, in general, a specific survey may be required to obtain more reliable data on the quantum of livestock produce and forest products.

Marine Products Assessing the potential availability of marine products and the cost of collection is somewhat difficult. Preliminary marine operations, essential for this purpose, have to be provided for in the feasibility study.

Processed Industrial Materials and Components

Processed industrial materials and components (base metals, semi-processed materials, manufactured parts, components, and sub-assemblies) represent important inputs for a number of industries. In studying them the following questions need to be answered: In the case of industrial materials, what are their properties?[1] What is the total requirement of the project? What quantity would be available from domestic sources? What quantity can be procured from foreign sources? How dependable are the supplies? What has been the past trend in prices? What is the likely future behaviour of prices?

Auxiliary Materials and Factory Supplies

In addition to the basic raw materials and processed industrial materials and components, a manufacturing project requires various auxiliary materials and factory supplies like chemicals, additives, packaging materials, paint, varnishes, oils, grease, cleaning materials, etc. The requirements of such auxiliary materials and supplies should be taken into account in the feasibility study.

Utilities

A broad assessment of utilities (power, water, steam, fuel, etc.) may be made at the time of the input study though a detailed assessment can be made only after formulating the project with respect to location, technology, and plant capacity. Since the successful operation of a project critically depends on the adequate availability of utilities, the following questions should be raised while conducting the inputs study. What quantities are required? What are the sources of supply? What would be the potential availability? What are the likely shortages/bottlenecks? What measures may be taken to augment supplies?

5.4 PRODUCT MIX

The choice of product mix is guided by market requirements. In the production of most of the items, variations in size and quality are aimed at satisfying a broad range of customers. For example, a garment manufacturer may have a wide range in terms of size and quality to cater to different customers. It may be noted that variation in quality can enable a

1. The analysis here may have to cover the following properties: (a) Physical properties: dimensions, form, specific gravity, viscosity, porosity, state (gas, liquid, solid) and melting and boiling points. (b) Mechanical properties: formability, machinability, tensile strength, shearing strength, elasticity, fatigue resistance, hardness, and anneal. (c) Chemical properties: form (suspension, emulsion), composition, purity, inflammability, and oxidising and reducing potentials. (d) Electrical and magnetic properties, magnetisation, conductance, and resistance.

company to expand its market and enjoy higher profitability. For example, a toilet soap manufacturing unit may, by variation in raw material, packaging, and sales promotion, offer a high profit margin soap to consumers in the upper-income brackets.

While planning the production facilities of the firm, some flexibility with respect to the product mix must be sought. Such flexibility enables the firm to alter its product mix in response to changing market conditions and enhances the power of the firm to survive and grow under different situations. The degree of flexibility chosen may be based on a careful analysis of the additional investment requirement for different degrees of flexibility.

5.5 PLANT CAPACITY

Plant capacity (also referred to as production capacity) refers to the volume or number of units that can be manufactured during a given period. Plant capacity may be defined in two ways: feasible normal capacity (FNC) and nominal maximum capacity (NMC). The feasible normal capacity refers to the capacity attainable under normal working conditions. This may be established on the basis of the installed capacity, technical conditions of the plant, normal stoppages, downtime for maintenance and tool changes, holidays, and shift patterns. The nominal maximum capacity is the capacity which is technically attainable and this often corresponds to the installed capacity guaranteed by the supplier of the plant. Our discussion will focus on the feasible normal capacity. Several factors have a bearing on the capacity decision. These are:

- Technological requirement
- Input constraints
- Investment cost
- Market conditions
- Resources of the firm
- Governmental policy

Technological Requirement

For many industrial projects, particularly in process type industries, there is a certain minimum economic size determined by the technological factor. For example, a cement plant should have a capacity of at least 300 tonnes per day in order to use the rotary kiln method; otherwise, it has to employ the vertical shaft method which is suitable for lower capacity.

Input Constraints

In a developing country like India, there may be constraints on the availability of certain inputs. Power supply may be limited; basic raw materials may be scarce; foreign exchange

available for imports may be inadequate. Constraints of these kinds should be borne in mind while choosing the plant capacity.

Investment Cost

When serious input constraints do not exist, the relationship between capacity and investment cost is an important consideration. Typically, the investment cost per unit of capacity decreases as the plant capacity increases. This relationship may be expressed as follows:

$$C_1 = C_2\left(\frac{Q_1}{Q_2}\right)^{\alpha} \tag{5.1}$$

where C_1 = derived cost for Q_1 units of capacity

C_2 = known cost for Q_2 units of capacity

α = a factor reflecting capacity–cost relationship. This is usually between 0.2 and 0.9.

Example Suppose the known investment cost for 5,000 units of capacity for the manufacturer of a certain item is Rs 1,000,000. What will be the investment cost for 10,000 units of capacity if the capacity-cost factor is 0.6.

The derived investment cost for 10,000 units of capacity may be obtained as follows:

$$C_1 = 1{,}000{,}000 \times \left(\frac{10{,}000}{5{,}000}\right)^{0.6} = \text{Rs } 1{,}516{,}000$$

Market Conditions

The anticipated market for the product/service has an important bearing on the plant capacity. If the market for the product is likely to be very strong, a plant of higher capacity is preferable. If the market is likely to be uncertain, it might be advantageous to start with a smaller capacity. If the market, starting from a small base, is expected to grow rapidly, the initial capacity may be higher than the initial level of demand—further additions to capacity may be effected with the growth of the market.

Resources of the Firm

The resources, both managerial and financial, available to a firm define a limit on its capacity decision. Obviously, a firm cannot choose a scale of operations beyond its financial resources and managerial capability.

Government Policy

The capacity level may be influenced by the policy of the government. Traditionally, the policy of the government was to distribute the additional capacity to be created in a cer-

tain industry among several firms, regardless of economies of scale. This policy has been substantially modified in recent years and the concept of 'minimum economic capacity' has been adopted in several industries.

5.6 LOCATION AND SITE

The choice of location and site follows an assessment of demand, size, and input requirement. Though often used synonymously, the terms 'location' and 'site' should be distinguished. Location refers to a fairly broad area like a city, an industrial zone, or a coastal area; site refers to a specific piece of land where the project would be set up.

The choice of location is influenced by a variety of considerations: proximity to raw materials and markets, availability of infrastructure, labour situation, governmental policies, and other factors.

Proximity to Raw Materials and Markets

An important consideration for location is the proximity to the sources of raw materials and nearness to the market for the final products. In terms of a basic locational model, the optimal location is one where the total cost (raw material transportation cost plus production cost plus distribution cost for the final product) is minimised. This generally implies that:
(i) a resource-based project like a cement plant or a steel mill should be located close to the source of the basic material (for example, limestone in the case of a cement plant and iron-ore in the case of a steel plant); (ii) a project based on imported material may be located near a port; and (iii) a project manufacturing a perishable product should be close to the centre of consumption.

However, for many industrial products proximity to the source of raw material or the centre of consumption may not be very important. Petro-chemical units or refineries, for example, may be located close to the source of raw material, or close to the centre of consumption, or at some intermediate point.

Availability of Infrastructure

Availability of power, transportation, water, and communications should be carefully assessed before a location decision is made.

Adequate supply of power is a very important condition for location—insufficient power can be a major constraint, particularly in the case of an electricity-intensive project like an aluminium plant. In evaluating power supply the following should be looked into: the quantum of power available, the stability of the power supply, the structure of the power tariff, and the investment required by the project for a tie-up in the network of the power supplying agency.

For transporting the inputs of the project and distributing the outputs of the project, adequate transport connections—whether by rail, road, sea, inland water, or air—are required. The availability, reliability, and cost of transportation for various alternative locations should be assessed.

Given the plant capacity and the type of technology, the water requirement for the project can be assessed. Once the required quantity is estimated, the amount to be drawn from the public utility system and the amount to be provided by the project from surface or sub-surface sources may be determined. For doing this the following factors may be examined: relative costs, relative dependabilities, and relative qualities.

In addition to power, transport, and water, the project should have adequate communication facilities like telephone and internet.

Labour Situation

In labour-intensive projects, the labour situation in a particular location becomes important. The key factors to be considered in evaluating the labour situation are:

- Availability of labour, skilled, semi-skilled and unskilled
- Prevailing labour rates
- Labour productivity
- State of industrial relations judged in terms of the frequency and severity of strikes and lockouts
- Degree of unionisation

Governmental Policies

Government policies have a bearing on location. In the case of public sector projects, location is directly decided by the government. It may be based on a wider policy for regional dispersion of industries.

In the case of private sector projects, location is influenced by certain governmental restrictions and inducements. The government may prohibit the setting up of industrial projects in certain areas which suffer from urban congestion. More positively, the government offers inducements for establishing industries in backward areas. These inducements consist of subsidies, concessional finance, sales tax loans, power subsidy, income tax benefits, lower promoter contribution, and so on.

Other Factors

Several other factors have to be assessed as well before arriving at a location decision. These are:

- Climatic conditions

- General living conditions
- Proximity to ancillary units
- Ease in coping with pollution

Climatic Conditions The climatic conditions like temperature, humidity, wind, sunshine, rainfall, snowfall, dust, flooding, and earthquakes have an important influence on location decision. They have a bearing on the cost as they determine the extent of air-conditioning, de-humidification, refrigeration, special drainage, and so on required for the project.

General Living Conditions The general living conditions like the cost of living, housing situation, safety, and facilities for education, health care, transportation and recreation need to be assessed carefully.

Proximity to Ancillary Units Most firms depend on ancillary units for components and parts. If the ancillary units are located nearby coordination becomes easy, transportation costs are lower, and inventory requirements become considerably less.

Ease in Coping with Environmental Pollution A project may cause environmental pollution in various ways: it may throw gaseous emissions; it may produce liquid and solid discharges; it may cause noise, heat, and vibrations. The location study should analyse the cost of mitigating environmental pollution to tolerable levels at alternative locations.

Site Selection

Once the broad location is chosen, attention needs to be focussed on the selection of a specific site. Two to three alternative sites must be considered and evaluated with respect to cost of land and cost of site preparation and development.

The cost of land tends to differ from one site to another in the same broad location. Sites close to a city cost more whereas sites away from the city cost less. Sites in an industrial area developed by a governmental agency may be available at a concessional rate.

The cost of site preparation and development depends on the physical features of the site, the need to demolish and relocate existing structures, and the work involved in obtaining utility connections to the site. The last element, viz., the work involved in obtaining utility connections and the cost associated with it should be carefully looked into. It may be noted in this context that the cost of the following may vary significantly from site to site: power transmission lines from the main grid, railway siding from the nearest railroad, feeder road connecting with the main road, transport of water, and disposal of effluents.

5.7 MACHINERIES AND EQUIPMENT

The requirement of machineries and equipment is dependent on production technology and plant capacity. It is also influenced by the type of project. For a process-oriented in-

dustry, like a petrochemical unit, machineries and equipment required should be such that the various stages are matched well. The choice of machineries and equipment for a manufacturing industry is somewhat wider as various machines can perform the same function with varying degrees of accuracy. For example, the configuration of machines required for the manufacture of refrigerators could take various forms. To determine the kinds of machinery and equipment required for a manufacturing industry, the following procedure may be followed: (i) Estimate the likely levels of production over time. (ii) Define the various machining and other operations. (iii) Calculate the machine hours required for each type of operation. (iv) Select machineries and equipment required for each function.

The equipment required for the project may be classified into the following types: (i) plant (process) equipment, (ii) mechanical equipment, (iii) electrical equipment, (iv) instruments, (v) controls, (vi) internal transportation system, and (vii) others.

In addition to the machineries and equipment, a list should be prepared of spare parts and tools required. This may be divided into: (i) spare parts and tools to be purchased with the original equipment, and (ii) spare parts and tools required for operational wear and tear.

Constraints in Selecting Machineries and Equipment

In selecting the machineries and equipment certain constraints should be borne in mind: (i) there may be a limited availability of power to set up an electricity-intensive plant like, for example, a large electric furnace; (ii) there may be difficulty in transporting heavy equipment to a remote location; (iii) workers may not be able to operate, at least in the initial periods, certain sophisticated equipment such as numerically controlled machines; (iv) the import policy of the government may preclude the import of certain machineries and equipment.

Procurement of Plant and Machinery

For procuring the plant and machinery, orders for different items of the plant and machinery may be placed with different suppliers or a turnkey contract may be given for the entire plant and machinery to a single supplier. The factors to be considered in selecting the supplier (s) of the plant and machinery are the desired quality of machinery, the level of technological sophistication, the relative reputation of the various suppliers, the expected delivery schedules, the preferred payment terms, and the required performance guarantees[2]. If inhouse technical expertise is inadequate, external consultant (s) may be employed to select the plant and machinery and supervise the installation of the same.

2. Performance guarantees provided by machinery suppliers are of three types: mechanical guarantees, input guarantees, and output guarantees.

5.8 STRUCTURES AND CIVIL WORKS

Structures and civil works may be divided into three categories: (i) site preparation and development, (ii) buildings and structures, and (iii) outdoor works.

Site Preparation and Development

This covers the following: (i) grading and leveling of the site; (ii) demolition and removal of existing structures; (iii) relocation of existing pipelines, cables, roads, power lines, etc.; (iv) reclamation of swamps and draining and removal of standing water; (v) connections for the following utilities from the site to the public network: electric power (high tension and low tension), water for drinking and other purposes, communications (telephone, telex, internet, etc.), roads, railway sidings; and (vi) other site preparation and development work.

Buildings and Structures

Buildings and structures may be divided into: (i) factory or process buildings; (ii) ancillary buildings required for stores, warehouses, laboratories, utility supply centres, maintenance services, and others; (iii) administrative buildings; (iv) staff welfare buildings, cafeteria, and medical service buildings; and (v) residential buildings.

Outdoor Works

Outdoor works cover (i) supply and distribution of utilities (water, electric power, communication, steam, and gas); (ii) handling and treatment of emission, wastages, and effluents; (iii) transportation and traffic signals; (iv) outdoor lighting; (v) landscaping; and (vi) enclosure and supervision (boundary wall, fencing, barriers, gates, doors, security posts, etc.)

5.9 ENVIRONMENTAL ASPECTS

A project may cause environmental pollution in various ways: it may throw gaseous emissions; it may produce liquid and solid discharges; it may cause noise, heat, and vibrations.

Projects that produce physical goods like cement, steel, paper, and chemicals by converting natural resource endowments into saleable products are likely to cause more environmental damage. Hence the environmental aspects of these projects have to be properly examined. The key issues that need to be considered in this respect are:

- What are the types of effluents and emissions generated?
- What needs to be done for proper disposal of effluents and treatment of emissions?
- Will the project be able to secure all environmental clearances and comply with all statutory requirements?

5.10 PROJECT CHARTS AND LAYOUTS

Once data is available on the principal dimensions of the project—market size, plant capacity, production technology, machineries and equipment, buildings and civil works, conditions obtaining at the plant site, and supply of inputs to the project—project charts and layouts may be prepared. These define the scope of the project and provide the basis for detailed project engineering and estimation of the investment and production costs.

The important charts and layout drawings are briefly described as follows:

1. *General Functional Layout* This shows the general relationship between equipment, buildings, and civil works. In preparing this layout, the primary consideration is to facilitate smooth and economical movement of raw materials, work-in-process, and finished goods. This means that:
   (a) The layout should seek to allow traffic flow in one direction to the extent possible, with a minimum of crossing.
   (b) Godowns, workshops, and other services must be functionally situated with respect to the main factory building.
2. *Material Flow Diagram* This shows the flow of materials, utilities, intermediate products, final products, by-products, and emissions. Along with the material flow diagram, a quantity flow diagram showing the quantities of flow may be prepared.
3. *Production Line Diagrams* These show how the production would progress along with the key information for the main equipment.
4. *Transport Layout* This shows the distances and means of transport outside the production line.
5. *Utility Consumption Layout* This shows the principal consumption points of utilities (power, water, gas, compressed air, etc.) and their required quantities and qualities. These layouts provide the basis for developing specifications for utility supply installations.
6. *Communication Layout* This shows how the various parts of the project will be connected with telephone, internet, intercom, etc.
7. *Organisational Layout* This shows the organisational set-up of the project along with information on personnel required for various departments and their interrelationship.
8. *Plant Layout* The plant layout is concerned with the physical layout of the factory. In certain industries, particularly process industries, the plant layout is dictated by the production process adopted. In manufacturing industries, however, there is much greater flexibility in defining the plant layout. The important considerations in preparing the plant layout are:
   - Consistency with production technology

- Smooth flow of goods from one stage to another
- Proper utilisation of space
- Scope of expansion
- Minimisation of production cost
- Safety of personnel

5.11 SCHEDULE OF PROJECT IMPLEMENTATION

As part of the technical analysis, a project implementation schedule is also usually prepared.
For preparing the project implementation schedule the following information is required:

- List of all possible activities from project planning to commencement of production.
- The sequence in which various activities have to be performed.
- The time required for performing the various activities.
- The resources normally required for performing the various activities.
- The implications of putting more resources or less resources than are normally required.

For small projects with few activities, a bar chart showing when a particular activity would begin and when it would end is a fairly simple tool for drawing up the implementation schedule. For most real life projects which have numerous activities and are fairly large, PERT/CPM analysis is required. PERT is an acronym for Programme Evaluation Review Technique and CPM is an acronym for Critical Path Method. These are network planning techniques that can handle innumerable activities, complex interdependency relationships, resource constraints, probabilistic estimates, and cost–time trade-offs. Lending institutions often insist on the use of network techniques by the project sponsors.

Work Schedule

The work schedule, as its name suggests, reflects the plan of work concerning installation as well as initial operations. The purpose of the work schedule is:

- To anticipate problems likely to arise during the installation phase and suggest possible means for coping with them.
- To establish the phasing of investments taking into account the availability of finances.
- To develop a plan of operations covering the initial period (the running-in period).

Often, it is found that the required inputs like raw material and power are not available in adequate quantity when the plant is ready for commissioning, or the plant is not ready when the raw material arrives.

In the first case the plant remains idle and in the second the material may tend to deteriorate and/or pose problems of storage. To avoid losses arising from idle capacity and

deterioration of stocks of material, the work schedule should be drawn up with care and realism so that commissioning of the plant is reasonably synchronised with the availability of the basic inputs.

5.12 NEED FOR CONSIDERING ALTERNATIVES

The need for considering alternatives has been touched upon earlier. This point, however, needs to be emphasised. There are alternative ways of transforming an idea into a concrete project. These alternatives may differ in one or more of the following aspects:

- Nature of project
- Production process
- Product quality
- Scale of operation and time phasing
- Location

Nature of Project The project may envisage the manufacture of all the parts and components in a vertically integrated unit or it may consist of an assembly type unit which obtains the bulk of the parts and components from outside suppliers. The project may consist of processing up to the finished stage or may stop at a semi-finished stage. These alternatives are available with respect to the nature of the project.

Production Process There may be several alternatives with respect to the production process. The availability and characteristics of raw materials, the cost structure, and the nature of markets served are factors that have to be borne in mind while deciding about the process.

Product Quality Barring a few products like clinical thermometers where a certain standard has to be maintained, the choice with respect to quality is fairly wide. This is particularly true in the case of consumer products like textiles, footwear, etc. The quality and product range decisions would depend on the characteristics of the market, the elasticity of demand, consumer preferences, and the nature of competition.

Scale of Operation and Time Phasing In many cases several scales of operation are feasible technically and financially. The choice of a particular scale would depend on the financial resources available, the nature of competition, the nature of demand, and the economies of scale.

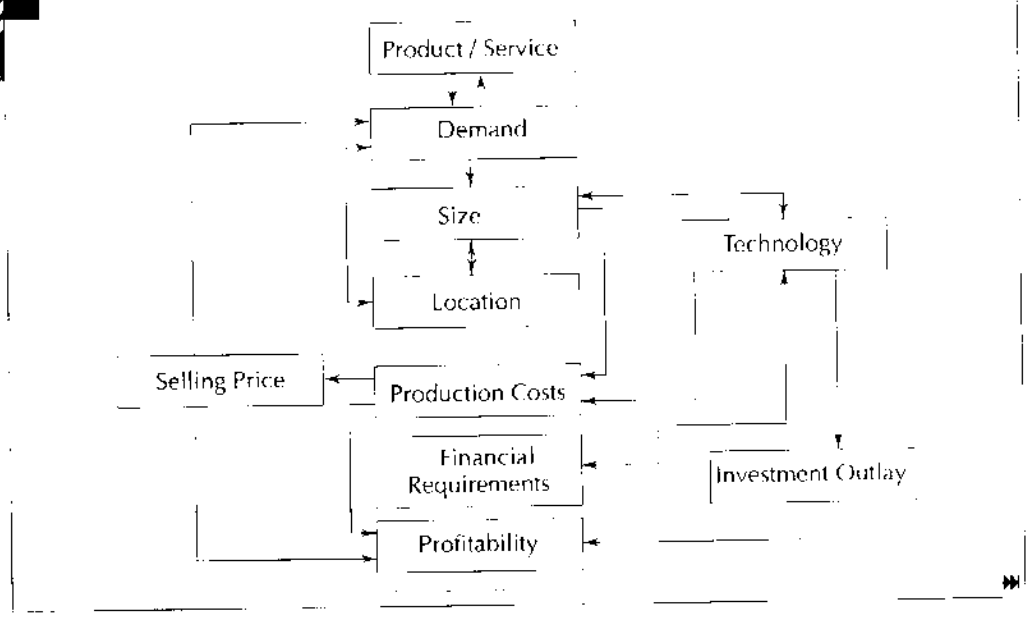
Further, a given capacity may be installed in one stage or in phases. The capital cost of capacity installation is usually lower when it is done in one stage. The cost of idle capacity, however, is higher when it is built in a single stage. The trade-off between these costs would determine the optimal pattern of time phasing.

Location Location and size are closely interrelated. Perhaps the same demand could be satisfied by: (i) a single plant for the entire market; or (ii) one large plant for the bulk of the market with a few smaller plants for the remaining market; or (iii) several plants of a similar size spread over the market areas. The choice would depend mainly on the trade-off between economies of scale in manufacturing and economies of distribution.

Key Project Inter-linkages

While evaluating various alternatives, the inter-linkages among key facets of the project like product (or service), demand, plant capacity, production technology, location, investment outlay, financial resources, production costs, selling price, and profitability must be borne in mind. Exhibit 5.1 shows these inter-linkages pictorially.

Exhibit 5.1 *Key Project Inter-linkages*



SUMMARY

- For manufacturing a product/service often two or more alternative technologies are available. The choice of technology is influenced by a variety of considerations: plant capacity, principal units, investment outlay, production cost, use by other units, product mix, latest developments, and ease of absorption.
- Satisfactory arrangements have to be made to obtain the technical know-how needed for the proposed manufacturing process.

- An important aspect of technical analysis is concerned with defining the materials and inputs required, specifying their properties in some detail, and setting up their supply programme. Materials may be classified into four broad categories: (i) raw materials, (ii) processed industrial materials and components, (iii) auxiliary materials and factory supplies, and (iv) utilities.
- The acquisition of technology from some other enterprise may be by way of (i) technology licensing, (ii) outright purchase, or (iii) joint venture arrangement.
- Appropriate technology refers to those methods of production which are suitable to local, economic, social, and cultural conditions.
- Several factors have a bearing on the plant capacity decision: technological requirements, input constraint, investment cost, market conditions, resources of the firm, and governmental policy.
- The choice of location is influenced by a variety of considerations: proximity to raw materials and markets, availability of infrastructure facilities, and other factors. Once a broad location is chosen, the attention needs to be focussed on the selection of a site—a specific piece of land where the project would be set up.
- The requirement of machinery and equipment is dependent on production technology and plant capacity. Further, it is influenced by the type of product.
- Structures and civil works may be divided into three categories: (i) site preparation and development, (ii) buildings and structures, and (iii) outdoor works.
- A project may cause environmental pollution in various ways. Hence the environmental aspects have to be properly examined.
- Once data is available on the principal dimensions of the project, project charts and layout may be prepared. The important charts and layout drawings are: (i) general functional layout, (ii) material flow diagram, (iii) production line diagram, (iv) transport layout, (v) utility consumption layout, (vi) communication layout, (vii) organisational layout, and (viii) plant layout.
- As part of the technical analysis, a project implementation is also prepared.
- The work schedule reflects the plan of work concerning installation as well as initial operation.
- There are alternative ways of transforming an idea into a concrete project. These alternatives may differ in one or more of the following aspects: nature of project, production process, quality of products, scale of operation, time phasing, and location.

Questions

1. What aspects are considered in technical analysis?
2. What factors have a bearing on the choice of technology?
3. List the key issues to be covered in a technical collaboration arrangement?

4. What are the broad types of materials and inputs? What questions would you raise in assessing whether the material and input requirements of the project would be reasonably met?
5. How would you evaluate the appropriateness of a technology?
6. What factors have a bearing on the plant capacity?
7. How would you determine the kinds of machinery and equipment required for a manufacturing industry?
8. Describe the important charts and layout drawings?
9. What information is required for preparing the project implementation schedule?
10. What is a work schedule? What purpose does it serve?
11. Discuss the importance of considering alternative ways of transforming an idea into a concrete project?

CHAPTER 6

Financial Estimates and Projections

There are three basic questions to be answered in a project appraisal exercise: Can we produce the goods or services? Can we sell the goods or services? Can we earn a satisfactory return on the investment made in the project?

For answering these questions we have to do a technical appraisal, a market and demand appraisal, and a financial appraisal. The previous two chapters covered technical appraisal and market and demand appraisal. This chapter begins the discussion on financial appraisal which will be covered over several chapters.

In this chapter we will discuss the estimates and projections required for financial appraisal. The discussion is guided to a large extent by the information required by financial institutions when promoters seek financial assistance from them.[1]

The chapter is organised into eight sections as follows:

- Cost of project
- Means of financing
- Estimates of sales and production
- Cost of production
- Working capital requirement and its financing
- Profitability projections
- Projected cash flow statements
- Projected balance sheets

1. For guiding promoters, financial institutions have developed an 'Application for Financial Assistance'. It is very long application form, running to over 115 pages. Appendix A, included at the end of the book presents a summarised version of this application form.

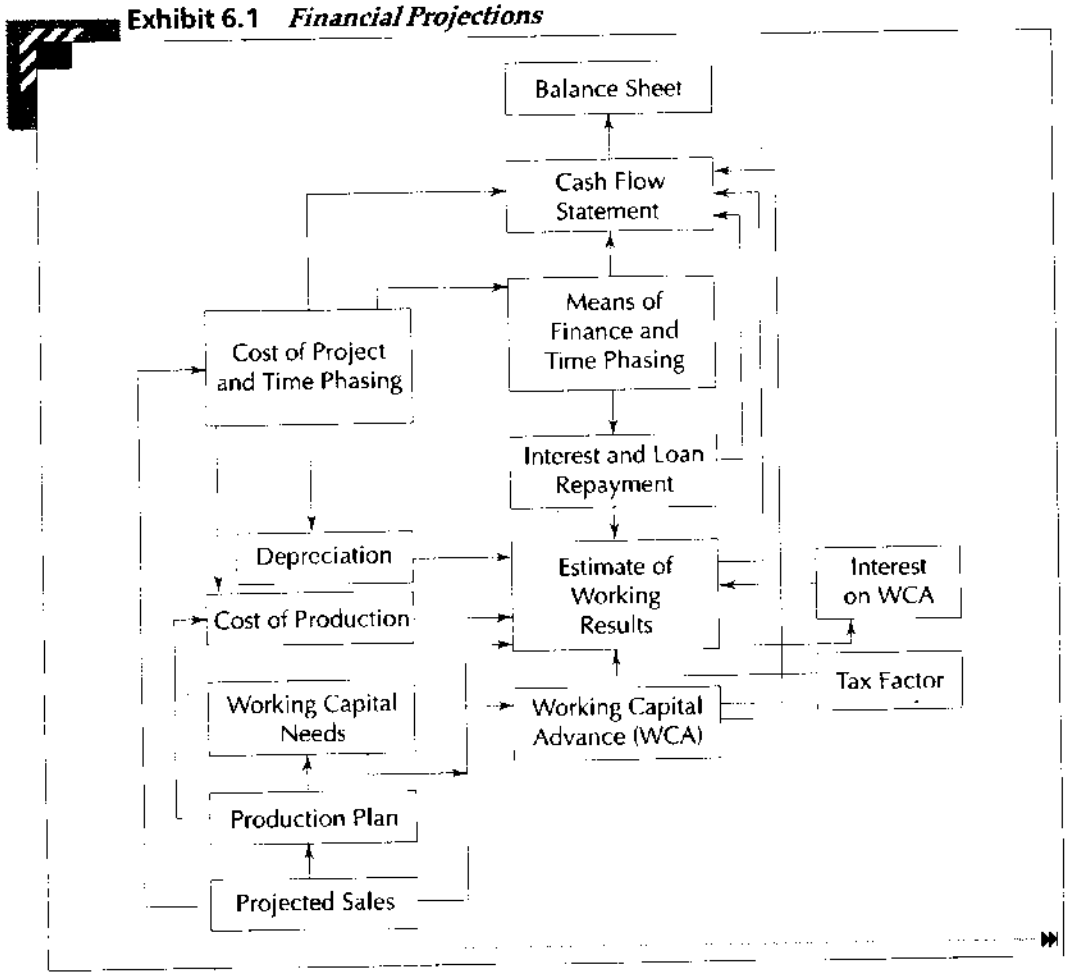
Before we dwell on the above financial estimates and projections, it is helpful to know how they are interrelated. Exhibit 6.1 presents a schematic diagram showing the interrelationship.

6.1 COST OF PROJECT

Conceptually, the cost of project represents the total of all items of outlay associated with a project which are supported by long-term funds. It is the sum of the outlays on the following:

- Land and site development
- Buildings and civil works
- Plant and machinery

Exhibit 6.1 *Financial Projections*



- Technical know-how and engineering fees
- Expenses on foreign technicians and training of Indian technicians abroad
- Miscellaneous fixed assets
- Preliminary and capital issue expenses
- Pre-operative expenses
- Margin money for working capital
- Initial cash losses

Land and Site Development

The cost of land and site development is the sum of the following:

- Basic cost of land including conveyance and other allied charges
- Premium payable on leasehold and conveyance charges
- Cost of levelling and development
- Cost of laying approach roads and internal roads
- Cost of gates
- Cost of tube wells

The cost of land varies considerably from one location to another. While it is very high in urban and even semi-urban locations, it is relatively low in rural locations. The expenditure on site development, too, varies widely depending on the location and topography of the land.

Buildings and Civil Works

Buildings and civil works cover the following:

- Buildings for the main plant and equipment
- Buildings for auxiliary services like steam supply, workshops, laboratory, water supply, etc.
- Godowns, warehouses, and open yard facilities
- Non-factory buildings like canteen, guest houses, time office, excise house, etc.
- Quarters for essential staff
- Silos, tanks, wells, chests, basins, cisterns, hoopers, bins, and other structures necessary for installation of the plant and equipment
- Garages
- Sewers, drainage, etc.
- Other civil engineering works.

The cost of the buildings and civil works depends on the kinds of structures required which, in turn, are dictated largely by the requirements of the manufacturing process. Once the kinds of structures required are specified, cost estimates are based on the plinth

area and the rates for various types of structures. These rates, of course, vary with the location to some extent.

Plant and Machinery

The cost of the plant and machinery, typically the most significant component of the project cost, consists of the following:

- Cost of imported machinery: This is the sum of (i) FOB (free on board) value, (ii) shipping, freight, and insurance cost, (iii) import duty, and (iv) clearing, loading, unloading, and transportation charges.
- Cost of indigenous machinery: This consists of (i) FOR (free on rail) cost, (ii) sales tax, octroi, and other taxes, if any, and (iii) railway freight and transport charges to the site.
- Cost of stores and spares
- Foundation and installation charges

The cost of the plant and machinery is based on the latest available quotation adjusted for possible escalation. Generally, the provision for escalation is equal to the following product: (latest rate of annual inflation applicable to the plant and machinery) × (length of the delivery period).

Technical Know-how and Engineering Fees

Often it is necessary to engage technical consultants or collaborators from India and/or abroad for advice and help in various technical matters like preparation of the project report, choice of technology, selection of the plant and machinery, detailed engineering, and so on. While the amount payable for obtaining the technical know-how and engineering services for setting up the project is a component of the project cost, the royalty payable annually, which is typically a percentage of sales, is an operating expense taken into account in the preparation of the projected profitability statements.

Expenses on Foreign Technicians and Training of Indian Technicians Abroad

Services of foreign technicians may be required in India for setting up the project and supervising the trial runs. Expenses on their travel, boarding, and lodging along with their salaries and allowances must be shown here. Likewise, expenses on Indian technicians who require training abroad must also be included here.

Miscellaneous Fixed Assets

Fixed assets and machinery which are not part of the direct manufacturing process may be referred to as miscellaneous fixed assets. They include items like furniture, office machinery and equipment, tools, vehicles, railway siding, diesel generating sets, trans-

formers, boilers, piping systems, laboratory equipment, workshop equipment, effluent treatment plants, fire fighting equipment, and so on. Expenses incurred for the procurement or use of patents, licences, trade marks, copyrights, etc. and deposits made with the electricity board may also be included here.

Preliminary and Capital Issue Expenses

Expenses incurred for identifying the project, conducting the market survey, preparing the feasibility report, drafting the memorandum and articles of association, and incorporating the company are referred to as preliminary expenses.

Expenses borne in connection with the raising of capital from the public are referred to as capital issue expenses. The major components of capital issue expenses are: underwriting commission, brokerage, fees to managers and registrars, printing and postage expenses, advertising and publicity expenses, listing fees, and stamp duty.

Pre-operative Expenses

Expenses of the following types incurred till the commencement of commercial production are referred to as pre-operative expenses: (i) establishment expenses, (ii) rent, rates, and taxes, (iii) travelling expenses, (iv) interest and commitment charges on borrowings, (v) insurance charges, (vi) mortgage expenses, (vii) interest on deferred payments, (viii) start-up expenses, and (ix) miscellaneous expenses.

Pre-operative expenses are directly related to the project implementation schedule. So, delays in project implementation, which are fairly common, tend to push up these expenses. Appreciative of this, financial institutions allow for some delay (20 to 25 percent) in the project implementation schedule and accordingly permit a cushion in the estimate for pre-operative expenses.

Pre-operative expenses incurred up to the point of time the plant and machinery are set up may be capitalised by apportioning them to fixed assets on some acceptable basis. Pre-operative expenses incurred from the point of time the plant and machinery are set up are treated as revenue expenditure. The firm may, however, treat them as deferred revenue expenditure and write them off over a period of time.

Provision for Contingencies

A provision for contingencies is made to provide for certain unforeseen expenses and price increases over and above the normal inflation rate which is already incorporated in the cost estimates.

To estimate the provision for contingencies the following procedure may be followed:
(i) Divide the project cost items into two categories, viz., 'firm' cost items and 'non-firm'

cost items (firm cost items are those which have already been acquired or for which definite arrangements have been made). (ii) Set the provision for contingencies at 5 to 10 percent of the estimated cost of non-firm cost items. Alternatively, make a provision of 10 percent for all items (including the margin money for working capital) if the implementation period is one year or less. For every additional one year, make an additional provision of 5 percent.

Margin Money for Working Capital

The principal support for working capital is provided by commercial banks and trade creditors. However, a certain part of the working capital requirement has to come from long-term sources of finance. Referred to as the 'margin money for working capital', this is an important element of the project cost.

The margin money for working capital is sometimes utilised for meeting over-runs in capital cost. This leads to a working capital problem (and sometimes a crisis) when the project is commissioned. To mitigate this problem, financial institutions stipulate that a portion of the loan amount, equal to the margin money for working capital, be blocked initially so that it can be released when the project is completed.

Initial Cash Losses

Most of the projects incur cash losses in the initial years. Yet, promoters typically do not disclose the initial cash losses because they want the project to appear attractive to the financial institutions and the investing public. Failure to make a provision for such cash losses in the project cost generally affects the liquidity position and impairs the operations. Hence prudence calls for making a provision, overt or covert, for the estimated initial cash losses.

6.2 MEANS OF FINANCE

To meet the cost of the project the following means of finance are available:

- Share capital
- Term loans
- Debenture capital
- Deferred credit
- Incentive sources
- Miscellaneous sources

Share Capital There are two types of share capital—equity capital and preference capital. *Equity capital* represents the contribution made by the owners of the business, the equity shareholders, who enjoy the rewards and bear the risks of ownership. Equity capital being

a risk capital carries no fixed rate of dividend. *Preference capital* represents the contribution made by preference shareholders and the dividend paid on it is generally fixed.

Term Loans Provided by financial institutions and commercial banks, *term loans* represent secured borrowings which are a very important source (and often the major source) for financing new projects as well as for the expansion, modernisation, and renovation schemes of existing firms. There are two broad types of term loans available in India: *rupee term loans* and *foreign currency term loans*. While the former are given for financing land, building, civil works, indigenous plant and machinery, and so on, the latter are provided for meeting the foreign currency expenditures towards the import of equipment and technical know-how.

Debenture Capital Akin to promissory notes, debentures are instruments for raising debt capital. There are two broad types of debentures: non-convertible debentures and convertible debentures. *Non-convertible debentures* are straight debt instruments. Typically they carry a fixed rate of interest and have a maturity period of 5 to 9 years. *Convertible debentures*, as the name implies, are debentures which are convertible, wholly or partly, into equity shares. The conversion period and price are announced in advance.

Deferred Credit Many a time the suppliers of the plant and machinery offer a deferred credit facility under which payment for the purchase of the plant and machinery can be made over a period of time.

Incentive Sources The government and its agencies may provide financial support as an incentive to certain types of promoters or for setting up industrial units in certain locations. These incentives may take the form of *seed capital assistance* (provided at a nominal rate of interest to enable the promoter to meet his contribution to the project), or *capital subsidy* (to attract industries to certain locations), or *tax deferment* or *exemption* (particularly from sales tax) for a certain period.

Miscellaneous Sources A small portion of the project finance may come from miscellaneous sources like unsecured loans, public deposits, and leasing and hire purchase finance. *Unsecured loans* are typically provided by the promoters to bridge the gap between the promoters' contribution (as required by the financial institutions) and the equity capital the promoters can subscribe to. *Public deposits* represent unsecured borrowings from the public at large. *Leasing and hire purchase finance* represent a form of borrowing different from the conventional term loans and debenture capital.

Planning the Means of Finance

We have described the various means of finance that can be tapped for a project. How should you go about determining the specific means of finance for a given project? The guidelines and considerations that should be borne in mind for this purpose are as follows:

- Norms of regulatory bodies and financial institutions

- Key business considerations

Norms of Regulatory Bodies and Financial Institutions In some countries, the proposed means of finance for a project must either be approved by a regulatory agency or conform to certain norms laid down by the government or financial institutions in this regard. The primary purpose of such regulations is to impart prudence to project financing decisions and provide a measure of protection to investors. In addition, the norms of financial institutions, which often provide substantial assistance to projects significantly shape and circumscribe project financing decisions.

Key Business Considerations The key business considerations which are relevant for the project financing decision are: cost, risk, control, and flexibility.

Cost In general the cost of debt funds is lower than the cost of equity funds. Why? The primary reason is that the interest payable on debt capital is a tax-deductible expense whereas the dividend payable on equity capital is not.

Risk The two main sources of risk for a firm (or project) are: business risk and financial risk. *Business risk* refers to the variability of earnings before interest and taxes and arises mainly from fluctuations in demand and variability of prices and costs. *Financial risk* represents the risk arising from financial leverage. It must be emphasised that while debt capital is cheap it is also risky because of the fixed financial burden associated with it.

Generally the affairs of the firm are, or should be, managed in such a way that the total risk borne by equity shareholders, which consists of business risk and financial risk, is not unduly high. This implies that if the firm is exposed to a high degree of business risk, its financial risk should be kept low. On the other hand, if the firm has a low business risk profile, it can assume a high degree of financial risk.

Control From the point of view of the promoters of the project, the issue of control is important. They would ordinarily prefer a scheme of financing which enables them to maximise their control, current as well as potential, over the affairs of the firm, given their commitment of funds to the project.

Flexibility This refers to the ability of a firm (or project) to raise further capital from any source it wishes to tap to meet the future financing needs. This provides manoeuvrability to the firm. In most practical situations, flexibility means that the firm does not fully exhaust its debt capacity. Put differently, it maintains reserve borrowing powers to enable it to raise debt capital to meet largely unforeseen future needs.

6.3 ESTIMATES OF SALES AND PRODUCTION

Typically, the starting point for profitability projections is the forecast of sales revenues. In estimating sales revenues, the following considerations should be borne in mind:

1. It is not advisable to assume a high capacity utilisation level in the first year of operation. Even if the technology is simple and the company may not face technical problems in achieving a high rate of capacity utilisation in the first year itself, there are likely to be other constraints like raw material shortage, limited power, marketing problems, etc. It is sensible to assume that capacity utilisation would be somewhat low in the first year and rise thereafter gradually to reach the maximum level in the third or fourth year of operation. A reasonable assumption with respect to capacity utilisation is as follows: 40–50 per cent of the installed capacity in the first year, 50–80 per cent in the second year, and 80–90 per cent from the third year onwards.
2. It is not necessary to make adjustments for stocks of finished goods. For practical purposes, it may be assumed that production would be equal to sales.
3. The selling price considered should be the price realisable by the company net of excise duty. It shall, however, include dealers' commission which is shown as an item of expense (as part of the sales expenses).
4. The selling price used may be the present selling price—it is generally assumed that changes in selling price will be matched by proportionate changes in cost of production.[2] If a portion of production is saleable at a controlled price, take the controlled price for that portion.

Sales and production are closely inter-related. Hence they may be estimated together. For this purpose, the format given in Exhibit 6.2, which shows Form XII A of the application form used by financial institutions in India, may be employed.

6.4 COST OF PRODUCTION

Given the estimated production, the cost of production may be worked out. The major components of cost of production are:

- Material cost
- Utilities cost
- Labour cost
- Factory overhead cost

Materials

The most important element of cost, the material cost comprises the cost of raw materials, chemicals, components, and consumable stores required for production. It is a function of the quantities in which these materials are required and the prices payable for them.

2. This assumption is commonly used by financial institutions. However, it is not very convincing.

Exhibit 6.2 ***Estimates of Production and Sales***

(Details may be furnished separately for each product and until the plant reaches maximum capacity utilisation)

	Product				Product			
	1st yr.	*2nd yr.*	*3rd yr.*	*4th yr.*	*1st yr.*	*2nd yr.*	*3rd yr.*	*4th yr.*
1. Installed capacity (qty. per day per annum)								
2. No. of working days								
3. No. of shifts								
4. Estimated production per day (qty.)								
5. Estimated annual production (qty.)								
6. Estimated output as % of plant capacity								
7. Sales (qty.) (after adjusting stocks)								
8. Value of sales (in '000 of Rs)								
Product (I)								
(II)								
(III)								

Note: Production in the initial period should be assumed at a reasonable level of utilisation of capacity increasing gradually to attain full capacity in subsequent years.

While estimating the material cost, the following points should be borne in mind:

1. The requirements of various material inputs per unit of output may be established on the basis of one or more of the following: (a) theoretical consumption norms, (b) experience of the industry, (c) performance guarantees, and (d) specification of machinery suppliers.
2. The total requirement of various material inputs can be obtained by multiplying the requirements per unit of output with the expected output during the year.
3. The prices of material inputs are defined in CIF (cost, insurance, and freight) terms.
4. The present costs of various material inputs is considered. In other words, the factor of inflation is ignored. It may be recalled that the factor of inflation is ignored in estimating the sales revenues too.
5. If seasonal fluctuations in prices are regular, the same must be considered in estimating the cost of material inputs.

Utilities

Utilities consist of power, water, and fuel. The requirements of power, water, and fuel may be determined on the basis of the norms specified by the collaborators, consultants, etc. or the consumption standards in the industry, whichever is higher.

The cost of power shown here would include only the cost of bought out power and it may be estimated on the basis of power tariff structure of the concerned electricity boards. The cost of captive power would naturally be reflected in the cost of fuel, etc. The cost payable to local authorities and charges payable to some other firms for water and/or steam supply may be shown separately. Where the entire water requirement is met out of one's own wells, water charges need not be shown separately. The cost of fuel (furnace oil, coal, firewood, bagasse, etc.) often an important item, is somewhat more difficult to estimate.

Labour

Labour cost is the cost of all the manpower employed in the factory. Labour cost naturally is a function of the number of employees and the rate of remuneration. The requirement of workers depends on the number of operators/helpers required for operating various machines and manning various services. The number of supervisory personnel and administrative staff may be calculated on the basis of the general norms prevailing in the industry.

In estimating remuneration rates, the prevailing rates in the industry/area should be taken into account. The remuneration should include, besides basic pay, dearness allowance, house rent allowance, conveyance allowance, medical reimbursement, leave travel concession, provident fund contribution, gratuity contribution, and bonus payments. In addition, account should be taken of vacations, overtime work, night work, work on holidays, etc. Sometimes labour cost is estimated by adding a certain percentage, on a global basis, to the basic pay. It is, however, advisable to make a detailed analysis, at least in the beginning. Labour cost estimates may be raised at the rate of 5 per cent per annum to allow for annual increment, etc.

Labour cost may be calculated for the year in which the maximum capacity utilisation is first achieved. For the earlier years, when the capacity utilisation tends to be low, somewhat lower labour costs, but not proportionately lower in relation to capacity, may be assumed.

Factory Overheads

The expenses on repairs and maintenance, rent, taxes, insurance on factory assets, and so on are collectively referred to as factory overheads. Repairs and maintenance expense depends on the state of the machinery—this expense tends to be lower in the initial years

and higher in the later years. Rent, taxes, insurance, etc. may be calculated at the existing rates. A provision should be made for meeting miscellaneous factory expenses. In addition, a contingency margin may be provided on the items of factory overheads.

6.5 WORKING CAPITAL REQUIREMENT AND ITS FINANCING

In estimating the working capital requirement and planning for its financing, the following points have to be born in mind:

1. The working capital requirement consists of the following: (i) raw materials and components (indigenous as well as imported), (ii) stocks of goods-in-process (also referred to as work-in-process), (iii) stocks of finished goods, (iv) debtors, (v) operating expenses and (vi) consumable stores.
2. The principal sources of working capital finance are: (i) working capital advances provided by commercial banks, (ii) trade credit, (iii) accruals and provisions, and (iv) long term sources of financing.
3. There are limits to obtaining working capital advances from commercial banks. They are in two forms: (i) the aggregate permissible bank finance is specified as per the norms of lending, followed by the lending bank, (ii) against each current asset a certain amount of margin money has to be provided by the firm.
4. The Tandon Committee has suggested three methods for determining the maximum permissible amount of bank finance for working capital. The method that is generally employed now is the second method[3]. According to this method, the maximum permissible bank finance is calculated as follows:

   Current assets as per the norms laid down by the Tandon Committee (0.75) _ Non-bank current liabilities like trade credit and provisions

   The implication of this norm is that at least 25 percent of current assets must be supported by long-term sources of finance.
5. The margin requirement varies with the type of current asset. While there is no fixed formula for determining the margin amount, the ranges within which margin requirements for various current assets lie are as follows:

Current Assets	*Margin*
Raw materials	10–25 percent
Work-in-process	20–40 percent
Finished goods	30–50 percent
Debtors	30–50 percent

Form IX B of the application form used by all Indian financial institutions, given in Exhibit 6.3, may be used to estimate the working capital requirement, the amount of bank finance available, and the margin money for working capital to be provided from long-term sources.

3. Note that now banks are free to follow their own norms of bending. Yet many of them follow the second method suggested by the Tandon Committee.

Exhibit 6.3 ***Margin Money for Working Capital***

Items	No. of Months Requirements	Bank Margin Availability	Amount	1 Year*		
				Amount of Bank Finance	Margin Money Required	Amount
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Indigenous raw materials/ components						
Less: Trade credits						
Net indigenous raw materials/components						
2. Imported raw materials/ components						
3. Consumable stores						
Less: Trade credit						
Net consumable stores						
4. Wages and salaries						
5. Cost of fuel, light and power, taxes, insurance, rent, etc.						
6. Cost of repairs and maintenance						
7. Packing and sales expenses (other than salaries and wages on sales staff which should be included under 4 above)						
8. Stock of finished goods at cost excluding depreciation (to be held for the period between production and realisation of sale proceeds)						
9. Stock of goods-in-process (cost of production, excluding depreciation during the period taken for one complete cycle, i.e. from the raw material to the finished goods stage)						
10. Outstanding debtors						
11. Other items of working capital, if any (excise duty payable on 1 month's sale, deposits for utilities, etc.)						
Less: Trade credits available on raw materials and consumables						
Net working capital**						

Note: 1. The information may be provided for the initial years until the unit reaches maximum capacity utilisation.
2. The amounts given here shall agree with the figures in the profitability statements as well as the cash flow statements.

* Similar information has to be furnished for the II, III, and IV years.

** Advance payments, if any, from customers against orders should be deducted from the net working capital and margin money.

6.6 PROFITABILITY PROJECTIONS (OR ESTIMATES OF WORKING RESULTS)

Given the estimates of sales revenues and cost of production, the next step is to prepare the profitability projections or estimates of working results (as they are referred to by term-lending financial institutions in India). The estimates of working results may be prepared along the following lines:

A Cost of production
B Total administrative expenses
C Total sales expenses
D Royalty and know-how payable
E Total cost of production (*A* + *B* + *C* + *D*)
F Expected sales
G Gross profit before interest : Expected sales − cost of prod^n (F − E)
H Total financial expenses
I Depreciation
J Operating Profit (*G* − *H* − *I*)
K Other income
L Preliminary expenses written off
M Profit/loss before taxation (*J* + *K* − *L*)
N Provision for taxation
O Profit after tax (*M* − *N*)
Less Dividend on
- Preference capital
- Equity capital

P Retained profit
Q Net cash accrual (*P* + *I* + *L*)

Exhibit 6.4 shows Form XII of the application form used by all Indian financial institutions for preparing the estimates of working results.

Cost of Production This represents the cost of materials, labour, utilities, and factory overheads as calculated earlier.

Total Administrative Expenses This consists of (i) administrative salaries, (ii) remuneration to directors, (iii) professional fees, (iv) light, postage, telegrams, and telephones, and office supplies (stationery, printing, etc.), (v) insurance and taxes on office property, and (vi) miscellaneous items.

Total Sales Expenses The expenses included under this head are: (i) commission payable to dealers, (ii) packing and forwarding charges, (iii) salary of sales staff (which may be increased at 5 percent per annum), (iv) sales promotion and advertising expenses, and (v) other miscellaneous expenses.

The selling expenses depend mainly on the nature of industry and the kind of competitive conditions that prevail. Typically, selling expenses vary between 5 and 10 percent of sales. The experience of similar firms in the industry may be used as a basic guideline.

Royalty and Know-how Payable Royalty and know-how payable annually may be shown here. The royalty rate is usually 2–5 per cent of sales. Further, royalty is payable often for a limited number of years, say 5 to 10 years.

Total Cost of Production This is simply the sum of cost of production, total administrative expenses, total sales expenses, and royalty and know-how payable.

Expected Sales The figures of expected sales are drawn from the estimates of sales and production prepared earlier in the financial analysis and projection exercise.

Gross Profit Before Interest This represents the difference between expected sales and total cost of production.

Total Financial Expenses Financial expenses consist of interest on term loans, interest on bank borrowings, commitment charges on term loans, and commission for bank guarantees. The principal financial expenses, of course, are interest on term loans and interest on bank borrowings.

In estimating the interest on term loans, two points should be borne in mind: (i) Interest on term loans is based on the present rate of interest charged by the term lending financial institutions and commercial banks. (ii) Interest amount would decrease according to the repayment schedule of the term loan.

The interest on bank borrowings may be estimated as follows: (i) determine the total requirement of the working capital, (ii) find out the quantum of bank borrowing that would be available against the total working capital requirement, and (iii) calculate the interest charges on the basis of the prevailing interest rates.

Depreciation This is an important item, particularly for capital-intensive projects. In figuring out the depreciation charge, the following points should be borne in mind:

1. Contingency margin and pre-operative expenses provided in estimating the cost of project should be added to the fixed assets proportionately to ascertain the value of fixed assets for determining the depreciation charge.

Exhibit 6.4 ***Estimates of Working Results***

(This statement should be prepared for ten years)

(In thousands of rupees)

	Year ending					
	20	*20*	*20*	*20*	*20*	*(ten years)*
A Cost of Production (as per statement in Form XI)						
Administrative expenses						
Administrative salaries						
Remuneration to directors						
Professional fees						
Light, postage, telegrams, and telephones, office supplies (stationery, printing, etc.)						
Insurance and taxes on office property						
Miscellaneous						
B Total Administrative Expenses						
C Total Sales Expenses						
D Royalty and Know-how Payable						
E Total Cost of Production (*A* + *B* + *C* + *D*)						
F Expected Sales (As per statement in Form XII-A)						
G Gross Profit Before Interest (*F* – *E*)						
Financial expenses						
Interest on term loans						
Interest on borrowings for working capital						
Guarantee commission						
H Total Financial Expenses						
I Depreciation						
J Operating Profit (*G*–*H*–*I*)						
K Other Income, if any (Given details)						
L Preliminary Expenses Written Off						
M Profit/Loss before Taxation (*J* + *K* – *L*)						
N Provision for Taxation						
O Profit After Tax (*M* – *N*)						
Less Dividend on						
Preference Capital						
Equity Capital (with rate)						
P Retained Profit						
Add Depreciation						
Preliminary Expenses Written Off						
Q Net Cash Accruals						

Note: Detailed working shall be provided for the calculation of depreciation (straightline and income tax method), interest, taxation, etc.

2. Preliminary expenses in excess of 2.5 per cent of the project cost (excluding working capital margin) should be added to fixed assets proportionately to ascertain the value of fixed assets for determining the depreciation charge.
3. The Income Tax Act specifies that the written down value method[4] should be used for tax purposes. It further specifies the rate of depreciation applicable to different kinds of assets.
4. For company law (financial reporting) purposes, the method of depreciation may be either the written down value (WDV) method or the straight line (SL) method. From 1988 onwards the depreciation rates under the Companies Act have been delinked from those under the Income Tax Act. The key depreciation rates under the Companies Act are as follows:

In percentage terms

	Single Shift		*Triple Shift*	
	WDV	*SL*	*WDV*	*SL*
1. Building (other than factory buildings)	5.00	1.63		
2. Factory buildings	10.00	3.34		
3. Plant and machinery (general rate)	13.91	4.75	27.82	10.34

Other Income This represents income arising from transactions not part of the normal operations of the firm. Examples of such transactions are: sale of machinery, disposal of scrap, etc. Except disposal of scrap, which can be reasonably anticipated and estimated, the effects of other non-operating transactions can hardly be estimated. Of course, when non-operating transactions result in a deficit, other income would be negative—put differently, there will be a non-operating loss.

Write-off of Preliminary Expenses Preliminary expenses up to 2.5 per cent of the cost of project or capital employed, whichever is higher, can be amortised in ten equal annual instalments.

Profit/Loss Before Taxation This is equal to: operating profit + other income—write-off of preliminary expenses.

Provision for Taxation To figure out the tax burden, a sound understanding of the Income Tax Act—a complicated legislation—and relevant case laws is required. While calculating

4. According to the written down value method, the depreciation charge is a certain percentage of the written down value of the asset. For example, if an asset costs Rs 1 million and the depreciation rate for it is 10 per cent, the depreciation charge for the first year would be Rs 100,000, the depreciation charge for the second year would be Rs 90,000 (10 per cent of Rs 9,00,000, the written down value after one year), so on and so forth. In general terms, the depreciation charge for the nth year is:

$$D_n = I\,(1-d)^{n-1}\,d \qquad (1)$$

where D_n = depreciation charge for the nth year
I = initial cost
d = depreciation rate

the taxable income, a variety of incentives and concessions have to be taken into account. Once the taxable income, as per the Income Tax Act, is calculated, the tax burden can be figured out fairly easily by applying the appropriate tax rates. Details pertaining to tax calculation are discussed in an appendix at the end of the book.

Profit After Taxation This is simply profit/loss before taxation minus provision for taxation. A part of profit after tax is usually paid out as dividend—dividend on preference capital and dividend on equity capital.

Retained Profit The difference between profit after tax and dividend payment is referred to as retained profit. It is also called ploughed back earnings.

Net Cash Accrual The net cash accrual from operations is equal to: retained profit + depreciation + write-off of preliminary expenses + other non-cash charges.

6.7 PROJECTED CASH FLOW STATEMENT

The cash flow statement shows the movement of cash into and out of the firm and its net impact on the cash balance within the firm. The format for preparing the cash flow statement, which is really a cash flow budget, as prescribed by the Indian financial institutions is shown in Exhibit 6.5. While this format calls for preparing the cash flow statement on a half-yearly basis for the construction period and on an annual basis for the operating period (for ten years) for managerial purposes, it may be helpful to prepare it on a quarterly basis for the construction period and on a half-yearly basis for the first 2 to 3 operating years for managerial purposes. This would facilitate better financial planning, project evaluation, and fund control.

Illustration

To illustrate how the projected cash flow statement is prepared let us consider a simple example. The balance sheet of Bhavishya Enterprises at the end of year n (the year which is just over) is as follows:

Liabilities		*Assets*		
Share capital	100	Fixed assets		180
Reserves and surplus	20	Investments		–
Secured loans	80	Current assets		180
Unsecured loans	50	Cash	20	
Current liabilities	90	Receivables	80	
Provisions	20	Inventories	80	
	360			360

The projected income statement and the distribution of earnings for the year $n + 1$ is given below:

Exhibit 6.5 ***Cash Flow Statement***

Sources of Funds

1. Share issue
2. Profit before taxation with interest added back
3. Depreciation provision for the year
4. Development rebate reserve
5. Increase in secured medium and long-term borrowings for the project
6. Other medium/long-term loans
7. Increase in unsecured loans and deposits
8. Increase in bank borrowings for working capital
9. Increase in liabilities for deferred payment (including interest) to machinery suppliers
10. Sale of fixed assets
11. Sale of investments
12. Other income (indicate details)

    Total (*A*)

Disposition of Funds

1. Capital expenditure for the project
2. Other normal capital expenditure
3. Increase in working capital*
4. Decrease in secured medium and long-term borrowings
   - All India Institutions
   - SFCs
   - Banks
5. Decrease in unsecured loans and deposits
6. Decrease in bank borrowings for working capital
7. Decrease in liabilities for deferred payments (including interest) to machinery suppliers
8. Increase in investments in other companies
9. Interest on term loans
10. Interest on bank borrowings for working capital
11. Taxation
12. Dividends
    - Equity
    - Preference
13. Other expenditure (indicate details)

    Total (*B*)

- Opening balance of cash in hand and at bank
- Net surplus/deficit (*A* – *B*)
- Closing balance of cash in hand and at bank

* Working capital here is defined as: (Current assets other than cash)–(Current liabilities other than bank borrowings)

Sales	400
Cost of goods sold	300
Depreciation	20
Profit before interest and taxes	80
Interest	20
Profit before tax	60
Tax	30
Profit after tax	30
Dividends	10
Retained earnings	20

During the year $n + 1$, the firm plans to raise a secured term loan of 20, repay a previous term loan to the extent of 5, and increase unsecured loans by 10. Current liabilities and provisions are expected to remain unchanged. Further, the firm plans to acquire fixed assets worth 30 and increase its inventories by 10. Receivables are expected to increase by 15. Other assets would remain unchanged, excepting, of course, cash. The firm plans to pay 10 by way of equity divided.

Given the above information, the projected cash flow statement of Bhavishya Enterprises is shown in Exhibit 6.6.

Exhibit 6.6 ***Projected Cash Flow Statement of Bhavishya Enterprises***

Sources of Funds	
Profit before tax with interest added back	80
Depreciation	20
Increase in secured loans	15
Increase in unsecured loans	10
Total (*A*)	125
Disposition of Funds	
Capital expenditure	30
Increase in working capital	25
Interest	20
Taxation	30
Dividends—Equity	10
Total (*B*)	115
Opening balance of cash in hand and at bank	20
Net surplus/deficit (*A* – *B*)	10
Closing balance of cash in hand and at bank	30

6.8 PROJECTED BALANCE SHEET

The balance sheet, showing the balance in various asset and liability accounts, reflects the financial condition of the firm at a given point of time. The format of a balance sheet as prescribed by the Companies Act is given in Exhibit 6.7.

Exhibit 6.7 ***Format of Balance Sheet Prescribed by the Companies Act***

Liabilities	*Assets*
Share capital	Fixed assets
Reserves and surplus	Investments
Secured loans	Current assets, loans and advances
Unsecured loans	Miscellaneous expenditures and losses
Current liabilities and provisions	

The liabilities side of the balance sheet shows the sources of finance employed by the business. A word about its components shown on the left hand side of Exhibit 6.7 is in order. *Share capital* consists of paid-up equity and preference capital. *Reserves and surplus* represent mainly the accumulated retained earnings. They are shown in different accounts like the capital reserve, the investment allowance reserve, and the general reserve. *Secured loans* represent the borrowings of the firm against which security has been provided. The important components of secured loans are debentures, term loans from financial institutions, and loans from commercial banks. *Unsecured loans* represent borrowings against which no specific security has been provided. The important constituents are: fixed deposits from public and unsecured loans from promoters. *Current liabilities* are obligations which mature in the near future, usually a year. These obligations arise mainly from items which enter the operating cycle: payables from acquiring materials and supplies used in production, and accruals of wages, salaries, and rentals. *Provisions* include mainly tax provision, provision for provident fund, provision for pension and gratuity, and provision for proposed dividends.

The assets side of the balance sheet shows how funds have been used in the business. The major asset components may be described briefly. *Fixed assets* are tangible long-lived resources ordinarily used for producing goods and services. They are shown at original cost less depreciation. *Investments* represent financial securities owned by the firm. *Current assets, loans and advances* consist of cash, debtors, inventories of different kinds, and loans and advances made by the firm. *Miscellaneous expenditures and losses* represent outlays not covered by the previously described asset accounts and accumulated losses, if any.

For preparing the projected balance sheet at the end of year $n + 1$, we need information about the following:

- the balance sheet at the end of year n
- the projected income statement and the distribution of earnings for the year $n + 1$
- the sources of external financing proposed to be tapped in the year $n + 1$
- the proposed repayment of debt capital (long-term, intermediate term, and short-term) during the year $n + 1$
- the outlays and the disposal of fixed assets during the year $n + 1$
- the changes in the level of current assets during the year $n + 1$
- the changes in other assets and certain outlays like preoperative and preliminary expenses (which are capitalised) during the year $n + 1$
- the cash balance at the end of year $n + 1$.

Illustration

By way of illustration, the projected balance sheet of Bhavishya Enterprises may be prepared. Based on the information provided in the previous section (where we introduced Bhavishya Enterprises), the projected balances in various asset and liability accounts are worked out in Exhibit 6.8.

Exhibit 6.8 ***Projected Balances in Liabilities and Assets Accounts***

Account Category	*Opening Balance*	*Changes During the Year*	*Closing Balance*
Liabilities			
Share capital	100	–	100
Reserves and surplus	20	+ 20 (Retained earnings)	40
Secured loans	80	+ 20 (Additional term loan) – 5 (Repayment)	95
Unsecured loans	50	+10 (Proposed increase)	60
Current liabilities	90	–	90
Provisions	20	–	20
			405
Assets			
Fixed assets	180	+30 (Additional outlay) – 20 (Depreciation)	190
Investments	–		–
Current assets	180		215
Cash	20		30*
Inventories	80	+10 (Proposed increase)	90
Receivables	80	+15 (Expected increase)	95
		Total	405

* This is the balancing item.

6.9 MULTI-YEAR PROJECTIONS

Having learnt the basics of projection, we shall now look at an illustration wherein financial projections are made over a longer time frame.

A new firm, ABC Limited, is being set up to manufacture alloy steel. The expected outlays and proposed financing during the construction and the first two operating years are shown in Exhibit 6.9.

The projected revenues and costs for the first two operating years are shown in Exhibit 6.10. It may be assumed that (i) the tax rate for the firm will be 60 per cent, (ii) no deductions (reliefs) are available, (iii) preliminary and pre-operative expenses will be written off during the first two operating years, and (iv) no dividend will be paid in the first two operating years.

Based on the above information, the projected profit and loss statements, projected cash flow statements, and projected balance sheets may be prepared as shown in Exhibits 6.11, 6.12, and 6.13.

Exhibit 6.9 ***Proposed Outlays and Financing of ABC Limited***

	Construction Period	1st Operating Year	(Rs in million) 2nd Operating Year
Outlays			
Preliminary and preoperative expenses	2	—	—
Fixed assets	20	20	10
Current assets (other than cash)	—	20	10
Financing			
Share capital	10	15	—
Term loan	15	15	7.5
Short-term bank borrowing	—	12	6

Exhibit 6.10 ***Projected Revenues and Costs***

	1st Operating Year	(Rs in Million) 2nd Operating Year
Sales	30	60
Cost of sales (excluding interest and depreciation)	30	40
Interest	4.8	6.4
Depreciation	2	2.8

Exhibit 6.11 ***Projected Profit and Loss Statements of ABC Limited***

	1st Operating Year	(Rs in Million) 2nd Operating Year
Sales	30	60
Cost of sales (excluding depreciation and interest)	30	40
Interest	4.8	6.4
Depreciation	2	2.8
Losses (absorbed)	—	6.8
Profit before tax	(6.8)	4
Tax	—	2.4
Profit after tax	(6.8)	1.6

Exhibit 6.12 ***Projected Cash Flow Statements for ABC Limited***

(Rs in million)

	Construction Period	1st Operating Year	2nd Operating Year
Sources of Funds			
Share issue	10	15	
Profit before taxation and interest added back*		(2)	17.2
Depreciation provision for the year		2	2.8
Increase in secured medium and long-term borrowings for the project	15	15	7.5
Increase in bank borrowings for working capital	—	12	6
Total (*A*)	25	42	33.5
Disposition of Funds			
Capital expenditure for the project	20	20	10
Increase in current assets	—	20	10
Interest	—	4.8	6.4
Other expenditure (preliminary and preoperative expenses)	2	—	—
Taxes	—	—	2.4
Total (*B*)	22	44.8	28.8
Opening balance of cash in hand and at cash at bank	—	3	0.2
Net surplus/deficit (*A* - *B*)	3	(2.8)	4.7
Closing balance of cash in hand and at bank	3	0.2	4.9

* This does not, of course, take into account losses absorbed.

- To judge a project from the financial angle, we need information about the following: (i) cost of project, (ii) means of financing, (iii) estimates of sales and production, (iv) cost of production, (v) working capital requirement and its financing, (vi) estimates of working results (profitability projections), (vii) break-even point, (viii) projected cash flow statements, and (ix) projected balance sheets.
- The cost of project represents the sum of all items of outlay associated with a project which are supported by long-term funds. It is the sum of outlays on the following: (i) land and site development, (ii) buildings and civil works, (iii) plant and machinery, (iv) technical know-how and engineering fees, (v) expenses on foreign technicians and training

Exhibit 6.13 ***Projected Balance Sheets of ABC Limited***

(Rs in Million)

Liabilities	*End of Construction Period*	*End of 1st Operating Year*	*End of 2nd Operating Year*	*Assets*	*End of Construction Period*	*End of 1st Operating Year*	*End of 2nd Operating Year*
Share capital	10	25	25	Fixed assets	20	38	45.2
Reserves and surplus			1.6	Current assets			
Secured loan				Cash	3	0.2	4.9
				Others	–	20	30
Term loan	15	30	37.5	Miscellaneous expenditures and losses			
Short-term bank borrowings	–	12	18				
				Preliminary and pre-operative expenses	2	2	2
				Profit and loss account balance	–	6.8	–
Total	25	67	82.1	Total	25	67	82.1

of Indian technicians abroad, (vi) miscellaneous fixed assets, (vii) preliminary and capital issue expenses, (viii) pre-operative expenses, (ix) provision for contingencies, (x) margin money for working capital, and (xi) initial cash losses.

- To meet the cost of project, the following sources of finance (referred to commonly as the means of finance) may be available: share capital (equity capital and preference capital), term loans (rupee term loans and foreign currency term loans), debenture capital (non-convertible debentures and convertible debentures), deferred credit, incentive sources (seed capital assistance, capital subsidy, and tax deferment or exemption), and miscellaneous sources (unsecured loans, public deposits, and lease and hire purchase finance).
- To determine the specific means of finance for a given project, the following should be borne in mind: (i) norms of regulatory bodies and financial institutions, and (ii) key business considerations, namely, cost, risk, control, and flexibility.
- Typically, the starting point for profitability projections is the forecast for sales revenues. In estimating sales it is reasonable to assume that capacity utilisation would be somewhat

low in the first year and rise thereafter gradually to reach the maximum level in the third or fourth year of operation.

- The major components of cost of production are: material cost, utilities cost, labour cost, and factory overhead cost. The material cost comprises the cost of raw materials, chemicals, components, and consumable stores required for production. The cost of utilities is the sum of the cost of power, water, and fuel. The labour cost includes the cost of all manpower employed in the factory. The expenses on repairs and maintenance, rent, taxes and insurance on factory assets, and so on are collectively referred to as factory overheads.
- In estimating the working capital requirement and planning for its financing, the following must be borne in mind: the build up of current assets till the rated level of capacity utilisation is reached, the maximum permissible bank finance as per the second method of lending recommended by the Tandon Committee, and the margin requirements against various current assets.
- The profitability projections or estimates of working results (as they are referred to by term-lending financial institutions) are prepared along the following lines: (i) cost of production, (ii) total administrative expenses, (iii) total sales expenses, (iv) royalty and know-how payable, (v) total cost of production, (vi) expected sales, (vii) gross profit before interest, (viii) total financial expenses, (ix) depreciation, (x) operating profit, (xi) other income, (xii) preliminary expenses written off, (xiii) profit/loss before taxation, (xiv) provision for taxation, (xv) profit after tax, (xvi) dividend, (xvii) retained profit, and (xviii) net cash accrual.
- The cash flow statement shows the movement of cash into and out of the firm and its net impact on the cash balance with the firm.
- The balance sheet, showing the balance in various asset and liability accounts, reflects the financial condition of the firm at a given point of time.

Questions

1. **Show how various financial estimates and projections are inter-related.**
2. **What are the components of cost of project? Discuss them in detail.**
3. **Describe briefly the various means of financing a project.**
4. **Discuss the key business considerations relevant for a project financing decision.**
5. **What considerations should be borne in mind while estimating sales revenues?**
6. **Discuss in detail the major components of cost of production.**
7. **What points should be kept in mind while estimating the working capital requirement and planning for its financing?**
8. **Discuss the items that are considered in estimating the working results.**
9. **What are the items found in the cash flow statement?**
10. **Discuss the contents of the balance sheet.**

Problems

1. The balance sheet of Swaraj Limited at the end of year n (the year which is just over) is as follows:

(Rs in million)

Liabilities		Assets	
Share capital	5	Fixed assets	11
Reserves and surplus	4	Investments	0.5
Secured loans	4	Current assets	11.5
Unsecured loans	3	• Cash	1
Current liabilities	6	• Receivables	4
Provisions	1	• Inventories	6.5
	23		23

The projected income statement and the distribution of earnings is given below:

(Rs in million)

Sales	25
Cost of goods sold	19
Depreciation	1.5
Profit before interest and taxes	4.5
Interest	1.2
Profit before tax	3.3
Tax	1.8
Profit after tax	1.5
Dividends	1.0
Retained earnings	0.5

During the year $n+1$, the firm plans to raise a secured term loan of Rs 1 million, repay a previous term loan to the extent of Rs 0.5 million. Current liabilities and provisions would increase by 5 per cent. Further, the firm plans to acquire fixed assets worth Rs 1.5 million and raise its inventories by Rs 0.5 million. Receivables are expected to increase by 5 per cent. The level of cash would be the balancing amount in the projected balance sheet. Given the above information, prepare the following:

(i) Projected cash flow statement

(ii) Projected balance sheet

2. Hitek Limited is being set up to manufacture plastic window frames. The expected outlays and proposed financing during the construction and the first operating year are shown below:

Outlays	Construction period	1st operating year
Land	120	—
Building	630	—
Plant and machinery	2700	—
Miscellaneous fixed assets	450	—
Preliminary expenses	150	—
Pre-operative expenses	600	—
Current assets (other than cash)	—	2400
	4650	2400
Financing		
Equity capital	1800	—
Term loan	3000	600
Short-term bank borrowing	—	1800
	4800	2400

The following information is available:

(a) The construction period will last for one year, beginning on 1st April of year n and ending on 31st march of year $n + 1$.

(b) The first operating period will begin on 1st April of year $n + 1$ and end on 31st March of year $n + 2$.

(c) The term loan will carry an interest of 20 percent. It is repayable in 16 equal semi-annual instalments after a grace period of 2 years. The interest on term loan during the construction period is included in *pre-operative expenses*. The term loan financing of 600 in the *first operating period* will occur right in the beginning of that year.

(d) Short-term bank borrowing of 1800 will occur right in the beginning of the first operating year. It will carry an interest rate of 18 percent.

(e) Pre-operative expenses may be allocated to land, building, plant and machinery, and miscellaneous fixed assets in proportion of their values.

(f) The expected revenues and cost of sales (excluding depreciation, other amortisation, and interest) for the first operating year are 4500 and 3000 respectively.

(g) The depreciation rates for company law purposes will be as follows:

Building	...	3.34 percent
Plant and machinery	...	8.09 percent
Miscellaneous fixed assets	...	8.09 percent

(h) There will be no tax liability for the first operating year.

Given the above information, complete the following projected statements:

Projected Income Statement for the 1st Operating Year

Sales	4500
Cost of sales	3000
Depreciation	—
Interest	—
Write-off of preliminary expenses	15
Net profit	—

Projected Cash Flow Statements

Sources	**Construction period**	**1st operating year**
Share capital	1800	...
Term loan	3000	...
Short-term bank borrowing		...
Profit before interest and tax		...
Depreciation		...
Write-off of preliminary expenses		...
	4800	...
Uses		
Capital expenditure	3900	...
Current assets (other than cash)	—	...
Preliminary expenses	150	...
Pre-operative expenses	600	
Interest	—	...
	4650	...
Opening cash balance	0	...
Net surplus/deficit	150	...
Closing balance	150	...

Projected Balance Sheets

Liabilities	31/3/*n* + 1	31/3/*n* +2	**Assets**	31/3/*n* + 1	31/3/*n* + 2
Share Capital	1800	...	Fixed Assets (Net)	4500	...
Reserves and Surplus	—	...			
Secured Loans:			Current Assets:		
— Term loan	3000	...	— Cash	150	...
— Short-term borrowing		...	— Other Current Assets		...
Unsecured Loans	—	...			

Current Liabilities and Provisions	—	...	**Miscellaneous Expenditures and Losses — Preliminary Expenses**	150	...
	4800	...		4800	...

APPENDIX 6A

VEGETRON LIMITED: A CASE STUDY ON FINANCIAL PROJECTIONS

Background

Vegetron Limited is a newly set up public limited company, promoted by Mr Muthaiah, Mr Balasubramaniam, and Mr Krishna. Mr Muthaiah, the managing director of the company, is a food technologist with over twenty years of experience in some of the well-known companies in the food sector. Mr Balasubramaniam, the finance director, is a qualified chartered accountant with over twenty-five years of industrial experience. Mr Krishna, the marketing director, has over fifteen years of experience in marketing food products.

Vegetron proposes to set up a plant to manufacture Textured Vegetable Protein (TVP), at a location not far from Bangalore. TVP is a high protein instant food mix, which is considered to be a substitute for meat. Due to its texture, TVP has an appeal for both vegetarians and non-vegetarians. So it is expected to enjoy a growing market. There are only two other units in the country manufacturing TVP, located near Bhopal and Delhi. Both of them are now doing reasonably well, though they had some problems initially.

Technical and Marketing Aspects

The process know-how for TVP is proposed to be supplied by Spectra Machines Private Limited, a project engineering company, which will supply the main extrusion plant. The indigenous extrusion plant developed by Spectra Machines is a cost-effective alternative to imported extrusion plants. While the extrusion plant of Spectra Machines costs Rs 5.5 million, a similar imported plant costs Rs 9 million (inclusive of customs duty). Spectra Machines have supplied similar plants to the other two manufacturers of TVP and they are running satisfactorily. Vegetron proposes to give a turn-key contract of Spectra Machines that covers supply and commissioning of the unit along with a guarantee for a satisfactory trial run for a consideration of Rs 6.2 million. A condition will stipulate that the last 25 per cent of the amount is to be released only after a satisfactory trial run.

Vegetron will require about 2000 TPA (tonnes per annum) of defatted soya as the raw material at its optimum capacity utilisation. Enquiries in Bhopal, which is the major centre for defatted soya, suggest that there is no problem whatsoever in procuring this quantity.

Vegetron plans to market its product in two forms: bulk TVP and branded TVP. While the former is sold as a commodity the latter is marketed as a branded product. The bulk TVP requires very little marketing effort as well as expenses but the margin on its sales is low. The branded TVP, on the other hand, entails considerable marketing effort and expenditure and the margin on its sales is high. It is expected that the revenues from bulk TVP and branded TVP will be in the ratio 80 : 20. Given this mix, the sales expenses are expected to be 10 per cent of net sales.

Cost of Project and Means of Finance

The cost of the project is estimated at Rs 11.44 million as follows:

	(Rs in million)
Land and site development	0.39
Building	1.50
Plant and machinery	6.20
Miscellaneous fixed assets	0.40
Preliminary expenses	0.20
Pre-operative expenses (including interest during construction)	1.15
Contingency margin	0.75
Working capital margin	0.85
	11.44

The proposed means of finance for the project are as follows:

	(Rs in million)
Share capital	4.0
Term loans	6.4
State governments' special incentive loan (Repayable in 6 instalments after 12 years)	1.04
	11.44

The discussions with state level financing agencies and a commercial bank suggest that it should be feasible to get term loans and working capital finance for the project.

Basic Assumptions Underlying Financial Projections

The profitability and other projections may be prepared on the basis of the following assumptions:

1. The construction period will last for one year.
2. The company would work for 300 days per year on a 2 shift basis. The installed capacity on this basis works out to 2880 TPA.

3. The company will start commercial production on April 1, of year 1. The expected capacity utilisation will be 50 per cent in the first year, 60 per cent in the second year, and 70 per cent for the third year and beyond.
4. The average sales realisation per kilogram of TVP will be Rs 12, net of excise duty.
5. The cost of raw materials and consumables will be 65 per cent of sales; the cost of power will be 4 percent of sales.
6. Wages and salaries are expected to be Rs 0.9 million, Rs 1 million, and Rs 1.2 million for the first, second, and third operating years. Thereafter, they would rise at the rate of 5 percent per year.
7. Factory overhead expenses will be Rs 50,000 for the first year. They will increase at the rate of 6 per cent per year subsequently.
8. Administration expenses will be Rs 100,000 per year.
9. Selling expenses will be 10 percent of sales.
10. The term loan will be repaid in 16 equal half-yearly instalments, with the first instalment falling due at the end of the second operating year. The interest rate on the outstanding term loan will be 14 percent.
11. The current asset requirements are expected to be as follows:

Raw materials (including consumables)	: 1.50 months
Stock-in-process	: 0.03 month
Finished goods	: 0.50 month
Book debt	: 1.00 month

12. The suppliers of raw materials and consumables will provide trade credit for half a month.
13. The bank finance for working capital will cost 18 percent.
14. The depreciation rates[1] for company law purposes are as follows:

Building	: 3.34 percent
Plant and machinery	: 8.09 percent
Miscellaneous fixed assets	: 5.15 percent

15. The depreciation rates for income tax[2] purposes are as follows, under the written down value method:

Building	: 10 percent
Plant and machinery and miscellaneous fixed assets	: 33.3 percent

16. The preliminary expenses may be written off in 10 equal annual instalments.
17. The income tax rate applicable is 45 percent. Further 30 percent of Gross Total Income will be allowed as deduction.
18. The firm plans to pay dividend from the second year. The dividend rate is proposed to be 12 percent for the second year. Thereafter, it would be enhanced by 2 percent every alternate year.

1, 2 Note that these were the rates when this project was set up. Current rates, however, are different.

In order to prepare the profitability estimates (estimates of working results), the projected cash flow statements, and the projected balance sheets, we need information about

(a) interest on term loan,
(b) working capital requirements, and
(c) depreciation schedule.

This is developed in Exhibits 6A.1, 6A.2, and 6A.3 respectively.

Putting together all the above information, the following projections have been prepared:

Exhibit 6A.4 : Profitability Estimates
Exhibit 6A.5 : Tax Calculation
Exhibit 6A.6 : Projected Cash Flow Estimates
Exhibit 6A.7 : Projected Balance Sheets

Exhibit 6A.1 *Interest on Term Loans*

(Rs in million)

Year	Loan o/s at the Beginning	Loan o/s at the End of the First Half Year	Loan o/s at the End of the Second Half Year	Int. for the First Half Year	Int. for the Second Half Year	Total Interest for the Term Loan
I	6.4	6.4	6.4	0.45	0.45	0.90
II	6.4	6.4	6.0	0.45	0.45	0.90
III	6.0	5.6	5.2	0.42	0.39	0.81
IV	5.2	4.8	4.4	0.36	0.34	0.70
V	4.4	4.0	3.6	0.31	0.28	0.59
VI	3.6	3.2	2.8	0.25	0.22	0.48
VII	2.8	2.4	2.0	0.20	0.17	0.36
VIII	2.0	1.6	1.2	0.14	0.11	0.25
IX	1.2	0.8	0.4	0.08	0.06	0.14
X	0.4	–	–	0.03	–	0.03

Exhibit 6A.2 *Working Capital Requirements*

(Rs in million)

	Item	Norms in Months	I year	II year	III year
1.	Raw Materials (including consumables)	1.5	1.40	1.67	1.97
2.	Stock-in-Process	0.03	0.03	0.04	0.04
3.	Finished Goods	0.5	0.52	0.62	0.75
4.	Book Debts*	1.0	1.44	1.73	2.02
	Total Current Assets		3.39	4.06	4.78
Less	Margin for Working Capital from Long-term Sources (25% of Total Current Assets)		0.85	1.02	1.20
Less	Trade Credit for Raw Materials and Consumable Stores	0.5	0.47	0.56	0.66
	Bank Finance for Working Capital		2.07	2.48	2.92

* Book debts include excise duty. However, for the sake of simplicity we have ignored excise duty here.

Exhibit 6A.3 *Depreciation Schedules*

(Rs in million)

A. Asset Valuation for Depreciation Purposes

Asset Expenses	*Basic Cost*	*Share of Preoperative Cost*	*Share of Contingency Margin*	*Total*
Land	0.39	0.05	0.03	0.47
Building	1.50	0.20	0.13	1.83
Plant and machinery	6.20	0.84	0.55	7.59
Miscellaneous fixed assets	0.40	0.05	0.04	0.49

B. Depreciation Schedule for Company Law Purposes (Straight Line Method)

Building (3.34%)	: 0.061
Plant and machinery (8.09%)	: 0.614
Miscellaneous fixed assets (5.15%)	: 0.025
Annual depreciation	: 0.700

C. (Depreciation Schedule for Income Tax Purposes (Written Down Value Method)

	I	II	III	IV	V	VI	VII	VIII	IX	X
Building (10%)	0.183	0.165	0.148	0.133	0.120	0.108	0.097	0.088	0.079	0.071
Plant and machinery and misc. fixed assets (33 1/3%)	2.693	1.795	1.197	0.798	0.532	0.355	0.236	0.158	0.105	0.070
Total	2.876	1.960	1.345	0.931	0.652	0.463	0.333	0.246	0.184	0.141

Exhibit 6A.4 *Profitability Estimates (Estimates of Working Results)*

(Rs in million)

	I Year	*II Year*	*III Year*	*IV Year*	*V Year*	*VI Year*	*VII Year*	*VIII Year*	*IX Year*	*X Year*
Installed Capacity (TPA)	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880
Production (TPA)	1440	1728	2016	2016	2016	2016	2016	2016	2016	2016
Capacity Utilisation	50%	60%	70%	70%	70%	70%	70%	70%	70%	70%
A Sales Realisation	17.28	20.74	24.19	24.19	24.19	24.19	24.19	24.19	24.19	24.19
B Cost of Production										
• Raw materials	11.23	13.48	15.72	15.72	15.72	15.72	15.72	15.72	15.72	15.72
• Power	0.69	0.83	0.97	0.97	0.97	0.97	0.97	0.07	0.97	0.97
• Wages and salaries	0.90	1.00	1.20	1.26	1.32	1.39	1.46	1.53	1.61	1.69
• Factory overheads	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.08
C Administration and Selling Expenses										
• Administration expenses	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
• Selling expenses	1.73	2.07	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42
D Gross Profit Before Interest	2.58	3.21	3.72	3.66	3.60	3.53	3.45	3.38	3.29	3.21
E Total Financial Expenses										
• Interest on term loans	0.90	0.90	0.81	0.70	0.59	0.48	0.36	0.25	0.14	0.03

• Interest on bank borrowing	0.37	0.45	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
F Depreciation	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
G Operating Profit	0.61	1.16	1.68	1.73	1.78	1.82	1.86	1.90	1.92	1.95
H Preliminary Expenses Written off	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
I Profit/Loss Before Tax	0.59	1.14	1.66	1.71	1.76	1.80	1.84	1.88	1.90	1.93
*J Provision for Tax**	–	–	–	0.25	0.57	0.64	0.70	0.73	0.76	0.78
K Profit after Tax	0.59	1.14	1.66	1.46	1.19	1.16	1.14	1.15	1.14	1.15
L Less: Dividend	–	0.48	0.48	0.56	0.56	0.64	0.64	0.72	0.72	0.80
M Retained Profit	0.59	0.66	1.18	0.90	0.63	0.52	0.50	0.43	0.42	0.35
N Add: Depreciation	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Preliminary expenses written off	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
O Net Cash Accruals	1.31	1.38	1.90	1.62	1.35	1.24	1.22	1.15	1.14	1.07

* The details of tax calculation are shown in Exhibit 6A.5.

Exhibit 6A.5 *Tax Calculation*

(Rs in million)

	I Year	*II Year*	*III Year*	*IV Year*	*V Year*	*VI Year*	*VII Year*	*VIII Year*	*IX Year*	*X Year*
• Profit/loss before tax	0.59	1.14	1.66	1.71	1.76	1.80	1.84	1.88	1.90	1.93
Add depreciation for company law purposes	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
	1.29	1.84	2.36	2.41	2.46	2.50	2.54	2.58	2.60	2.63
Less depreciation for tax purposes	2.88	1.96	1.35	0.93	0.65	0.46	0.33	0.25	0.18	0.14
	(1.59)	(0.12)	1.01	1.48	1.81	2.04	2.21	2.33	2.42	2.49
Less unabsorbed depreciation of earlier years	–	–	1.01	0.70	–	–	–	–	–	–
• Gross total income	–	–	–	0.78	1.81	2.04	2.21	2.33	2.42	2.49
Less deduction for newly set up industrial undertaking under section 80I for 10 years from the initial year @ 30% of gross total income	–	–	–	0.23	0.54	0.61	0.66	0.70	0.73	0.75
• Total income	–	–	–	0.55	1.27	1.43	1.55	1.63	1.69	1.74
• Income tax @ 45 per cent of total income	–	–	–	0.25	0.57	0.64	0.70	0.73	0.76	0.78

* For calculating the income tax only the basic rate is considered. The surcharge has been ignored because it tends to vary from year to year.

Exhibit 6A.6 *Projected Cash Flow Statements*

(Rs in million)

	Construction Period	I Year	II Year	III Year	IV Year	V Year	VI Year	VII Year	VIII Year	IX Year	X Year
Sources of Funds											
• Share issue	4.00										
• Profit before taxation with interest added back		1.86	2.49	3.00	2.94	2.88	2.81	2.73	2.66	2.57	2.49
• Depreciation		0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
• Preliminary expenses written off		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
• Increase in secured medium and long-term borrowings	6.40	–	–	–	–	–	–	–	–	–	–
• Increase in bank borrowings for working capital		2.07	0.41	0.44	–	–	–	–	–	–	–
• Increase in the State Govt's Special Incentive Loan	1.04	–	–	–	–	–	–	–	–	–	–
Total (*A*)	11.44	4.65	3.62	4.16	3.66	3.60	3.53	3.45	3.38	3.29	3.21
Disposition of Funds											
• Capital expenditure for the project	10.39	–	–	–	–	–	–	–	–	–	–
• Increase in working capital		2.92	0.58	0.62	–	–	–	–	–	–	–
• Preliminary expenses	0.20	–	–	–	–	–	–	–	–	–	–
• Decrease in secured medium and long-term borrowings		–	0.40	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.40
• Interest on term loans		0.90	0.90	0.81	0.70	0.59	0.48	0.36	0.25	0.14	0.03
• Interest on bank borrowings for working capital		0.37	0.45	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
• Taxation		–	–	–	0.25	0.57	0.64	0.70	0.73	0.76	0.78
• Dividend		–	0.48	0.48	0.56	0.56	0.64	0.64	0.72	0.72	0.80
Total (*B*)	10.59	4.19	2.81	3.24	2.84	3.05	3.09	3.03	3.03	2.95	2.54
• Opening balance of cash in hand and at bank	0	0.85	1.31	2.12	3.04	3.86	4.41	4.85	5.27	5.62	5.96
• Net surplus/deficit *A–B*	0.85	0.46	0.81	0.92	0.82	0.55	0.44	0.42	0.35	0.34	0.67
• Closing balance of cash in hand and at bank	0.85	1.31	2.12	3.04	3.86	4.41	4.85	5.27	5.62	5.96	6.63

Exhibit 6A.7 *Projected Balance Sheets*

(Rs in million)

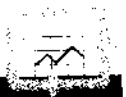
	At the End of the Construction Period	I Year	II Year	III Year	IV Year	V Year	VI Year	VII Year	VIII Year	IX Year	X Year
Liabilities											
• Share Capital	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
• Reserves and Surplus	–	0.59	1.25	2.43	3.33	3.96	4.48	4.98	5.41	5.83	6.18
• Secured Loans											
– Term loans	6.40	6.40	6.00	5.20	4.40	3.60	2.80	2.00	1.20	0.40	–
– Working capital adv.	–	2.07	2.48	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92
• Unsecured Loans											
– State Govt. loan	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
• Current Liabilities and Provisions											
– Trade credit	–	0.47	0.56	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Total	11.44	14.57	15.33	16.25	15.25	16.18	15.90	15.60	15.23	14.85	14.80
Assets											
• Fixed Assets											
– Gross block	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39
– Less accumulated depreciation	–	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
– Net fixed assets	10.39	9.69	8.99	8.29	7.59	6.89	6.19	5.49	4.79	4.09	3.39
• Investments	–	–	–	–	–	–	–	–	–	–	–
• Current Assets, Loans and Advances											
– Raw materials	–	1.40	1.67	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
– Stock-in-process	–	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
– Finished goods	–	0.52	0.62	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
– Book debts	–	1.44	1.73	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
– Cash and bank balances	0.85	1.31	2.12	3.04	3.86	4.41	4.85	5.27	5.62	5.96	6.63
• Miscellaneous Expenditure and Losses											
– Preliminary expenses	0.20	0.18	0.16	0.14	0.12	0.10	0.08	0.06	0.04	0.02	–
Total	11.44	14.57	15.33	16.25	15.25	16.18	15.90	15.60	15.23	14.85	14.80

PART III

Selection: Basic Techniques

7. The Time Value of Money
8. Investment Criteria
9. Project Cash Flows
10. The Cost of Capital
11. Risk Analysis of Single Investments

CHAPTER



7

The Time Value of Money

Money has time value. A rupee today is more valuable than a rupee a year hence. Why? There are several reasons:

- Individuals, in general, prefer current consumption to future consumption.
- Capital can be employed productively to generate positive returns. An investment of one rupee today would grow to $(1 + r)$ a year hence (r is the rate of return earned on the investment).
- In an inflationary period a rupee today represents a greater real purchasing power than a rupee a year hence.

Most financial problems involve cash flows occurring at different points of time. These cash flows have to be brought to the same point of time for purposes of comparison and aggregation. Hence it is important to understand the tools of compounding and discounting which underlie most of what is done in finance —from valuing securities to analysing projects, from determining lease rentals to choosing the right financing instruments, from setting up the loan amortisation schedules to valuing companies, so on and so forth.

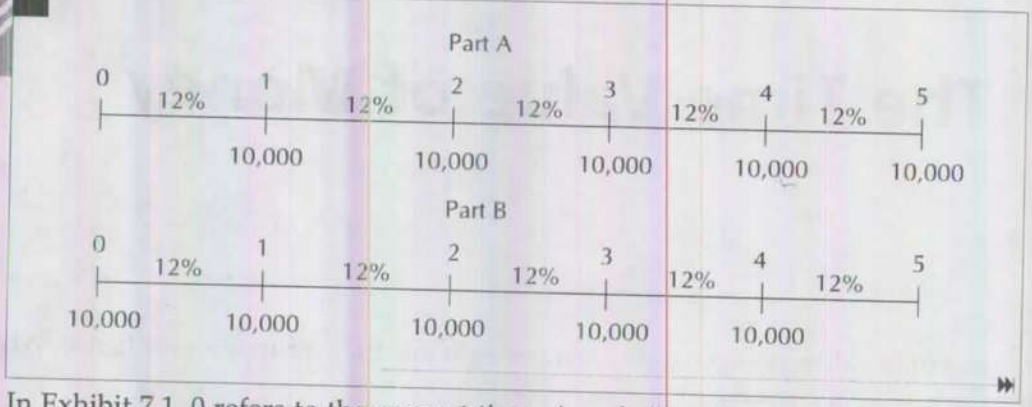
This chapter discusses the methods for dealing with the time value of money. The material covered in this chapter will serve as a foundation for understanding the discounted cash flow techniques —the most important techniques for investment evaluation—which are discussed in the following chapter. This chapter is divided into six sections as follows:

- Time lines and notation
- Future value of a single amount
- Present value of a single amount
- Future value of an annuity
- Present value of an annuity
- Intra-year compounding and discounting

7.1 TIME LINES AND NOTATION

When cash flows occur at different points in time, it is easier to deal with them using a *time line*. A time line shows the timing and the amount of each cash flow in a cash flow stream. Thus, a cash flow stream of Rs 10,000 at the end of each of the next five years can be depicted on a time line like the one shown in Part A of Exhibit 7.1.

Exhibit 7.1 *Time Line*



In Exhibit 7.1, 0 refers to the present time. A cash flow that occurs at time 0 is already in present value terms and hence does not require any adjustment for time value of money. It is necessary to distinguish between a *period of time* and a *point of in time*. Period 1 which is the first year is the portion of time line between point 0 and point 1. The cash flow occurring at point 1 is the cash flow that occurs at the end of period 1. Finally, the discount rate, which is 12 percent in our example, is specified for each period on the time line and it may differ from period to period. If the cash flow occurs at the beginning, rather than the end, of each year, the time line would be as shown in Part B of Exhibit 7.1. Note that a cash flow occurring at the end of year 1 is equivalent to a cash flow occurring at the beginning of year 2.

Cash flows can be positive or negative. A positive cash flow is called a *cash inflow;* and a negative cash flow, a *cash outflow*.

The following notation will be used in our discussion:

PV : Present value
FV_n : Future value n years hence
C_t : Cash flow occurring at the end of year t
A : A stream of constant periodic cash flow over a given time
r : Interest rate or discount rate
g : Expected growth rate in cash flows
n : Number of periods over which the cash flows occur.

7.2 FUTURE VALUE OF A SINGLE AMOUNT

Suppose you invest Rs1,000 for three years in a savings account that pays 10 percent interest per year. If you let your interest income be reinvested, your investment will grow as follows:

First year	: Principal at the beginning	1,000
	Interest for the year (Rs1,000 × 0.10)	100
	Principal at the end	1,100
Second year	: Principal at the beginning	1,100
	Interest for the year (Rs1,100 × 0.10)	110
	Principal at the end	1,210
Third year	: Principal at the beginning	1,210
	Interest for the year (Rs1,210 × 0.10)	121
	Principal at the end	1,331

Formula

The process of investing money as well as reinvesting the interest earned thereon is called compounding. The future value or compounded value of an investment after n years when the interest rate is r percent is :

$$FV_n = PV(1+r)^n \tag{7.1}$$

In this equation $(1+r)^n$ is called the future value interest factor or simply the future value factor.

To solve future value problems you have to find the future value factors. You can do it in different ways. In the example given above, you can multiply 1.10 by itself three times or more generally $(1+r)$ by itself n times. This becomes tedious when the period of investment is long.

Fortunately, you have an easy way to get the future value factor. Most calculators have a key labelled "y^x". So all that you have to do is to enter 1.10, press the key labelled y^x, enter 3, and press the "=" key to obtain the answer.

Alternatively, you can consult a future value interest factor (FVIF) table. Exhibit 7.2 presents one such table showing the future value factors for certain combinations of periods and interest rates. A more comprehensive table is given in Appendix A at the end of the book.

Suppose you deposit Rs1,000 today in a bank which pays 10 percent interest compounded annually, how much will the deposit grow to after 8 years and 12 years?

$$\text{Rs } 1{,}000\ (1.10)^8 = \text{Rs } 1{,}000\ (2.144)$$
$$= \text{Rs } 2{,}144$$

The future value, 12 years hence, will be:

$$\text{Rs } 1{,}000\ (1.10)^{12} = \text{Rs } 1{,}000\ (3.138)$$
$$= \text{Rs } 3{,}138$$

Exhibit 7.2 *Value of $FVIF_{r,n}$ for Various Combinations of r and n*

n/r	6%	8%	10%	12%	14%
2	1.124	1.166	1.210	1.254	1.300
4	1.262	1.360	1.464	1.574	1.689
6	1.419	1.587	1.772	1.974	2.195
8	1.594	1.851	2.144	2.476	1.853
10	1.791	2.159	2.594	3.106	3.707
12	2.012	2.518	3.138	3.896	4.817

While tables are easy to use they have a limitation as they contain values only for a small number of interest rates. So often you may have to use a calculator.

Graphic View

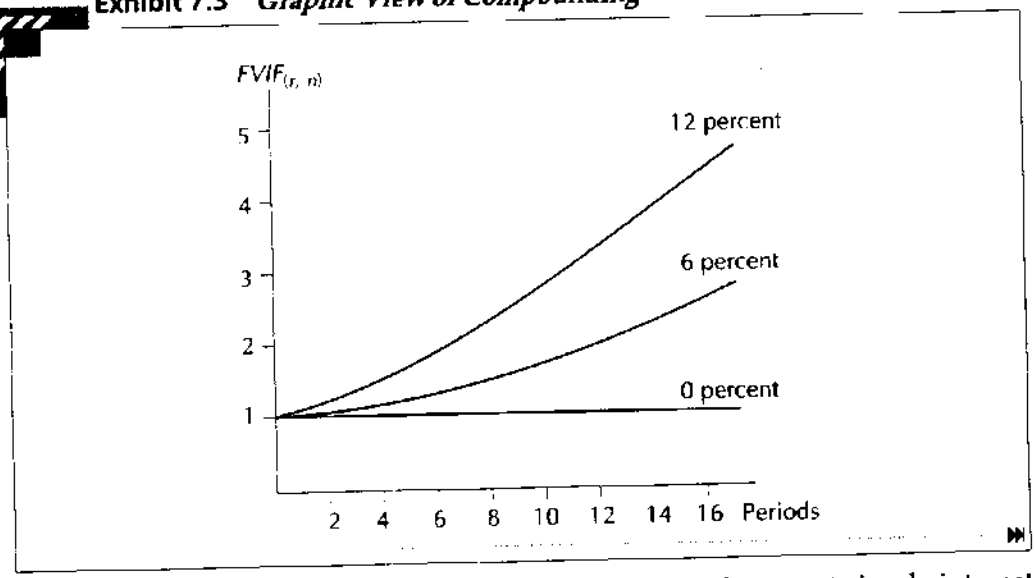
Exhibit 7.3 graphically shows how one rupee would grow over time for different interest rates. Naturally the higher the interest rates, the faster the growth rate. We have plotted the growth curves for three interest rates: 0 percent, 6 percent, and 12 percent. Growth curves can be readily plotted for other interest rates.

Compound and Simple Interest

So far we have assumed that the money is invested at compound interest which means that each interest payment is reinvested to earn further interest in future periods. By contrast, if no interest is earned on interest, the investment earns only simple interest. In such a case the investment grows as follows:

Future value = Present value [1 + Number of years × Interest rate]

Exhibit 7.3 ***Graphic View of Compounding***



For example, an investment of Rs 1,000, if invested at 12 percent simple interest rate will in 5 years time become:

$$1{,}000\ [1 + 5 \times 0.12\ ] = \text{Rs } 1{,}600$$

Exhibit 7.4 shows how an investment of Rs 1,000 grows over time under simple interest as well as compound interest when the interest rate is 12 percent. From this exhibit you can feel the power of compound interest. As Albert Einstein once remarked: "I don't know what the seven wonders of the world are, but I know the eighth—compound interest". You may be wondering why your ancestors did not display foresight. Hopefully, you will show concern for your posterity.

Exhibit 7.4 ***Value of Rs 1000 Invested at 12 Percent Simple and Compound Interest***

	Simple Interest					*Compound Interest*				
Year	*Starting Balance*	+	*Interest*	=	*Ending Balance*	*Starting Balance*	+	*Interest*	=	*Ending Balance*
1	1000	+	100	=	1100	1000	+	100	=	1100
5	1400	+	100	=	1500	1464	+	146	=	1610
10	1900	+	100	=	2000	2358	+	236	=	2594
20	2900	+	100	=	3000	6116	+	612	=	6728
50	5900	+	100	=	6000	106,718	+	10672	=	117,390
100	10,900	+	100	=	11000	12,527,829	+	1,252,783	=	13,780,612

Doubling Period

Investors commonly ask the question: How long would it take to double the amount at a given rate of interest? To answer this question we may look at the future value interest factor table. Looking at Exhibit 7.2 we find that when the interest rate is 12 percent it takes about 6 years to double the amount, when the interest is 6 percent it takes about 12 years to double the amount, so on and so forth. Is there a rule of thumb which dispenses with the use of the future value interest factor table? Yes, there is one and it is called the rule of 72. According to this rule of thumb the doubling period is obtained by dividing 72 by the interest rate. For example, if the interest rate is 8 percent, the doubling period is about 9 years (72/8). Likewise, if the interest rate is 4 percent the doubling period is about 18 years (72/4). Though somewhat crude, it is a handy and useful rule of thumb.

If you are inclined to do a slightly more involved calculation, a more accurate rule of thumb is the rule of 69. According to this rule of thumb, the doubling period is equal to:

$$0.35 + \frac{69}{\text{Interest Rate}}$$

As an illustration of this rule of thumb, the doubling period is calculated for two interest rates, 10 percent and 15 percent.

Interest Rate	*Doubling Period*
10 percent	$0.35 + \frac{69}{10} = 7.25$ years
15 percent	$0.35 + \frac{69}{15} = 4.95$ years

Finding the Growth Rate

The formula we used to calculate future value is quite general and it can be applied to answer other types of questions related to growth. Suppose your company currently has 5,000 employees and this number is expected to grow by 5 percent per year. How many employees will your company have in 10 years? The number of employees 10 years hence will be:

$$5{,}000 \times (1.05)^{10} = 5000 \times 1.629 = 8{,}145$$

Consider another example. Phoenix Limited had revenues of Rs 100 million in 1990 which increased to Rs 1000 million in 2000. What was the compound growth rate in revenues? The compound growth rate may be calculated as follows:

$$100\,(1+g)^{10} = 1{,}000$$

$$(1+g)^{10} = \frac{1000}{100} = 10$$

$$(1+g) = 10^{1/10}$$
$$g = 10^{1/10} - 1$$
$$= 1.26 - 1 = 0.26 \text{ or } 26 \text{ percent}$$

7.3 PRESENT VALUE OF A SINGLE AMOUNT

Suppose someone promises to give you Rs 1,000 three years hence. What is the present value of this amount if the interest rate is 10 percent? The present value can be calculated by discounting Rs 1,000, to the present point of time, as follows :

Value three years hence = Rs 1,000

Value two years hence $= \text{Rs } 1{,}000\left(\frac{1}{1.10}\right)$

Value one year hence $= \text{Rs } 1{,}000\left(\frac{1}{1.10}\right)\left(\frac{1}{1.10}\right)$

Present Value $= \text{Rs } 1{,}000\left(\frac{1}{1.10}\right)\left(\frac{1}{1.10}\right)\left(\frac{1}{1.10}\right)$

Formula

The process of discounting, used for calculating the present value, is simply the inverse of compounding. The present value formula can be readily obtained by manipulating the compounding formula:

$$FV_n = PV\ (1+r)^n \tag{7.2}$$

Dividing both the sides of Eq. (7.2) by $(1+r)^n$, we get:

$$PV = FV_n\ [1\ /\ (1+r)^n] \tag{7.3}$$

The factor $1/(1+r)^n$ in Eq. (7.3) is called the discounting factor or the present value interest factor ($PVIF_{r,n}$). Exhibit 7.5 gives the value of $PVIF_{r,n}$ for several combinations of r and n. A more detailed table of $PVIF_{r,n}$ is given in Appendix A at the end of this book.

What is the present value of Rs 1,000 receivable 6 years hence if the rate of discount is 10 percent?

The present value is:

$$\text{Rs } 1{,}000 \times PVIF_{10\%,6} = \text{Rs } 1{,}000\ (0.5645) = \text{Rs } 564.5$$

What is the present value of Rs 1,000 receivable 20 years hence if the discount rate is 8 percent? Since Exhibit 7.5 does not have the value of $PVIF_{8\%,20}$ we obtain the answer as follows:

$$\text{Rs } 1{,}000\left(\frac{1}{1.08}\right)^{20} = \text{Rs } 1{,}000\left(\frac{1}{1.08}\right)^{10}\left(\frac{1}{1.08}\right)^{10}$$

$$= \text{Rs } 1{,}000\ (PVIF_{8\%,10})(PVIF_{8\%,10})$$

$$= \text{Rs } 1{,}000\ (0.463)(0.463) = \text{Rs } 214$$

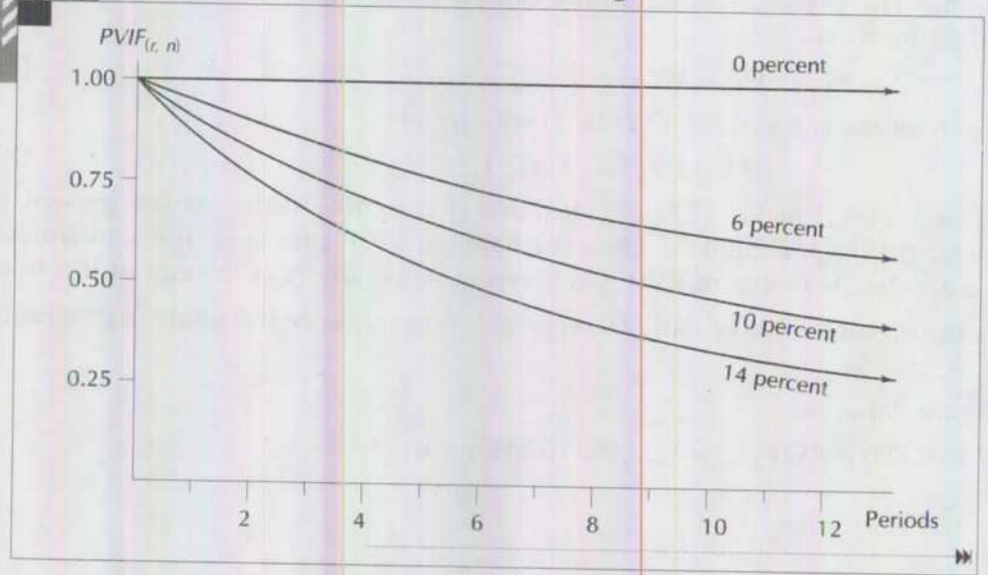
Exhibit 7.5 *Value of $PVIF_{r,n}$ for Various Combinations of r and n*

n/r	6%	8%	10%	12%	14%
2	0.890	0.857	0.826	0.797	0.770
4	0.792	0.735	0.683	0.636	0.592
6	0.705	0.630	0.565	0.507	0.456
8	0.626	0.540	0.467	0.404	0.351
10	0.558	0.463	0.386	0.322	0.270
12	0.497	0.397	0.319	0.257	0.208

Graphic View of Discounting

Exhibit 7.6 graphically shows how the present value interest factor varies in response to changes in interest rate and time. The present value interest factor declines as the interest rate rises and as the length of time increases.

Exhibit 7.6 *Graphic View of Discounting*



Present Value of an Uneven Series

In financial analysis we often come across uneven cash flow streams. For example, the cash flow stream associated with a capital investment project is typically uneven. Likewise, the dividend stream associated with an equity share is usually uneven and perhaps growing.

The present value of a cash flow stream—uneven or even—may be calculated with the help of the following formula:

$$PV_n = \frac{A_1}{(1+r)} + \frac{A_2}{(1+r)^2} + \ldots + \frac{A_n}{(1+r)^n} = \sum_{t=1}^{n} \frac{A_t}{(1+r)^t}$$

where PV_n = present value of a cash flow stream

A_t = cash flow occurring at the end of year t

r = discount rate

n = duration of the cash flow stream

Exhibit 7.7 shows the calculation of the present value of an uneven cash flow stream, using a discount rate of 12 percent.

Exhibit 7.7 ***Present Value of an Uneven Cash Flow Stream***

Year	*Cash Flow* Rs	$PVIF_{12\%,n}$	*Present Value of Individual Cash Flow*
1	1,000	0.893	893
2	2,000	0.799	1,594
3	2,000	0.712	1,424
4	3,000	0.636	1,908
5	3,000	0.567	1,701
6	4,000	0.507	2,028
7	4,000	0.452	1,808
8	5,000	0.404	2,020
Present Value of the Cash Flow Stream			13,376

7.4 FUTURE VALUE OF AN ANNUITY

An annuity is a stream of constant cash flow (payment or receipt) occurring at regular intervals of time. The premium payments of a life insurance policy, for example, are an annuity. When the cash flows occur at the end of each period, the annuity is called an ordinary annuity or a deferred annuity. When the cash flows occur at the beginning of each period, the annuity is called an annuity due. Our discussion here will focus on a regular annuity—the formulae of course can be applied, with some modification, to an annuity due.

Suppose you deposit Rs 1,000 annually in a bank for 5 years and your deposits earn a compound interest rate of 10 percent. What will be the value of this series of deposits (an annuity) at the end of 5 years? Assuming that each deposit occurs at the end of the year, the future value of this annuity will be:

$$\text{Rs } 1{,}000(1.10)^4 + \text{Rs } 1{,}000(1.10)^3 + \text{Rs } 1{,}000(1.10)^2 + \text{Rs } 1{,}000(1.10) + \text{Rs } 1{,}000$$
$$= \text{Rs } 1{,}000(1.464) + \text{Rs } 1{,}000(1.331) + \text{Rs } 1{,}000(1.21) + \text{Rs } 1{,}000(1.10) + \text{Rs } 1{,}000$$
$$= \text{Rs } 6{,}105$$

The time line for this annuity is shown in Exhibit 7.8.

Formula

In general terms the future value of an annuity is given by the following formula:

$$FVA_n = A\,(1+r)^{n-1} + A\,(1+r)^{n-2} + \ldots + A$$
$$= A\,[(1+r)^n - 1]\,/r \qquad (7.5)^1$$

where FVA_n = future value of an annuity which has a duration of n periods

A = constant periodic flow

r = interest rate per period

n = duration of the annuity

The term $[(1+r)^n - 1]/r$ is referred to as the future value interest factor for an annuity ($FVIFA_{r,n}$). The value of this factor for several combinations of r and n is given in Exhibit 7.9. A more detailed table is given in Appendix 7A at the end of this chapter.

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1. The formula for the future value of an annuity is derived as follows:

The future value of an annuity is:

$$FVA_n = A\,(1+r)^{n-1} + A\,(1+r)^{n-2} + \ldots + A\,(1+r) + A \qquad (1)$$

Multiplying both the sides of (1) by $(1+r)$ gives:

$$FVA_n(1+r) = A\,(1+r)^n + A\,(1+r)^{n-1} + \ldots + A\,(1+r)^2 + A\,(1+r) \qquad (2)$$

Subtracting (1) from (2) yields:

$$FVA_n r = A\,[(1+r)^n - 1] \qquad (3)$$

Dividing both the sides of (3) by r gives:

$$FVA_n = A\left(\frac{(1+r)^n - 1}{r}\right) \qquad (4)$$

Exhibit 7.8 *Time Line for an Annuity*

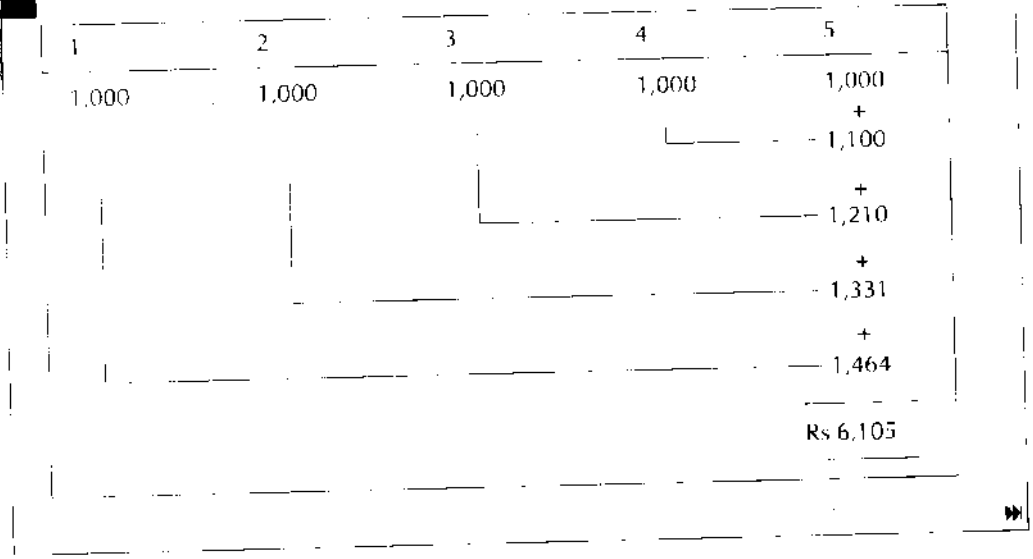


Exhibit 7.9 *Value of $FVIFA_{r,n}$ for Various Combinations of r and n*

n/r	6%	8%	10%	12%	14%
2	2.060	2.080	2.100	2.120	2.140
4	4.375	4.507	4.641	4.779	4.921
6	6.975	7.336	7.716	8.115	8.536
8	9.897	10.636	11.436	12.299	13.232
10	13.181	14.487	15.937	17.548	19.337
12	16.869	18.977	21.384	24.133	27.270

Applications

The future value annuity formula can be applied in a variety of contexts. Its important applications are illustrated as follows:

Knowing What Lies in Store for You Suppose you have decided to deposit Rs 30,000 per year in your Public Provident Fund Account for 30 years. What will be the accumulated amount in your Public Provident Fund Account at the end of 30 years if the interest rate is 11 percent?

The accumulated sum will be: Rs 30,000 ($FVIFA_{11\%,30yrs}$)

$$= \text{Rs } 30{,}000 \left(\frac{(1.11)^{30} - 1}{0.11} \right)$$

$$= \text{Rs } 30{,}000 \; [\; 199.02]$$

$$= \text{Rs } 5{,}970{,}600$$

How Much Should You Save Annually You want to buy a house after 5 years when it is expected to cost Rs 2 million. How much should you save annually if your savings earn a compound return of 12 percent?

The future value interest factor for a 5 year annuity, given an interest rate of 12 percent, is:

$$\text{FVIFA}_{n=5,\, r=12\%} = \frac{(1+0.12)^5 - 1}{0.12} = 6.353$$

The annual savings should be:

$$\frac{\text{Rs } 2{,}000{,}000}{6.353} = \text{Rs } 314{,}812$$

Annual Deposit in a Sinking Fund Futura Limited has an obligation to redeem Rs 500 million bonds 6 years hence. How much should the company deposit annually in a sinking fund account wherein it earns 14 percent interest to cumulate Rs 500 million in 6 years time?

The future value interest factor for a 5 year annuity, given an interest rate of 14 percent is:

$$\text{FVIFA}_{n=6,\, r=14\%} = \frac{(1+0.14)^4 - 1}{0.14} = 8.536$$

The annual sinking fund deposit should be:

$$\frac{\text{Rs } 500 \text{ million}}{8.536} = \text{Rs } 58.575 \text{ million}$$

Finding the Interest Rate A finance company advertises that it will pay a lump sum of Rs 8,000 at the end of 6 years to investors who deposit annually Rs 1,000 for 6 years. What interest rate is implicit in this offer?

The interest rate may be calculated in two steps:

1. Find the $\text{FVIFA}_{r,\,6}$ for this contract as follows:

   $\text{Rs } 8{,}000 = \text{Rs } 1{,}000 \times \text{FVIFA}_{r,\,6}$

   $$\text{FVIFA}_{r,\,6} = \frac{\text{Rs } 8{,}000}{\text{Rs } 1{,}000} = 8000$$

2. Look at the $\text{FVIFA}_{r,\,n}$ table and read the row corresponding to 6 years until you find a value close to 8,000. Doing so, we find that
   $\text{FVIFA}_{12\%,\,6}$ is 8.115
   So, we conclude that the interest rate is slightly below 12 percent.

How Long Should You Wait You want to take a trip to the moon which costs Rs 1,000,000. The cost is expected to remain unchanged in nominal terms. You can save annually Rs 50,000 to fulfill your desire. How long will you have to wait if your savings earn an interest of 12 percent?

The future value of an annuity of Rs 50,000 that earns 12 percent is equated to Rs 1,000,000.

$$50{,}000 \times FVIFA_{n=?,12\%} = 1{,}000{,}000$$

$$50{,}000 \times \left(\frac{1.12^n - 1}{0.12}\right) = 1{,}000{,}000$$

$$1.12^n - 1 = \frac{1{,}000{,}000}{50{,}000} \times 0.12 = 2.4$$

$$1.12^n = 2.4 + 1 = 3.4$$

$$n \log 1.12 = \log 3.4$$

$$n \times 0.0492 = 0.5315$$

$$n = \frac{0.5315}{0.0492} = 10.8 \text{ years}$$

You will have to wait for about 11 years.

7.5 PRESENT VALUE OF AN ANNUITY

Suppose you expect to receive Rs 1,000 annually for 3 years, each receipt occurring at the end of the year. What is the present value of this stream of benefits if the discount rate is 10 percent? The present value of this annuity is simply the sum of the present values of all the inflows of this annuity:

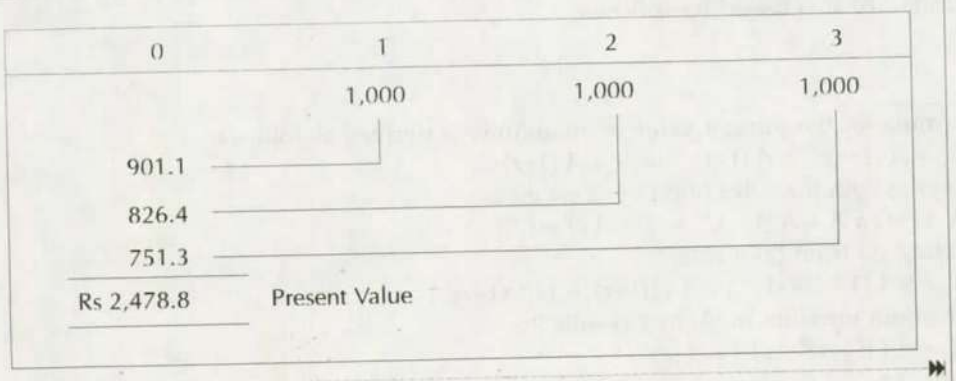
$$\text{Rs } 1{,}000\left(\frac{1}{1.10}\right) + \text{Rs } 1{,}000\left(\frac{1}{1.10}\right)^2 + \text{Rs } 1{,}000\left(\frac{1}{1.10}\right)^3$$

$$= \text{Rs } 1{,}000 \times 0.9091 + \text{Rs } 1{,}000 \times 0.8264 + \text{Rs } 1{,}000 \times 0.7513$$

$$= \text{Rs } 2{,}478.8$$

The time line for this problem is shown in Exhibit 7.10.

Exhibit 7.10 *Time Line*



Formula

In general terms the present value of an annuity may be expressed as follows:

$$PVA_n = \frac{A}{(1+r)} + \frac{A}{(1+r)^2} + \ldots + \frac{A}{(1+r)^{n-1}} + \frac{A}{(1+r)^n}$$

$$= A\left(\frac{1}{(1+r)} + \frac{1}{(1+r)^2} + \ldots + \frac{1}{(1+r)^{n-1}} + \frac{1}{(1+r)^n}\right)$$

$$= A\,\{[(1+r)^n - 1] / r(1+r)^n\} \qquad (7.6)^2$$

where PVA_n = present value of an annuity which has a duration of n periods

A = constant periodic flow

r = discount rate

$[(1+r)^n - 1] / r(1+r)^n$ is referred to as the present value interest factor for an annuity ($PVIFA_{r,n}$). It is, as can be seen clearly, simply equal to the product of the future value interest factor for an annuity ($FVIFA_{r,n}$) and the present value interest factor ($PVIF_{r,n}$). Exhibit 7.11 shows the value of $PVIFA_{r,n}$ for several combinations of r and n. A more detailed table of $PVIFA_{r,n}$ values is found in Appendix A at the end of this book.

Exhibit 7.11 *Value of $PVIFA_{r,n}$ for Different Combinations of r and n*

n/r	6%	8%	10%	12%	14%
2	1.833	1.783	1.737	1.690	1.647
4	3.465	3.312	3.170	3.037	2.914
6	4.917	4.623	4.355	4.111	3.889
8	6.210	5.747	5.335	4.968	4.639
10	7.360	6.710	6.145	5.650	5.216
12	8.384	7.536	6.814	6.194	5.660

Applications

The present value annuity formula can be applied in a variety of contexts. Its important applications are discussed as follows:

2. The formula for the present value of an annuity is derived as follows:

$PVA_n = A\,(1+r)^{-1} + A\,(1+r)^{-2} + \ldots + A\,(1+r)^{-n}$ (1)

Multiplying both the sides of (1) by $(1+r)$ gives:

$PVA_n\,(1+r) = A + A\,(1+r)^{-1} + \ldots + A\,(1+r)^{-n+1}$ (2)

Subtracting (1) from (2) yields:

$PVA_n\,r = A\,[1 - (1+r)^{-n}] = A\,\{[(1+r)^n - 1] / (1+r)^n\}$ (3)

Dividing both the sides of (3) by r results in :

$PVA_n = A\,\{[(1+r)^n - 1] / r\,(1+r)^n\}$ (4)

How Much Can You Borrow for a Car After reviewing your budget, you have determined that you can afford to pay Rs 12,000 per month for 3 years towards a new car. You call a finance company and learn that the going rate of interest on car finance is 1.5 percent per month for 36 months. How much can you borrow?

To determine how much you can borrow, we have to calculate the present value of Rs 12,000 per month for 36 months at 1.5 percent per month.

Since the loan payments are an ordinary annuity, the present value interest factor of annuity is:

$$\text{PVIFA}_{r,n} = \frac{(1+r)^n - 1}{r(1+r)^n} = \frac{(1+.015)^{36} - 1}{.015(1+.015)^{36}} = \frac{1.7091 - 1}{0.0256} = 27.70$$

Hence the present value of 36 payments of Rs 12,000 each is:

Present value = Rs 12,000 × 27.70 = Rs 332,400

You can, therefore, borrow Rs 332,400 to buy the car.

Period of Loan Amortisation You want to borrow Rs 1,080,000 to buy a flat. You approach a housing finance company which charges 12.5 percent interest. You can pay Rs 180,000 per year toward loan amortisation. What should be the maturity period of the loan?

The present value of annuity of Rs 180,000 is set equal to Rs 1,000,000.

$180{,}000 \times \text{PVIFA}_{n,r} = 1{,}080{,}000$

$180{,}000 \times \text{PVIFA}_{n=?,\, r=12.5\%} = 1{,}080{,}000$

$$180{,}000 \frac{1.125^n - 1}{0.125 \times 1.125^n} = 1{,}080{,}000$$

Given this equality the value of n is calculated as follows:

$$\frac{1.125^n - 1}{0.125 \times 1.125^n} = \frac{1{,}080{,}000}{180{,}000} = 6$$

$$1.125^n - 1 = 6\,(0.125 \times 1.125^n) = 0.75 \times 1.125^n$$

$$0.25 \times 1.125^n = 1$$

$$1.125^n = 4$$

$$n \log 1.125 = \log 4$$

$$n \times 0.0512 = 0.6021$$

$$n = \frac{0.6021}{0.0512} = 11.76 \text{ years}$$

You can perhaps request for a maturity of 12 years.

Determining the Loan Amortisation Schedule Most loans are repaid in equal periodic instalments (monthly, quarterly, or annually), which cover interest as well as principal repayment. Such loans are referred to as *amortised loans*.

For an amortised loan we would like to know (a) the periodic instalment payment and (b) the loan amortisation schedule showing the break up of the periodic instalment payments between the interest component and the principal repayment component. To illustrate how these are calculated, let us look at an example.

Suppose a firm borrows Rs 1,000,000 at an interest rate of 15 percent and the loan is to be repaid in 5 equal instalments payable at the end of each of the next 5 years. The annual instalment payment A is obtained by solving the following equation:

$$\text{Loan amount} = A \times \text{PVIFA}_{n=5,\, r=15\%}$$
$$1{,}000{,}000 = A \times 3.352$$
$$\text{Hence } A = 298{,}329$$

The amortisation schedule is shown in Exhibit 7.12. The interest component is the largest for year 1 and progressively declines as the outstanding loan amount decreases.

Exhibit 7.12 ***Loan Amortisation Schedule***

Year	Beginning Amount (1)	Annual Instalment (2)	Interest (3)	Principal Repayment (2)–(3) = (4)	Remaining Balance (1)–(4) = (5)
1	1,000,000	298,329	150,000	148,329	851,671
2	851,671	298,329	127,751	170,578	681,093
3	681,093	298,329	102,164	196,165	484,928
4	484,928	298,329	72,739	225,590	259,338
5	259,338	298,329	38,901	259,428	−90[1]

a. Interest is calculated by multiplying the beginning loan balance by the interest rate.
b. Principal repayment is equal to annual instalment minus interest.
[1] Due to rounding off error a small balance is shown.

Determining the Periodic Withdrawal Your father deposits Rs 300,000 on retirement in a bank which pays 10 percent annual interest. How much can be withdrawn annually for a period of 10 years?

$$A = \text{Rs } 300{,}000 \times \frac{1}{\text{PVIFA}_{10\%,10}}$$
$$= \text{Rs } 300{,}000 \times \frac{1}{6.145}$$
$$= \text{Rs } 48{,}819$$

Finding the Interest Rate Suppose someone offers you the following financial contract: If you deposit Rs 10,000 with him he promises to pay Rs 2,500 annually for 6 years. What interest rate do you earn on this deposit? The interest rate may be calculated in two steps:

Step 1 Find the $PVIFA_{r,6}$ for this contract by dividing Rs 10,000 by Rs 2,500

$$PVIFA_{r,6} = \frac{\text{Rs } 10{,}000}{\text{Rs } 2{,}500} = 4.000$$

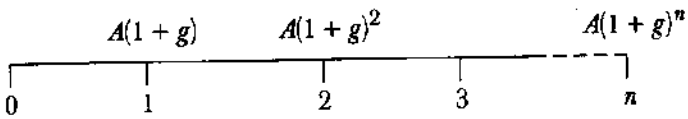
Step 2 Look at the PVIFA table and read the row corresponding to 6 years until you find a value close to 4.000. Doing so, you find that

$PVIFA_{12\%,6}$ is 4.111 and $PVIFA_{14\%,6}$ is 3.889

Since 4.000 lies in the middle of these values the interest rate lies (approximately) in the middle. So, the interest rate is 13 percent.

Present Value of a Growing Annuity

A cash flow that grows at a constant rate for a specified period of time is a growing annuity. The time line of a growing annuity is shown below:



The present value of a growing annuity can be determined using the following formula:

$$\text{PV of a Growing Annuity} = A(1+g)\left(\frac{1-\dfrac{(1+g)^n}{(1+r)^n}}{r-g}\right) \qquad (7.7)^3$$

3. The formula for the present value of a growing annuity (PVGA) is derived as follows:

$$PVGA = \frac{A(1+g)}{(1+r)} + \frac{A(1+g)^2}{(1+r)^2} + \ldots + \frac{A(1+g)^n}{(1+r)^n} \qquad (1)$$

Multiplying both the sides of (1) by $(1+g)/(1+r)$ gives:

$$PVGA \times \frac{(1+g)}{(1+r)} = \frac{A(1+g)^2}{(1+r)^2} + \frac{A(1+g)^3}{(1+r)^3} + \ldots + \frac{A(1+g)^{n+1}}{(1+r)^{n+1}} \qquad (2)$$

Subtracting (2) from (1) yields:

$$PVGA\left(1-\frac{(1+g)}{(1+r)}\right) = \frac{A(1+g)}{(1+r)} - \frac{A(1+g)^{n+1}}{(1+r)^{n+1}} \qquad (3)$$

This simplifies to:

$$PVGA = A(1+g)\left[\frac{1-\dfrac{(1+g)^n}{(1+r)^n}}{r-g}\right] \qquad (4)$$

The above formula can be used when the growth rate is less than the discount rate ($g < r$) as well as when the growth rate is more than the discount rate ($g > r$). However, it does not work when the growth rate is equal to the discount rate ($g = r$)—in this case, the present value is simply equal to nA.

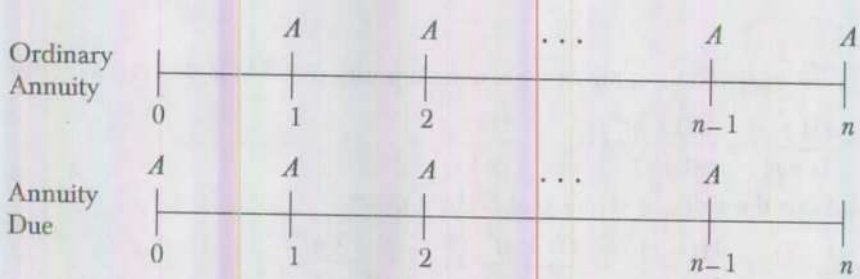
For example, suppose you have the right to harvest a teak plantation for the next 20 years over which you expect to get 100,000 cubic feet of teak per year. The current price per cubic feet of teak is Rs 500, but it is expected to increase at a rate of 8 percent per year. The discount rate is 15 percent. The present value of the teak that you can harvest from the teak forest can be determined as follows:

$$\text{PV of teak} = \text{Rs } 500 \times 100{,}000\ (1.08) \left(\frac{1 - \frac{1.08^{20}}{1.15^{20}}}{0.15 - 0.08} \right)$$

$$= \text{Rs } 551{,}802{,}857$$

A Note on Annuities Due

So far we have discussed ordinary annuities in which cash flows occur at the end of each period. There is a variation, which is fairly common, in which cash flows occur at the beginning of each period. Such an annuity is called an *annuity due*. For example, when you enter into a lease for an apartment, the lease payments are due at the beginning of the month. The first lease payment is made at the beginning, the second lease payment is due at the beginning of the second month, so on and so forth. The time lines for ordinary annuity and annuity due are shown below:



Since the cash flows of an annuity due occur one period earlier in comparison to the cash flows on an ordinary annuity, the following relationship holds:

Annuity due value = Ordinary annuity value × $(1+r)$

This applies for both present and future values. So, two steps are involved in calculating the value of an annuity due. First, calculate the present or future value as though it were an ordinary annuity. Second, multiply your answer by $(1+r)$.

Present Value of a Perpetuity

A perpetuity is an annuity of infinite duration. Hence, the present value of a perpetuity may be expressed as follows:

$$P_\infty = A \times \text{PVIFA}_{r,\infty} \tag{7.8}$$

where P_∞ = present value of a perpetuity
A = constant annual payment
$\text{PVIFA}_{r,\infty}$ = present value interest factor for a perpetuity (an annuity of infinite duration)

What is the value of $\text{PVIFA}_{r,\infty}$? It is equal to:

$$\sum_{t=1}^{\infty} \frac{1}{(1+r)^t} = \frac{1}{r} \tag{7.9}$$[4]

Put in words, it means that the present value interest factor of a perpetuity is simply 1 divided by the interest rate expressed in decimal form. Hence, the present value of a perpetuity is simply equal to the constant annual payment divided by the interest rate. For example, the present value of a perpetuity of Rs 100,000 if the interest rate is 10 percent is equal to: Rs 100,000/0.10 = Rs 10,000. Intuitively this is quite convincing because an initial sum of Rs 100,000 would, if invested at a rate of interest of 10 percent, provide a constant annual income of Rs 10,000 for ever without any impairment of the capital value.

7.6 INTRA-YEAR COMPOUNDING AND DISCOUNTING

So far we have assumed that compounding is done annually. Now we consider the case where compounding is done more frequently. Suppose you deposit Rs 1,000 with a finance company which advertises that it pays 12 percent interest semi-annually—this means that the interest is paid every six months. Your deposit (if interest is not withdrawn) grows as follows:

4. The formula for $\text{PVIFA}_{r,\infty}$ is derived as follows:

$$\text{PVIFA}_{r,\infty} = 1(1+r)^{-1} + 1(1+r)^{-2} + \ldots + 1(1+r)^{-\infty} \tag{1}$$

Multiplying both the sides of (1) by $(1+r)$ gives:

$$\text{PVIFA}_{r,\infty}(1+r) = 1 + 1(1+r)^{-1} + \ldots + 1(1+r)^{-\infty+1} \tag{2}$$

Subtracting (1) from (2) yields:

$$\text{PVIFA}_{r,\infty} \times r = 1 - 1(1+r)^{-\infty} \tag{3}$$

Since the second term on the right hand side of (3) vanishes, we get:

$$\text{PVIFA}_{r,\infty} \times r = 1 \tag{4}$$

This results in:

$$\text{PVIFA}_{r,\infty} \times r = \frac{1}{r} \tag{5}$$

First six months	: Principal at the beginning	= Rs 1,000.0
	Interest for 6 months	= Rs 60.0
	$\text{Rs } 1{,}000 \times \frac{.12}{2}$	
	Principal at the end	= Rs 1,060.0
Second six months	: Principal at the beginning	= Rs 1,060.0
	Interest for 6 months	= Rs 63.6
	$\text{Rs } 1{,}060 \times \frac{.12}{2}$	
	Principal at the end	= Rs 1,123.6

Note that if compounding is done annually, the principal at the end of one year would be Rs 1,000 (1.12) = Rs 1,120. The difference of Rs 3.6 (between Rs 1,123.6 under semi-annual compounding and Rs 1,120 under annual compounding) represents interest on interest for the second half year.

The general formula for the future value of a single cash flow after n years when compounding is done m times a year is:

$$FV_n = PV\left(1 + \frac{r}{m}\right)^{m \times n} \tag{7.10}$$

Suppose you deposit Rs 5,000 in a bank for 6 years. If the interest rate is 12 percent and the frequency of compounding is 4 times a year your deposit after 6 years will be:

$$\text{Rs } 5{,}000\left(1 + \frac{0.12}{4}\right)^{4 \times 6} = \text{Rs } 5{,}000\ (1.03)^{24}$$

$$= \text{Rs } 5{,}000 \times 2.0328 = \text{Rs } 10{,}164$$

Effective versus Stated Rate

We have seen above that Rs 1,000 grows to Rs 1,123.6 at the end of a year if the stated rate of interest is 12 percent and compounding is done semi-annually. This means that Rs 1,000 grows at the rate of 12.36 percent per annum. The figure of 12.36 percent is called the effective interest rate—the rate of interest under annual compounding which produces the same result as that produced by an interest rate of 12 percent under semi-annual compounding.

The general relationship between the effective interest rate and the stated annual interest rate is as follows:

$$\text{Effective interest rate} = \left(1 + \frac{\text{Stated annual interest rate}}{m}\right)^{m} - 1$$

where m is the frequency of compounding per year.

Suppose a bank offers 12 percent stated annual interest rate. What will be the effective interest rate when compounding is done annually, semiannually, and quarterly?

$$\text{Effective interest rate with annual compounding} = \left(1 + \frac{0.12}{1}\right)^1 - 1 = 0.12$$

$$\text{Effective interest rate with semi-annual compounding} = \left(1 + \frac{0.12}{2}\right)^2 - 1 = 0.1236$$

$$\text{Effective interest rate with quarterly compounding} = \left(1 + \frac{0.12}{4}\right)^4 - 1 = 0.1255$$

When compounding becomes continuous, the effective interest rate is expressed as follows[5]:

$$\text{Effective interest rate} = e^r - 1 \tag{7.11}$$

where e = base of natural logarithm

r = stated interest rate

Exhibit 7.13 shows how compounding frequency impacts on the effective interest rate. From this exhibit it is clear that the effect of increasing the frequency of compounding

Exhibit 7.13 ***Compounding Frequency and Effective Interest Rate***

Frequency	*Rate*	*m*	*Formula*	*Effective Interest Rate*
Annual	12	1	0.12	12 percent
Semi-annual	12	2	$\left(1+\frac{0.12}{2}\right)^2 - 1$	12.36
Quarterly	12	4	$\left(1+\frac{0.12}{4}\right)^4 - 1$	12.55
Monthly	12	12	$\left(1+\frac{0.12}{12}\right)^{12} - 1$	12.68
Weekly	12	52	$\left(1+\frac{0.12}{52}\right)^{52} - 1$	12.73
Daily	12	356	$\left(1+\frac{0.12}{365}\right)^{365} - 1$	12.75
Continuous	12		$e^{0.12} - 1$	12.75

5. See Appendix 7A.

is not as dramatic as some would believe it to be—the additional gains dwindle as the frequency of compounding increases.

Shorter Discounting Periods

Sometimes cash flows have to be discounted more frequently than once a year—semi-annually, quarterly, monthly, or daily. As in the case of intra-year compounding, the shorter discounting period implies that (i) the number of periods in the analysis increases, and (ii) the discount rate applicable per period decreases. The general formula for calculating the present value in the case of shorter discounting period is :

$$PV = FV_n \left(\frac{1}{1 + r/m} \right)^{mn} \qquad (7.12)$$

where PV= present value

FV_n = cash flow after n years

m = number of times per year discounting is done

r = annual discount rate

To illustrate, consider a cash flow of Rs 10,000 to be received at the end of four years. The present value of this cash flow when the discount rate is 12 percent (r =12 percent) and discounting is done quarterly (m = 4) is determined as follows:

$$PV = \text{Rs } 10{,}000 \times PVIF_{r/m,\, m \times n}$$

$$= \text{Rs } 10{,}000 \times PVIF_{3\%,16}$$

$$= \text{Rs } 10{,}000 \times 0.623 = \text{Rs } 6{,}230$$

SUMMARY

- Money has time value. A rupee today is more valuable than a rupee a year hence.
- When cash flows occur at different points in time, it is easier to deal with them using a time line. A time line shows the timing and the amount of each cash flow in a cash flow stream.
- The process of investing money as well as reinvesting the interest earned thereon is called compounding. The future or compounded value of an investment after n years when the interest rate is r percent is:
  Future value$_n$ = Present value $(1 + r)^n$
- If no interest is earned on interest the investment earns only simple interest. In such a case the investment grows as follows:
  Future value = Present value $[1 + nr]$
- According to the rule of 72, the doubling period under compounding is obtained by dividing 72 by the interest rate.

- The process of discounting, used for calculating the present value, is simply the inverse of compounding. The present value formula is:
  $PV = FV_n [\ 1/(1+r)^n\ ]$
- The present value of a cash flow is equal to:

$$PV_n = \sum_{t=1}^{n} \frac{A_t}{(1+r)^t}$$

- An annuity is a stream of constant cash flow (payment or receipt) occurring at regular intervals of time. When the cash flows occur at the end of each period the annuity is called a regular annuity or a deferred annuity. When the cash flows occur at the beginning of each period, the annuity is called an annuity due.
- The future value of an annuity is given by the formula:
  $FVA_n = A\ [(1 + r)^n - 1] / r$
- The present value of an annuity is given by the formula:
  $PVA_n = A\ \{\ [(1 + r)^n - 1] / r(1 + r)^n\ \}$
- A cash flow that grows at a constant rate for a specified period of time is a growing annuity. The present value of a growing annuity is given by the following formula:
  PV of a Growing Annuity $= A(1+g)\ \{[1 - (1 + g)^n/(1 + r)^n\ ]/r - g\}$
- Since the cash flows of an annuity due occur one period earlier in comparison to the cash flows of an ordinary annuity, the following relationship holds:
  Annuity due value = Ordinary annuity value $\times (1 + r)$
- A perpetuity is an annuity of infinite duration. The present value of a perpetuity is:
  Present value of a perpetuity $= A/r$
- The general formula for the future value of a single cash flow after n years when compounding is done m times a year is:
  $FV_n = PV\ [1 + r/\ m]^{mn}$
- The relationship between effective interest rate and the stated annual interest rate is as follows:

$$\text{Effective interest rate} = 1 + \left(\frac{\text{Stated annual interest rate}}{m}\right)^m - 1$$

- When compounding becomes continuous the effective interest rate is expressed as:
  Effective interest rate $= e^r - 1$
- The formula for calculating the present value in the case of shorter compounding period is:
  $PV = FV_n\ [1/\ (1 + r/m)\ ]^{mn}$

Questions

1. Why does money have time value?
2. State the general formula for the future value of a single amount.
3. What is the difference between compound and simple interest?
4. Explain the rule of 72.
5. Explain the rule of 69. How does it compare with the rule of 72.
6. State the general formula for calculating the present value of a single amount.
7. What is an annuity? What is the difference between an ordinary annuity and an annuity due?
8. State the formula for the future value of an annuity.
9. State the formula for the present value of an annuity.
10. What is a growing annuity? What is the formula for finding the present value of a growing annuity?
11. What is the formula for the present value of a perpetuity?
12. State the formula for the future value of a single cash flow after n years when compounding is done m times a year.
13. What is the relationship between the effective interest rate and the stated interest rate?
14. State the formula for calculating the present value of a single cash flow when discounting is done m times a year.
15. A firm's earnings grew from Re 1 per share to Rs 3 per share over a period of 10 years. The total growth was 200 percent, but the annual compound growth rate was less than 20 percent. Why?

Problems

1. Calculate the value 5 years hence of a deposit of Rs 1,000 made today if the interest rate is (a) 8 percent, (b) 10 percent, (c) 12 percent, and (d) 15 percent.
2. If you deposit Rs 5,000 today at 12 percent rate of interest in how many years (roughly) will this amount grow to Rs 1,60,000 ? Work this problem using the *rule of 72* — do not use tables.
3. A finance company offers to give Rs 8,000 after 12 years in return for Rs 1,000 deposited today. Using the *rule of 69*, figure out the approximate interest offered.
4. You can save Rs 2,000 a year for 5 years, and Rs 3,000 a year for 10 years thereafter. What will these savings cumulate to at the end of 15 years, if the rate of interest is 10 percent?
5. Mr Vinay plans to send his son for higher studies abroad after 10 years. He expects the cost of these studies to be Rs 1000,000. How much should he save annually to have a sum of Rs 1000,000 at the end of 10 years, if the interest rate is 12 percent ?
6. A finance company advertises that it will pay a lump sum of Rs 10,000 at the end of

6 years to investors who deposit annually Rs 1,000. What interest rate is implicit in this offer?

7. Someone promises to give you Rs 5,000 after 10 years in exchange for Rs 1,000 today. What interest rate is implicit in this offer?
8. Find the present value of Rs 10,000 receivable after 8 years if the rate of discount is (i) 10 percent, (ii) 12 percent, and (iii) 15 percent.
9. What is the present value of a 5-year annuity of Rs 2,000 at 10 percent?
10. At the time of his retirement, Mr Jingo is given a choice between two alternatives: (a) an annual pension of Rs 10,000 as long as he lives, and (b) a lump sum amount of Rs 50,000. If Mr Jingo expects to live for 15 years and the interest rate is 15 percent, which option appears more attractive?
11. Mr X deposits Rs 100,000 in a bank which pays 10 percent interest. How much can he withdraw annually for a period of 30 years. Assume that at the end of 30 years the amount deposited will whittle down to zero.
12. What is the present value of an income stream which provides Rs 1,000 at the end of year one, Rs 2,500 at the end of year two, and Rs 5,000 during each of the years 3 through 10, if the discount rate is 12 percent?
13. What is the present value of an income stream which provides Rs 2,000 a year for the first five years and Rs 3,000 a year forever thereafter, if the discount rate is 10 percent?
Hint: The present value for a perpetual annuity is derived by dividing the constant annual flow by the discount factor.
14. What amount must be deposited today in order to earn an annual income of Rs 5,000 beginning from the end of 15 years from now? The deposit earns 10 percent per year.
15. Suppose someone offers you the following financial contract. If you deposit Rs 20 000 with him he promises to pay Rs 4 000 annually for 10 years. What interest rate would you earn on this deposit?
16. What is the present value of the following cash flow streams?

End of year	*Stream A*	*Stream B*	*Stream C*
1	100	1,000	500
2	200	900	500
3	300	800	500
4	400	700	500
5	500	600	500
6	600	500	500
7	700	400	500
8	800	300	500
9	900	200	500
10	1,000	100	500

The discount rate is 12 percent.

17. Suppose you deposit Rs 10,000 with an investment company which pays 16 percent interest with quarterly compounding. How much will this deposit grow to in 5 years?
18. How much would a deposit of Rs 5,000 at the end of 5 years be, if the interest rate is 12 percent and if the compounding is done quarterly?
19. What is the difference between the effective rate of interest and stated rate of interest in the following cases:
    Case A: Stated rate of interest is 12 percent and the frequency of compounding is six times a year.
    Case B: Stated rate of interest is 24 percent and the frequency of compounding is four times a year.
    Case C: Stated rate of interest is 24 percent and the frequency of compounding is twelve times a year.
20. If the interest rate is 12 percent how much investment is required now to yield an income of Rs 12,000 per year from the beginning of the 10th year and which continues thereafter forever?
21. You have a choice between Rs 5,000 now and Rs 20,000 after 10 years. Which would you choose? What does your preference indicate?
22. Mr Raghu deposits Rs 10,000 in a bank now. The interest rate is 10 percent and compounding is done semi-annually. What will the deposit grow to after 10 years? If the inflation rate is 8 percent per year, what will be the value of the deposit after 10 years in terms of the current rupees?
23. How much should be deposited at the beginning of each year for 10 years in order to provide a sum of Rs 50,000 at the end of 10 years?
24. A person requires Rs 20,000 at the beginning of each year from 2005 to 2009. How much should he deposit at the end of each year from 1995 to 2000? The interest rate is 12 percent.
25. What is the present value of Rs 2,000 receivable annually for 30 years? The first receipt occurs after 10 years and the discount rate is 10 percent.
26. After five years Mr Ramesh will receive a pension of Rs 600 per month for 15 years. How much can Mr Ramesh borrow now at 12 percent interest so that the borrowed amount can be paid with 30 percent of the pension amount? The interest will be accumulated till the first pension amount becomes receivable.
27. Mr Prakash buys a scooter with a bank loan of Rs 6,000. A monthly instalment of Rs 300 is payable to the bank for the next 24 months towards the repayment of the loan with interest. What interest rate does the bank charge?
28. South India Corporation has to retire Rs 10 million of debentures each at the end of 8, 9, and 10 years from now. How much should the firm deposit in a sinking fund account annually for 5 years, in order to meet the debenture retirement need? The net interest rate earned is 8 percent.
29. Mr Longman receives a provident fund amount of Rs 100,000. He deposits it in a bank

(*Contd.*)

which pays 10 percent interest. If he withdraws annually Rs 20,000, how long can he do so?

30. Phoenix Company borrows Rs 500,000 at an interest rate of 14 percent. The loan is to be repaid in 4 equal annual instalments payable at the end of each of the next 4 years. Prepare the loan amortisation schedule.
31. You want to borrow Rs 1,500,000 to buy a flat. You approach a housing company which charges 13 percent interest. You can pay Rs 200,000 per year toward loan amortisation. What should be the maturity period of the loan?
32. You are negotiating with the government the right to mine 100,000 tons of iron ore per year for 15 years. The current price per ton of iron is Rs 3000 and it is expected to increase at the rate of 6 percent per year. What is the present value of the iron ore that you can mine if the discount rate is 16 percent?

APPENDIX 7A

CONTINUOUS COMPOUNDING AND DISCOUNTING

In Chapter 7 we have assumed that compounding or discounting takes place at specific intervals (annually, semi-annually, quarterly, and so forth). In this appendix we explore the implications of continuous compounding and discounting.

In Chapter 7, the following relationship was established for a case when compounding occurs m times a year

$$i_e = \left(1 + \frac{r}{m}\right)^m - 1 \qquad (7A.1)$$

where i_e = effective interest rate
r = stated interest rate
m = frequency of compounding

Eq. (7A.1) may be expressed as:

$$i_e = \left(\left(1 + \frac{1}{m/r}\right)^{m/r}\right)^r - 1 \qquad (7B.2)$$

Putting $x = m/r$ in Eq. (7B.2), we get

$$i_e = \left(\left(1 + \frac{1}{x}\right)^x\right)^r - 1 \qquad (7B.3)$$

In continuous compounding $m \to \infty$. This means $x \to \infty$ in Eq. (7B.3). Now,

$$\text{Lim} = \left(1 + \frac{1}{x}\right)^x = e = 2.71828 \ldots \; x \to \infty \qquad (7B.4)$$

So from Eq. (7B.3), we get

$$i_e = e^r - 1 \tag{7B.5}$$

This means

$$(1 + i_e) = e^r \tag{7B.6}$$

Given the relationship between the stated (or nominal) interest rate and the effective interest rate, we get the following:

$$\text{FVIF}_{r,n} = e^{rn} \tag{7B.7}$$

$$\text{PVIF}_{r,n} = e^{-rn} \tag{7B.8}$$

$$\text{FVIFA}_{r,n} = \frac{e^{rn} - 1}{r} \tag{7B.9}$$

$$\text{PVIFA}_{r,n} = \frac{1 - e^{-rn}}{r} \tag{7B.10}$$

where FVIF = future value interest factor

PVIF = present value interest factor

FVIFA = future value interest factor for an annuity

PVIFA = present value interest factor for an annuity

CHAPTER

8

Investment Criteria

The key steps involved in determining whether a project is worthwhile or not are:

- Estimate the costs and benefits of the project
- Assess the riskiness of the project
- Calculate the cost of capital
- Compute the criterion of merit and judge whether the project is good or bad

For pedagogic purposes, we find it more convenient to start with a discussion of the criteria of merit, referred to as investment criteria or capital budgeting techniques. A familiarity with these criteria will facilitate an easier understanding of costs and benefits, risk analysis, and cost of capital.

There are several criteria that have been suggested by economists, accountants, and others to judge the worthwhileness of capital projects. More than thirty criteria have been proposed, in the extensive literature on this subject. Some are general and applicable to a wide range of investments; others are specialised and suitable for certain types of investments and industries.

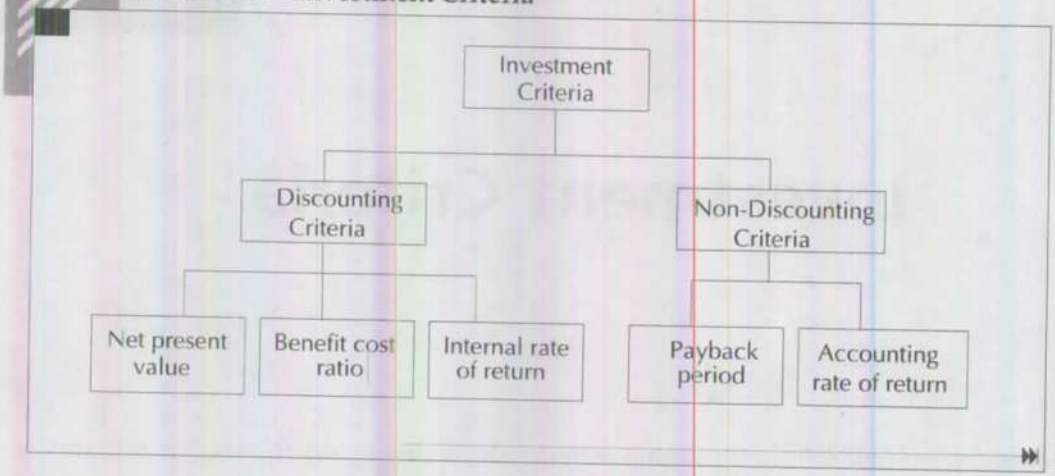
The important investment criteria, classified into two broad categories—discounting criteria and non-discounting criteria are shown in Exhibit 8.1.

This chapter discusses these criteria in some detail. In addition, it looks at how investment appraisal is done in practice, both in India and abroad. It is organised into nine sections as follows:

- Net present value
- Benefit cost ratio
- Internal rate of return
- Urgency
- Payback period

- Accounting rate of return
- Assessment of various methods
- Investment appraisal: Indian practice
- Investment appraisal: International practice

Exhibit 8.1 ***Investment Criteria***



8.1 NET PRESENT VALUE

The net present value (NPV) of a project is the sum of the present values of all the cash flows —positive as well as negative—that are expected to occur over the life of the project. The general formula for NPV is:

$$\text{NPV of a Project} = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - \text{Initial investment} \qquad (8.1)$$

where C_t = cash flow at the end of year t

n = life of the project

r = discount rate

To illustrate the calculation of net present value, consider a project which has the following cash flow stream:

Year	*Cash Flow*
0	Rs (1,000,000)
1	200,000
2	200,000
3	300,000
4	300,000
5	350,000

The cost of capital[1], r, for the firm is 10 percent. The net present value of the proposal is:

$$NPV = \frac{200,000}{(1.10)^1} + \frac{200,000}{(1.10)^2} + \frac{300,000}{(1.10)^3} + \frac{300,000}{(1.10)^4} + \frac{350,000}{(1.10)^5} - 1000,000 = -\text{Rs } 5,273$$

The net present value represents the net benefit over and above the compensation for time and risk. Hence the decision rule associated with the net present value criterion is: Accept the project if the net present value is positive and reject the project if the net present value is negative. (If the net present value is zero, it is a matter of indifference.)

Properties of the NPV Rule

The net present value has certain properties that make it a very attractive decision criterion. These are discussed below:

Net Present Values are Additive The net present value of a package of projects is simply the sum of the net present values of individual projects included in the package. This property has several implications:

- The value of a firm can be expressed as the sum of the present value of projects in place as well as the net present value of prospective projects:
  Value of a firm = Σ Present value of projects + ΣNPV of expected future projects
  The first term on the right hand side of this equation captures the value of *assets in place* and the second term the value of *growth opportunities*.
- When a firm terminates an existing project which has a negative NPV based on its expected future cash flows, the value of the firm increases by that amount. Likewise, when a firm undertakes a new project that has a negative NPV, the value of the firm decreases by that amount.
- When a firm divests itself of an existing project, the price at which the project is divested affects the value of the firm. If the price is greater/lesser than the present value of the anticipated cash flows of the project the value of the firm will increase/decrease with the divestiture.
- When a firm takes on a new project with a positive NPV, its effect on the value of the firm depends on whether its NPV is in line with expectation. Hindustan Lever Limited, for example, is expected to take on high positive NPV projects and this expectation is reflected in its value. Even if the new projects taken on by Hindustan

1. The cost of capital must reflect the risk of the project. While the details of how the cost of capital is calculated are discussed in Chapter 10, for the present we assume that the cost of capital figure is given and includes an appropriate premium for risk.

Lever Limited have positive NPV, the value of the firm may drop if the NPV is not in line with the high expectation of investors.

- When a firm makes an acquisition and pays a price in excess of the present value of the expected cash flows from the acquisition it is like taking on a negative NPV project and hence will diminish the value of the firm.

Intermediate Cash Flows are Invested at Cost of Capital The NPV rule assumes that the intermediate cash flows of a project—that is, cash flows that occur between the initiation and the termination of the project—are reinvested at a rate of return equal to the cost of capital.

NPV Calculation Permits Time-Varying Discount Rates So far we have assumed that the discount rate remains constant over time. This need not always be the case. The NPV can be calculated using time-varying discount rates. The general formula of NPV is as follows:

$$\text{NPV} = \sum_{t=1}^{n} \frac{C_t}{(1+r_t)^t} - \text{Initial investment} \tag{8.2}$$

where C_t = cash flow at the end of year t

r_t = discount rate for year t

In even more general terms NPV is expressed as follows:

$$\text{NPV} = \sum_{t=1}^{n} \frac{C_t}{\prod_{j=1}^{t}(1+r_j)} - \text{Initial investment} \tag{8.3}$$

where C_t = cash flow at the end of year t

r_j = one period discount rate

n = life of the project

The discount rate may change over time for the following reasons: (a) The level of interest rates may change over time—the term structure of interest rates sheds light on expected rates in the future. (b) The risk characteristics of the project may change over time, resulting in changes in the cost of capital. (c) The financing mix of the project may vary over time, causing changes in the cost of capital.

To illustrate, assume that you are evaluating a 5-year project involving software development. You believe that the technological uncertainty associated with this industry leads to higher discount rates in the future.

Discount rate	14%	15%	16%	18%	20%
Investment	−₹ 12000				
Cash flow		4,000	5,000	7,000	6,000	5,000

The present value of the cash flows can be calculated as follows:

PV of C_1 = 4,000 / 1.14 = 3509

PV of C_2 = 5,000 / (1.14 * 1.15) = 3814

PV of C_3 = 7,000 / (1.14 * 1.15 * 1.16) = 4603

PV of C_4 = 6,000 / (1.14 * 1.15 * 1.16 * 1.18) = 3344

PV of C_5 = 5,000 / (1.14 * 1.15 * 1.16 * 1.18 * 1.20) = 2322

NPV of project = 3509 + 3814 + 4603 + 3344 + 2322 – 12000 = Rs 5592

NPV of a Simple Project Decreases as the Discount Rate Increases A simple project involves an initial cash outflow, or a series of initial cash outflows, followed by cash inflows. The NPV of a simple project steadily decreases as the discount rate increases. The decrease in NPV, however, is at a decreasing rate.[2]

Rationale for the NPV Rule

The net present value criterion has a sound rationale underlying it. To understand this, let us look at a simple problem concerning a choice between current consumption and future consumption. Suppose you have a cash inflow of *OA* now (year 0) and *OB* in a year from now (year 1) as shown by point X in Exhibit 8.2. Further assume that through the capital market you can transfer wealth across time by lending or borrowing. The opportunity for lending or borrowing is represented by the line *CXD*. The slope of this line is $(1 + r)$, where r denotes the 1-year rate of interest. If you lend your present cash inflow of *OA* at an interest rate of r percent, your consumption in year 1 will be augmented by $OA\ (1 + r)$, which is *BD*. Alternatively, if you borrow against your future inflow, you can augment your current consumption by $OB/(1 + r)$ which is equal to *AC*. In general you can reach any point on the line *CXD*, by lending or borrowing.

2. To demonstrate this point, consider a simple project which has the following cash flow stream:

$$-C_0, C_1, C_2, \ldots, C_N$$

The net present value as a function of the discount rate, r, may be expressed as:

$$\text{NPV}(r) = -C_0 + C_1(1+r)^{-1} + C_2(1+r)^{-2} + \ldots + C_N(1+r)^{-N} \quad (1)$$

Assuming that r is a continuous variable and NPV(r) is a continuous and differentiable function, we get:

$$\frac{d\,\text{NPV}(r)}{d(1+r)} = -C_1(1+r)^{-2} - 2C_2(1+r)^{-3} - \ldots - NC_N(1+r)^{-(N+1)} \quad (2)$$

This is negative for all values of $-1 < r < \infty$.

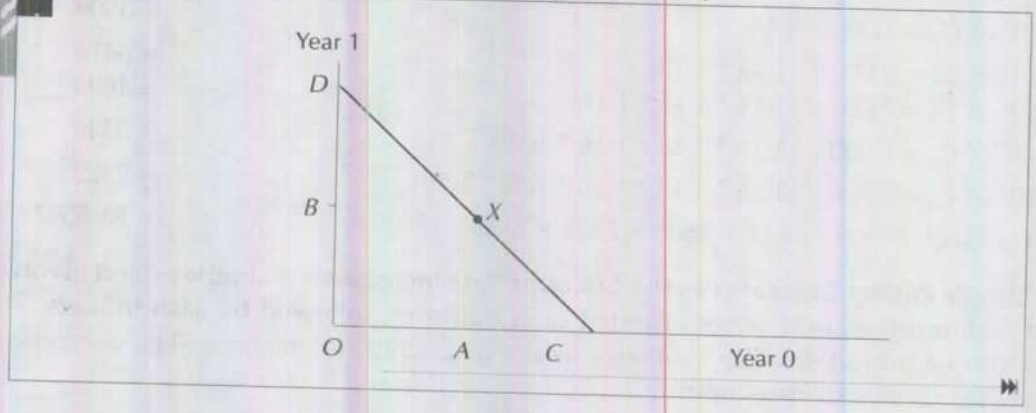
Hence the net present value of a simple project is steadily decreasing.

The second derivative of the net present value function with respect to $(1 + r)$ is:

$$\frac{d\,\text{NPV}(r)}{d(1+r)^2} = 2C_1(1+r)^{-3} + 6C_2(1+r)^{-4} - \ldots + N(N+1)C_N(1+r)^{-(N+2)} \quad (3)$$

This is positive for all values of $-1 < r < \infty$. Hence the net present value function decreases at a decreasing rate.

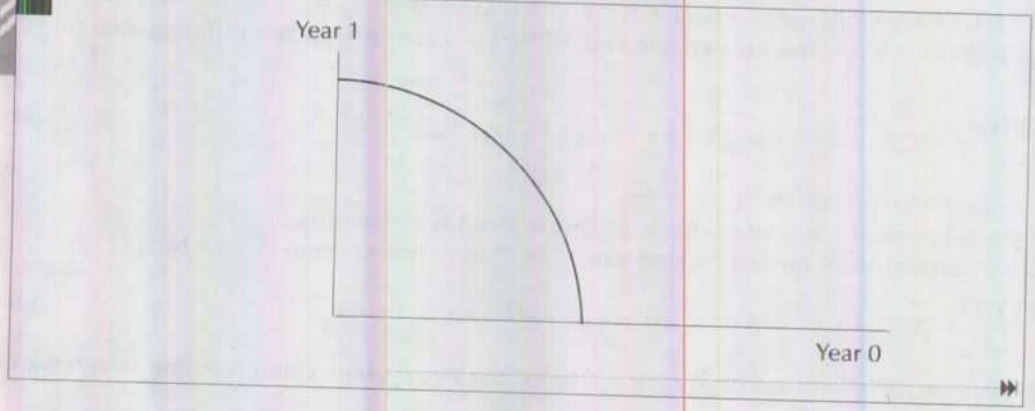
Exhibit 8.2 ***Lending and Borrowing Opportunity***



Your investment opportunity, however, is not limited to just lending or borrowing in the capital market. You may also consider investment in land, building, plant, machinery, and other real assets. The investment opportunity line which shows the returns from buying real assets is shown in Exhibit 8.3. This investment opportunity line, unlike the lending or borrowing line of Exhibit 8.2, is not a straight line. Its slope is high to begin with but declines progressively because the marginal return from additional investment in real assets tends to decline.

How is your welfare affected by the possibility of investing in real assets along with the possibility of lending or borrowing? To answer this question, we consider the situation illustrated in Exhibit 8.4 in which we assume, for the sake of simplicity, that your initial resources are equal to *OD*. The opportunity to invest in real assets is represented by the line *DXE* and the lending–borrowing opportunity on the capital market is represented by the straight line *DL*.

Exhibit 8.3 ***Investment Opportunity Curve***



Now let us look at what happens when you invest different amounts in real assets.

- Investment of *DF* in real assets
- Investment of *DG* (an amount greater than *DF*) in real assets
- Investment of *DH* (an amount less than *DF*) in real assets

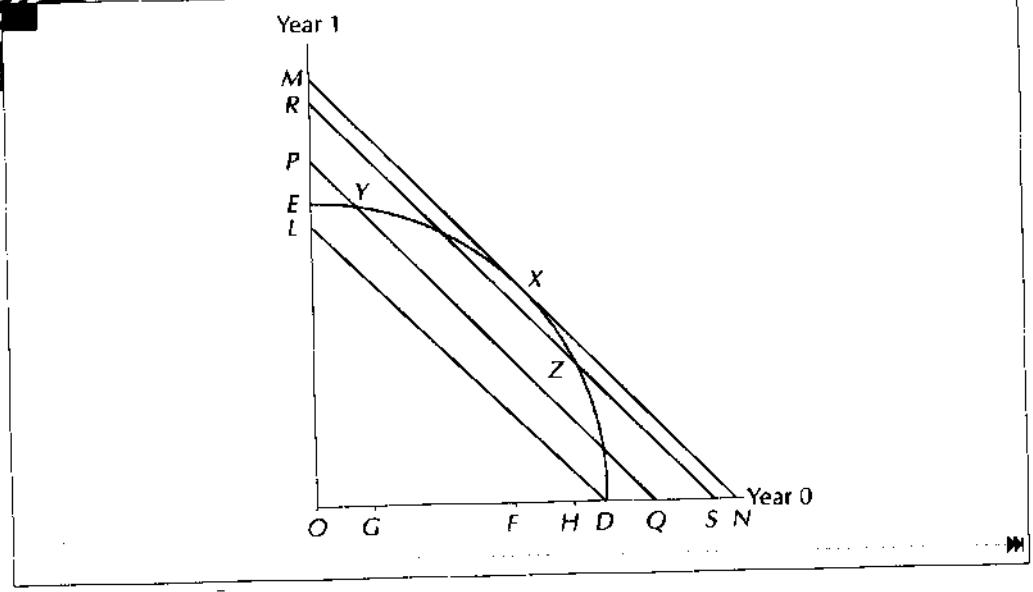
If you invest *DF* in real assets, a sacrifice of *DF* in year 0 brings a benefit of *FX* in year 1. As a result you move from point *D* to point *X* on the real asset investment opportunity line. From point *X* you can move along the line *MN* by availing of lending–borrowing opportunities. (The line *MN*, it may be noted, is parallel to the line *DL*—all lending–borrowing lines are parallel to each other.)

If you invest *DG* in real assets you move from *D* to *Y* on the real asset investment opportunity line. From *Y* you can move along the line *PQ* by availing of lending–borrowing opportunities in the capital market.

If you invest *DH* in real assets you move from *D* to *Z* on the real asset investment opportunity frontier. From *Z* you can move along the line *RS* by availing of lending–borrowing opportunities in the capital market.

What do we find when we compare the three cases? If you invest an amount equal to *DF* in real assets you reach the consumption frontier *MN*; if you invest an amount equal to *DG* in real assets you reach the consumption frontier *PQ*; if you invest an amount equal to *DH* in real assets you reach the consumption frontier *RS*. Clearly, investment of an amount equal to *DF* in real assets is the most desirable course of action since it takes you to the highest consumption frontier.

Exhibit 8.4 ***Investment and Lending–Borrowing Opportunities***



Investment of an amount equal to DF in real assets, it may be emphasised, is also the investment which has the highest net present value. This is clear from a comparison of the following:

Net present value of investment DF = Present value of benefits – Present value of costs
$= NF - DF = DN$

Net present value of investment DG = Present value of benefits – Present value of costs
$= QG - DG = DQ$

Net present value of investment DH = Present value of benefits – Present value of costs
$= SH - DH = DS$

Thus, when the net present value is maximised, you reach the highest consumption frontier. This, then, constitutes the rationale for the net present value criterion.

Modified Net Present Value

The standard net present value method is based on the assumption that the intermediate cash flows are reinvested at a rate of return equal to the cost of capital. When this assumption is not valid, the reinvestment rates applicable to the intermediate cash flows need to be defined for calculating the modified net present value. The steps involved in this process are as follows:

Step 1 Calculate the terminal value of the project's cash inflows using the explicitly defined reinvestment rate(s) which is supposed to reflect the profitability of the investment opportunities ahead of the firm.

$$TV = \sum_{t=1}^{n} CF_t(1+r')^{n-t} \qquad (8.4)$$

where TV = terminal value of the project's cash inflows

CF_t = cash inflow at the end of year t

r' = reinvestment rate applicable to the cash inflows of the project

Step 2 Determine the modified net present value

$$\text{NPV}^* = \frac{TV}{(1+r)^n} - I \qquad (8.5)$$

where NPV^* = modified net present value

TV = terminal value

r = cost of capital

I = investment outlay

To illustrate the calculation of NPV*, consider two projects, X and Y:

	Project X	*Project Y*
Investment outlay	*Rs 110,000*	*Rs 110,000*
Cash inflows		
Year 1	31,000	71,000
Year 2	40,000	40,000
Year 3	50,000	40,000
Year 4	70,000	20,000

The NPV* for X and Y may be calculated for two reinvestment rates, 14 percent and 20 percent, assuming a cost of capital of 10 percent.

Step 1 The terminal values of the cash inflows of projects X and Y for the two reinvestment rates are:

$$TV\ (X)_{14\%} = 31{,}000(1.14)^3 + 40{,}000(1.14)^2 + 50{,}000(1.14) + 70{,}000 = \text{Rs } 224{,}911$$

$$TV\ (X)_{20\%} = 31{,}000(1.20)^3 + 40{,}000(1.20)^2 + 50{,}000(1.20) + 70{,}000 = \text{Rs } 241{,}168$$

$$TV\ (Y)_{14\%} = 71{,}000(1.14)^3 + 40{,}000(1.14)^2 + 40{,}000(1.14) + 20{,}000 = \text{Rs } 223{,}911$$

$$TV\ (Y)_{20\%} = 31{,}000(1.20)^3 + 40{,}000(1.20)^2 + 50{,}000(1.20) + 70{,}000 = \text{Rs } 249{,}488$$

Step 2 The NPV* of projects X and Y for the two reinvestment rates are:

$$\text{NPV}^*(X)_{14\%} = \frac{TV(X)_{14\%}}{(1.10)^4} - 110{,}000 = \text{Rs } 43{,}614$$

$$\text{NPV}^*(X)_{20\%} = \frac{TV(X)_{20\%}}{(1.10)^4} - 110{,}000 = \text{Rs } 54{,}717$$

$$\text{NPV}^*(Y)_{14\%} = \frac{TV(Y)_{14\%}}{(1.10)^4} - 110{,}000 = \text{Rs } 42{,}931$$

$$\text{NPV}^*(Y)_{20\%} = \frac{TV(Y)_{20\%}}{(1.10)^4} - 110{,}000 = \text{Rs } 60{,}400$$

Determining the Capital Budget under Conditions of Increasing Marginal Cost of Capital

When the marginal cost of capital is constant, the optimal capital budget consists of all projects which have a positive net present value at the given marginal cost of capital. However, when the marginal cost of capital increases at discrete points as more and more financing is sought, determination of the optimal capital budget is not easy. While a precise solution to this problem can be a bit involved, a reasonably satisfactory solution can be reached as follows:

1. Determine the set of projects that has the highest net present value for each level of financing before a break in the marginal cost of capital schedule.
2. Choose the level of financing and the corresponding set of investment projects which has the highest net present value.

To illustrate the above procedure consider an example. The Deodhar Corporation has estimated that its marginal cost of capital schedule is as follows:

Level of financing (Rs in million)	*Marginal cost of capital %*
50	11
100	12
150	13
200	14

The firm first identifies a set of investment projects which generate the highest net present value given a capital budget constraint of Rs 50 million and a discount rate of 11 percent; it then identifies a set of investment projects which generate the highest net present value given a capital budget constraint of Rs 100 million and a discount rate of 12 percent; so on and so forth. The net present value of investment projects identified at various levels of financing (and investment) is given below:

Level of financing (Rs in million)	*Net present value of the chosen set (Rs in million)*
50	20
100	35
150	45
200	42

The highest net present value occurs when the firm invests Rs 150 million. So this represents the optimal capital budget.

Limitations

Despite its advantages and a direct linkage to the objective of value maximisation, the NPV rule has its opponents who point towards some limitations:

- The NPV is expressed in absolute terms rather than relative terms and hence does not factor in the scale of investment. Thus, project *A* may have an NPV of 5,000 while project *B* has an NPV of 2,500, but project *A* may require an investment of 50,000 whereas project *B* may require an investment of just 10,000. Advocates of NPV, however, argue that what matters is the surplus value, over and above the hurdle rate, irrespective of what the investment is.
- The NPV rule does not consider the life of the project. Hence, when mutually exclusive projects with different lives are being considered, the NPV rule is biased in favour of the longer term project.

8.2 BENEFIT COST RATIO

There are two ways of defining the relationship between benefits and costs:

$$\text{Benefit Cost Ratio: BCR} = \frac{\text{PVB}}{I} \tag{8.6}$$

$$\text{Net Benefit Cost Ratio: NBCR} = \frac{\text{PVB} - I}{I} = \text{BCR} - 1 \tag{8.7}$$

where PVB = present value of benefits

I = initial investment

To illustrate the calculation of these measures, let us consider a project which is being evaluated by a firm that has a cost of capital of 12 percent.

Initial investment:		Rs 1,000,000
Benefits:	Year 1	25,000
	Year 2	40,000
	Year 3	40,000
	Year 4	50,000

The benefit cost ratio measures for this project are:

$$\text{BCR} = \frac{\frac{25,000}{(1.12)} + \frac{40,000}{(1.12)^2} + \frac{40,000}{(1.12)^3} + \frac{50,000}{(1.12)^4}}{100,000} = 1.145$$

$$\text{NBCR} = \text{BCR} - 1 = 0.145$$

The two benefit cost ratio measures, because the difference between them is simply unity, give the same signals. The following decision rules are associated with them:

When BCR	*or*	*NBCR*	*Rule is*
>1		>0	Accept
=1		=0	Indifferent
<1		<0	Reject

Evaluation

The proponents of benefit cost ratio argue that since this criterion measures net present value per rupee of outlay, it can discriminate better between large and small investments and hence is preferable to the net present value criterion.

How valid is this argument? Weingartner who examined this criterion theoretically, finds that: (i) Under unconstrained conditions, the benefit cost ratio criterion will accept

and reject the same projects as the net present value criterion. (ii) When the capital budget is limited in the current period, the benefit cost ratio criterion may rank projects correctly in the order of decreasingly efficient use of capital. However, its use is not recommended because it provides no means for aggregating several smaller projects into a package that can be compared with a large project. (iii) When cash outflows occur beyond the current period, the benefit cost ratio criterion is unsuitable as a selection criterion.

8.3 INTERNAL RATE OF RETURN

The internal rate of return (IRR) of a project is the discount rate which makes its NPV equal to zero. Put differently, it is the discount rate which equates the present value of future cash flows with the initial investment. It is the value of r in the following equation:

$$\text{Investment} = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

where C_t = cash flow at the end of year t

r = internal rate of return (IRR)

n = life of the project

In the NPV calculation we assume that the discount rate (cost of capital) is known and determine the NPV. In the IRR calculation, we set the NPV equal to zero and determine the discount rate that satisfies this condition.

To illustrate the calculation of IRR, consider the cash flows of a project being considered by Techtron Limited:

Year	0	1	2	3	4
Cash flow	(100,000)	30,000	30,000	40,000	45,000

The IRR is the value of r which satisfies the following equation:

$$100{,}000 = \frac{30{,}000}{(1+r)^1} + \frac{30{,}000}{(1+r)^2} + \frac{40{,}000}{(1+r)^3} + \frac{45{,}000}{(1+r)^4}$$

The calculation of r involves a process of trial and error. We try different values of r till we find that the right-hand side of the above equation is equal to 100,000. Let us, to begin with, try r = 15 percent. This makes the right-hand side equal to:

$$\frac{30{,}000}{(1.15)} + \frac{30{,}000}{(1.15)^2} + \frac{40{,}000}{(1.15)^3} + \frac{45{,}000}{(1.15)^4} = 100{,}802$$

This value is slightly higher than our target value, 100,000. So we increase the value of r from 15 percent to 16 percent. (In general, a higher r lowers and a smaller r increases the right-hand side value). The right-hand side becomes:

$$\frac{30,000}{(1.16)} + \frac{30,000}{(1.16)^2} + \frac{40,000}{(1.16)^3} + \frac{45,000}{(1.16)^4} = 98,641$$

Since this value is now less than 100,000, we conclude that the value of r lies between 15 percent and 16 percent. For most of the purposes this indication suffices.

If a more refined estimate of r is needed, use the following procedure:

1. Determine the net present value of the two closest rates of return.
   (NPV / 15 percent) = 802
   (NPV / 16 percent) = 1,359
2. Find the sum of the absolute values of the net present values obtained in Step 1.
   802 + 1,359 = 2,161
3. Calculate the ratio of the net present value of the smaller discount rate, identified in step 1, to the sum obtained in Step 2.

   $$\frac{802}{2,161} = 0.37$$
4. Add the number obtained in Step 3 to the smaller discount rate.

   15 + 0.37 = 15.37 percent

The internal rate of return, calculated in this manner, is a very close approximation to the true internal rate of return.

The decision rule for IRR is as follows:

Accept : If the IRR is greater than the cost of capital

Reject : If the IRR is less than the cost of capital

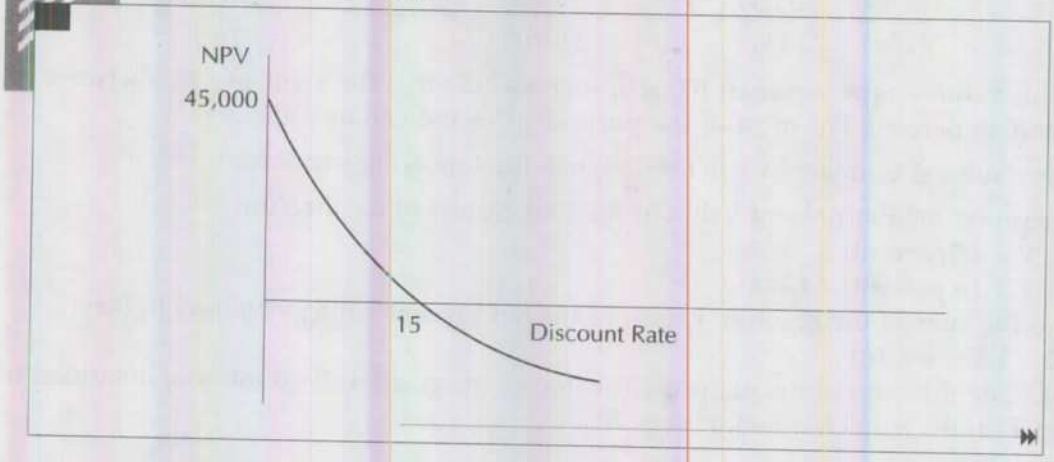
NPV and IRR

By now you may have noticed that the IRR rule is quite similar to the NPV rule. To see the link between them, let us plot the values of NPV for the project of Techtron Limited for different discount rates. The NPV profile is shown in Exhibit 8.5 where the NPV is plotted on the vertical or y-axis and the discount rate on the horizontal or x-axis. The NPV profile provides valuable insights:

- The IRR is the point at which the NPV profile crosses the x-axis.
- The slope of the NPV profile reflects how sensitive the project is to discount rate changes.

Do the IRR and the NPV rules lead to identical decisions? Yes, provided two conditions are satisfied. First, the cash flows of the project must be *conventional*, implying that the first cash flow (initial investment) is negative and the subsequent cash flows are positive. Second, the project must be *independent*, meaning that the project can be accepted or rejected without reference to any other project.

Exhibit 8.5 ***NPV Profile***



Problems with IRR

There are problems in using IRR when the cash flows of the project are not conventional or when two or more projects are being compared to determine which one is the best. In the first case it is difficult to define "What is IRR" and in the second case IRR can be misleading. Further, IRR cannot distinguish between lending and borrowing. Finally, IRR is difficult to apply when short-term interest rates differ from long-term interest rates.

Non-conventional Cash Flows Consider a project which has the following cash flow stream associated with it:

	Cash Flow		
Project	C_0	C_1	C_2
M	–160,000	+1,000,000	–1,000,000

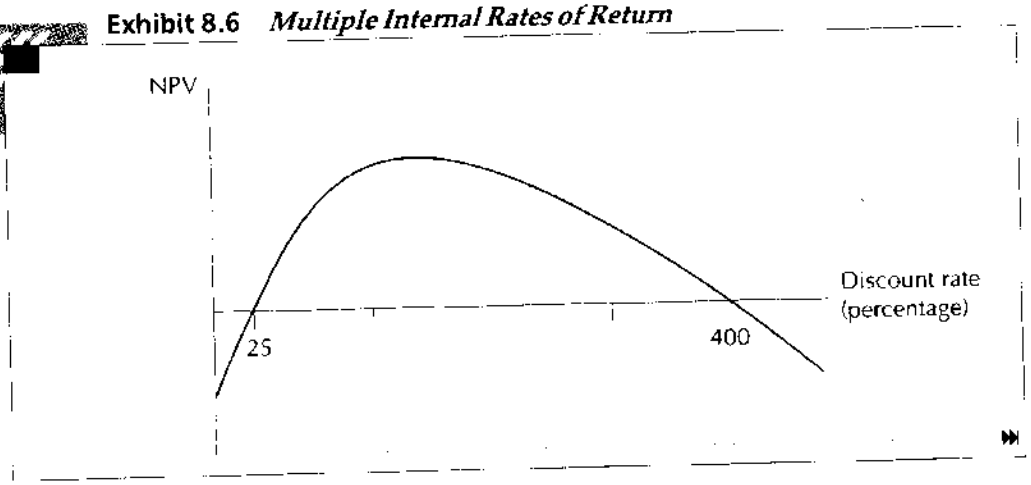
The IRR equation for this cash flow stream is:

$$-160{,}000 + \frac{1{,}000{,}000}{(1+r)} - \frac{1{,}000{,}000}{(1+r)^2} = 0$$

There are two roots of this equation, viz., 1.25 and 5.00. The IRRs corresponding to these roots are 25 percent and 400 percent. This is illustrated by the NPV profile shown in Exhibit 8.6.

In Exhibit 8.6, the NPV is zero at two discount rates, viz., 25 percent and 400 percent. Which of these is the correct IRR? We can't say. There is no unambiguous correct answer. This is the problem of multiple rates of return and in such cases the IRR rule breaks down.

Exhibit 8.6 ***Multiple Internal Rates of Return***



As if this were not enough, there can also be cases in which no IRR exists. For example, project P has a positive NPV for all discount rates and hence no IRR:

	Cash flow				*NPV*	
Project	C_0	C_1	C_2	*IRR, Percent*	*at 15%*	*at 30%*
P	+15,000	−45,000	+37,500	*None*	4225	10562

Several modifications of the IRR rule have been suggested for such cases. These modifications are neither adequate nor necessary, for the simple solution lies in using the NPV rule.

Mutually Exclusive Projects Often firms have to choose from two or more mutually exclusive projects. In such cases IRR can be misleading.

Consider projects P and Q

	Cash flow		*IRR*	*NPV*
Project	C_0	C_1		*(assuming r =12 percent)*
P	−10,000	20,000	100%	7,857
Q	−50,000	75,000	50%	16,964

Both the projects are good, but Q , with its higher NPV, contributes more to the value of the firm. Yet from an IRR point of view P looks better than Q. Hence the IRR rule seems unsuitable for ranking projects of different scales.

The IRR rule, of course, can be salvaged in such cases by considering the IRR on the incremental cash flow. Here is how we do it. Looking at P, the project which requires the smaller outlay, we find that it is highly attractive because its IRR is 100 percent, far above the cost of capital which is 12 percent. Now we ask: What is the rate of return on the incremental cash flow if we switch from P (the low-outlay project) to Q (the high-outlay project)? The incremental cash flow associated with such a switch is:

C_0	C_1
−40,000	55,000

The IRR of this cash flow stream is 37.5 percent, much above the cost of capital. Hence it is desirable to switch from P to Q.

Thus, unless you look at the incremental cash flow, IRR is not a reliable rule for ranking projects of different scales.

IRR is also unreliable for ranking projects which have different patterns of cash flow over time. Consider two projects, X and Y, being evaluated by a firm that has a cost of capital of 10 percent.

Project	C_0	C_1	C_2	C_3	C_4	*IRR*	*NPV at 10%*
X	−110,000	+31,000	+40,000	+50,000	+70,000	22%	36,613
Y	−110,000	+71,000	+40,000	+40,000	+20,000	25%	31,314

Both the projects look good but X, with its higher NPV, contributes more to the value of the firm. Yet from an IRR point of view, Y looks more attractive. Hence the IRR rule can be misleading when a choice has to be made between mutually exclusive projects which have different patterns of cash flow over time.

Of course, in this case too the IRR rule can be salvaged by considering the IRR on the incremental cash flow.

As the examples suggest, when mutually exclusive projects are evaluated it is much simpler to use the NPV rule rather than the IRR rule.

Lending vs. Borrowing The IRR rule cannot distinguish between lending and borrowing and hence a high IRR need not necessarily be a desirable thing.

To illustrate this point, let us consider two projects A and B

	Cash flow		*IRR*	*NPV at 10% discount rate*
Project	C_0	C_1		
A	−4000	+6000	50%	145
B	+4000	−7000	75%	−236

The IRR for project A is 50 percent, whereas the IRR for project B is 75 percent. Does this mean that B is more attractive than A? Certainly not. A is a very attractive project, whereas B is a highly undesirable project. Why? A involves investing 4000 at a rate of return of 50 percent, whereas B involves borrowing 4000 at a rate of return of 75 percent. Yet if we go by the IRR figures, B appears more attractive than A.

Differences between Short-term and Long-term Interest Rates Recall our general formula for calculating NPV:

$$\text{NPV} = \sum_{t=1}^{n} \frac{C_t}{(1+r_t)^t} - \text{Initial investment}$$

Thus, the cash flow for year 1, C_1, is discounted at the opportunity cost of capital for year 1, r_1; the cash flow for year 2, C_2, is discounted at the opportunity cost of capital for year 2, r_2; so on and so forth.

The IRR rule says that a project should be accepted if its IRR is greater than the opportunity cost of capital. But what should we do when there are several opportunity costs? Should we compare IRR with r_1 or r_2 or r_3 ... or r_n? We have to, in effect, compute a complex weighted average of various rates to get a number comparable to the IRR. Given the difficulty in doing so, it makes sense to ignore IRR, when short-term interest rates differ from long-term interest rates, and simply calculate NPV.

What Does IRR Mean?

There are two possible economic interpretations of internal rate of return: (i) The internal rate of return represents the rate of return on the unrecovered investment balance in the project. (ii) The internal rate of return is the rate of return earned on the initial investment made in the project.

To understand the nature of these interpretations, consider a project with the following cash flows.

Year	Cash flow
0	Rs –300,000
1	0
2	417,000
3	117,000

The internal rate of return of this project is the value of r in the expression

$$0 = \frac{-300,000}{(1+r)^0} + \frac{0}{(1+r)^1} + \frac{417,000}{(1+r)^2} + \frac{117,000}{(1+r)^3}$$

The value of r which satisfies the above expression is 30 percent. This figure, according to the first interpretation of internal rate of return, reflects the rate of return on the unrecovered investment balance. The unrecovered investment balance is defined as:

$$F_t = F_{t-1}(1+r) + C_t \qquad (8.8)^3$$

3. Recognising that $F_0 = CF_0$, we may obtain the following by applying the recursive relationship in Eq. (8.8)

$F_0 = C_0$ (1)

$F_1 = F_0(1+r) + C_1 = C_0(1+r) + C_1$ (2)

$F_2 = F_1(1+r) + C_2 = C_0(1+r)^2 + C_1(1+r) + C_2$ (3)

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$F_n = F_{n-1}(1+r) + C_n = C_0(1+r)^n + C_1(1+r)^{n-1} + \cdots + C_n$ (4)

where F_t = unrecovered investment balance at the end of year t

F_{t-1} = unrecovered investment balance at the end of year $t-1$

C_t = cash flow at the end of year t

Exhibit 8.7 shows that if 30 percent rate of return is applied on the unrecovered investment balance, the balance in the project reduces to 0 at the end of its life.

Exhibit 8.7 ***Unrecovered Investment Balance***

Year	Unrecovered Investment Balance at the Beginning	Interest for the Year	Cash Flow at the End of the Year of the Year	Unrecovered Investment Balance at the End
	F_{t-1}	$F_{t-1}(1+r)$	C_t	$F_{t-1}(1+r)+C_t$
1	Rs – 300,000	– 90,000	0	–390,000
2	Rs – 390,000	–117,000	417,000	– 90,000
3	Rs – 90,000	– 27,000	117,000	0

Now, let us consider the second interpretation according to which, the internal rate of return is the compounded rate of return earned on the initial investment, for the entire life of the project. This means that if a project involves an initial outlay of I, has an internal rate of return of r percent, and has a life of n years, the value of the benefits of the project, assessed at the end of n years, will be $I(1+r)^n$. In our numerical example, where the initial investment is Rs 300,000, the internal rate of return of the project is 30 percent, and the life of the project is three years, the value of the benefits of the project, assessed at the end of three years, will be Rs 300,000 $(1+0.30)^3$ = Rs 659,100.

The second interpretation of internal rate of return is based on the assumption that the intermediate flows of the project are reinvested at a rate of return equal to the internal rate of return of the project. For our numerical example, it means that the intermediate cash inflow of Rs 417,000 occurring at the end of the second year (this is the only intermediate cash inflow for the project) can be reinvested at a rate of return equal to 30 percent. Given this assumption, we find that the value of all benefits, assessed at the end of three years, works out to Rs 659,100 as follows:

Year	Benefit (cash inflow)	Compounded Value at the End of 3 Years
1		
2	Rs 417,000	542,100
3	Rs 117,000	117,000
		Sum = 659,100

Which economic interpretation should we put on internal rate of return? Since it is often not possible for a firm to reinvest intermediate inflows at a rate of return equal to the

project's internal rate of return, the first interpretation seems more realistic. Hence, we may view internal rate of return as the rate of return on the time-varying, unrecovered investment balance in the project, rather than the compounded rate of return on the initial investment. This point deserves to be understood because the notion of internal rate of return generally creates the impression that it is the rate of return earned on a sustained basis on the initial investment over the life of the project.

Redeeming Qualities

Despite its deficiencies, IRR is immensely popular in practice, even more than NPV. It perhaps fills a need that NPV does not. Managers as well as financial analysts usually think in terms of rates of return rather than absolute rupee values. Although IRR can be misleading the result can be readily interpreted by all parties. As Samuel Weaver says: "The resulting IRR can be mentally compared to expected inflation, the current borrowing rates, the cost of capital, an equity's portfolio return, and so on." No wonder surveys suggest that the IRR is the most popular investment evaluation technique.

Further, in certain situations, the IRR offers a practical advantage over NPV. You can't estimate the NPV unless you know the discount rate, but you can still calculate the IRR. Suppose you don't know the discount rate but you find that the project has an IRR of 35 percent, you would perhaps accept the project because it is unlikely that the discount rate would be that high. The pros and cons of IRR are summarised below:

Pros	*Cons*
• Closely related to NPV	• May lead to multiple rates of return
• Easy to understand and interpret	• May result in incorrect decisions in comparing mutually exclusive projects

Modified IRR

Despite NPV's conceptual superiority, managers seem to prefer IRR over NPV because IRR is intuitively more appealing as it is a percentage measure. Is there a percentage measure that overcomes the shortcomings of the regular IRR? Yes, there is one and it is called the modified IRR or MIRR.

The procedure for calculating MIRR is as follows:

Step 1 Calculate the present value of the costs (PVC) associated with the project, using the cost of capital (r) as the discount rate.

$$\text{PVC} = \sum_{t=0}^{n} \frac{\text{Cash outflow}_t}{(1+r)^t}$$

Step 2 Calculate the terminal value (TV) of the cash inflows expected from the project.

$$\text{TV} = \sum_{t=0}^{n} \text{Cash inflow}_t (1+r)^{n-t}$$

Step 3 Obtain MIRR by solving the following equation:

$$\text{PVC} = \frac{TV}{(1+MIRR)^n}$$

To illustrate the calculation of MIRR let us consider an example. Pentagon Limited is evaluating a project that has the following cash flow stream associated with it:

Year	0	1	2	3	4	5	6
Cash flow (Rs in million)	−120	−80	20	60	80	100	120

The cost of capital for Pentagon is 15 percent. The present value of costs is:

$$120 + \frac{80}{(1.15)} = 189.6$$

The terminal value of cash inflows is:

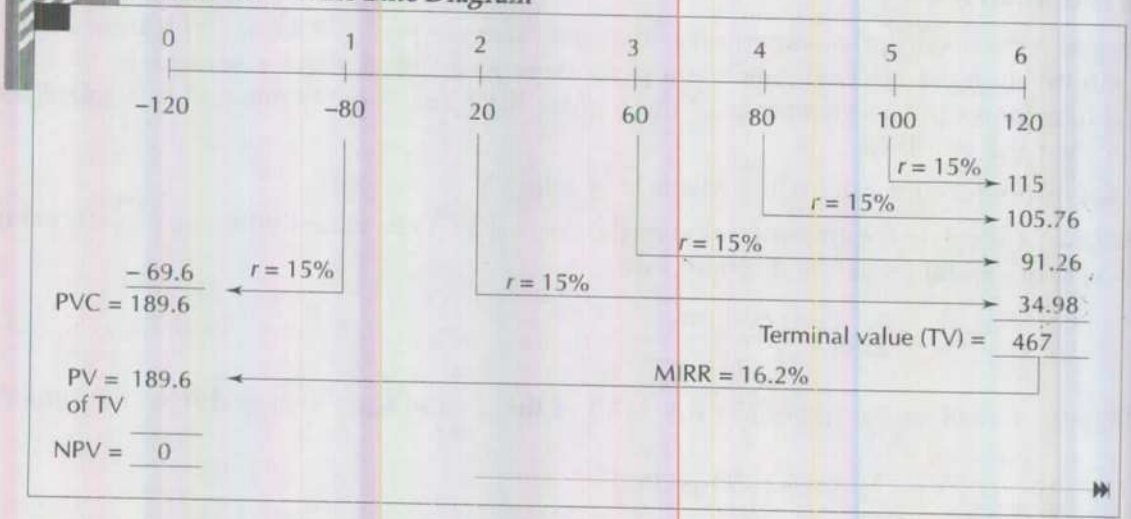
$$20(1.15)^4 + 60(1.15)^3 + 80(1.15)^2 + 100(1.15) + 120$$
$$= 34.98 + 91.26 + 105.76 + 115 + 120 = 467$$

The MIRR is obtained as follows:

$$189.6 = \frac{467}{(1+MIRR)^6}$$
$$(1 + \text{MIRR})^6 = 2.463$$
$$1 + \text{MIRR} = 2.463^{1/6} = 1.162$$
$$\text{MIRR} = 1.162 - 1 = 0.162 \text{ or } 16.2 \text{ percent}$$

The time line diagram for this problem is given in Exhibit 8.8.

Exhibit 8.8 ***Time Line Diagram***



Evaluation MIRR is superior to the regular IRR in two ways. First, MIRR assumes that project cash flows are reinvested at the cost of capital whereas the regular IRR assumes that project cash flows are reinvested at the project's own IRR. Since reinvestment at cost of capital (or some other explicit rate) is more realistic than reinvestment at IRR, MIRR reflects better the true profitability of a project. Second, the problem of multiple rates does not exist with MIRR.

Thus, MIRR is a distinct improvement over the regular IRR. Is it as good as NPV in choosing between mutually exclusive projects? Without getting into technicalities, let us note the following:

- If the mutually exclusive projects are of the same size, NPV and MIRR lead to the same decision irrespective of variations in life.
- If the mutually exclusive projects differ in size there is a possibility of conflict.

What is the verdict ? MIRR is better than the regular IRR in measuring true rate of return. However, for choosing among mutually exclusive projects of different size, NPV is a better alternative in measuring the contribution of each project to the value of the firm.

8.4 URGENCY

According to this criterion, projects that are deemed to be more urgent get priority over projects that are regarded as less urgent.

The problem with this criterion is: How can the degree of urgency be determined? In certain situations, of course, it may not be difficult to identify really urgent investments. For example, some minor equipment that has failed may have to be replaced immediately to ensure continuity of production. Non-replacement of such equipment may mean considerable losses arising from stoppage in production. It may be futile in such a case to go into a detailed analysis and delay the decision.

In many situations, however, it is difficult to determine the relative degree of urgency because of the lack of an objective basis. The use of urgency criterion may imply that the persuasiveness of those who propose projects would become a very important factor in investment decisions. Resource allocation may degenerate into a political battle.

In view of these limitations of the urgency criterion, we suggest that in general it should not be used for investment decision making. In exceptional cases, where genuine urgency exists, it may be used provided investment outlays are not large.

8.5 PAYBACK PERIOD

The payback period is the length of time required to recover the initial cash outlay on the project. For example, if a project involves a cash outlay of Rs 600,000 and generates cash inflows of Rs 100,000, Rs 150,000, Rs 150,000, and Rs 200,000, in the first, second, third, and fourth years, respectively, its payback period is 4 years because the sum of cash inflows during the 4 years is equal to the initial outlay. When the annual cash inflow is a constant sum, the payback period is simply the initial outlay divided by the annual cash inflow. For example, a project which has an initial cash outlay of Rs 1,000,000 and a constant annual cash inflow of Rs 300,000 has a payback period of Rs 1,000,000/300,000 = 3⅓ years.

According to the payback criterion, the shorter the payback period, the more desirable the project. Firms using this criterion generally specify the maximum acceptable payback period. If this is n years, projects with a payback period of n years or less are deemed worthwhile and projects with a payback period exceeding n years are considered unworthy.

Evaluation

A widely used investment criterion, the payback period seems to offer the following *advantages:*

- It is simple, both in concept and application. It does not use involved concepts and tedious calculations and has few hidden assumptions.
- It is a rough and ready method for dealing with risk. It favours projects which generate substantial cash inflows in the earlier years and discriminates against projects which bring substantial cash inflows in the later years but not in the earlier years. Now, if risk tends to increase with futurity—in general, this may be true—the payback criterion may be helpful in weeding out risky projects.
- Since it emphasises earlier cash inflows, it may be a sensible criterion when the firm is pressed with problems of liquidity.

The *limitations* of the payback criterion, however, are very serious:

- It fails to consider the time value of money. Cash inflows, in the payback calculation, are simply added without suitable discounting. This violates the most basic principle of financial analysis which stipulates that cash flows occurring at different points of time can be added or subtracted only after suitable compounding/discounting.
- It ignores cash flows beyond the payback period. This leads to discrimination against projects which generate substantial cash inflows in later years. To illustrate, consider the cash flows of two projects, *A* and *B*:

Year	*Cash Flow of A*	*Cash Flow of B*
0	Rs (100,000)	Rs (100,000)
1	50,000	20,000
2	30,000	20,000
3	20,000	20,000
4	10,000	40,000
5	10,000	50,000
6	–	60,000

The payback criterion prefers *A*, which has a payback period of 3 years in comparison to *B* which has a payback period of 4 years, even though *B* has very substantial cash inflows in the years 5 and 6.

- It is a measure of the project's capital recovery, not profitability.
- Though it measures a project's liquidity, it does not indicate the liquidity position of the firm as a whole, which is more important. Weingartner writes: "The usually designated speculative and/or precautionary motive of firms to hold liquid or near liquid funds in order to seize upon unexpected opportunities is a different motive from that which requires each new investment separately to recover its original cost within a short period."[4]

Discounted Payback Period

A major shortcoming of the conventional payback period is that it does not take into account the time value of money. To overcome this limitation, the discounted payback period has been suggested. In this modified method, cash flows are first converted into their present values (by applying suitable discounting factors) and then added to ascertain the period of time required to recover the initial outlay on the project. Exhibit 8.9 illustrates the calculation of discounted payback period. Looking at the last column in this exhibit, we find that the discounted payback period is between 3 and 4 years.

Reasons for the Popularity of Payback Period

Despite its serious shortcomings, the payback period is widely used in appraising investments. Why? It appears that the payback measure serves as a proxy for certain types of information which are useful in investment decision making.

4. H.M. Weingartner, "Some Views on the Payback Period and Capital Budgeting Decisions" *Management Science*, Vol.15 (August 1969), p. 599.

- The payback period may be regarded roughly as the reciprocal for the internal rate of return when the annual cash inflow is constant and the life of the project fairly long.[5]
- The payback period is somewhat akin to the break-even point. A rule of thumb, it serves as a useful short-cut in the process of information generation and evaluation.
- The payback period conveys information about the rate at which the uncertainty associated with a project is resolved. The shorter the payback period, the faster the uncertainty associated with the project is resolved. The longer the payback period, the slower the uncertainty associated with the project is resolved. Decision makers, it may be noted, prefer an early resolution of uncertainty. Why? An early resolution of uncertainty enables the decision maker to take prompt corrective action, adjust his consumption patterns, and modify/change other investment decisions.

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5. The following analysis bears this out:
Let I = initial outlay, c = constant annual cash flow, S = salvage value, and n = life of the project. The internal rate of return is the value of r in the equation:

$$I = \sum_{t=1}^{n} \frac{c}{(1+r)^t} + \frac{S}{(1+r)^n} \tag{1}$$

Since

$$\sum_{t=1}^{n} \frac{c}{(1+r)^t} = \frac{c}{r} - \frac{c}{r}\left[\frac{1}{(1+r)}\right]^n \tag{2}$$

the internal rate of return equation becomes

$$I = \frac{c}{r} - \frac{c}{r}\left[\frac{1}{1+r}\right]^n + \frac{S}{(1+r)^n} \tag{3}$$

When n is very large, the last two terms on the right-hand side of the above expression become negligible.
Hence,

$$I \simeq \frac{c}{r} \tag{4}$$

This means

$$r \simeq \frac{c}{I} \tag{5}$$

In words, the internal rate of return is approximately the inverse of the payback period.

Exhibit 8.9 ***Calculation of Discounted Payback Period***

Year	*Cash Flow*	*Discounting Factor @10%*	*Present Value*	*Cumulative Net Cash Flow after Discounting*
0	Rs –10,000	1.000	Rs –10,000	–10,000
1	3,000	0.909	2,727	7,273
2	3,000	0.826	2,478	– 4,795
3	4,000	0.751	3,004	– 1,791
4	4,000	0.683	2,732	941
5	5,000	0.621	3,105	
6	2,000	0.565	1,130	
7	3,000	0.513	1,539	

8.6 ACCOUNTING RATE OF RETURN

The accounting rate of return, also referred to as the average rate of return on investment, is a measure of profitability which relates income to investment, both measured in accounting terms. Since income and investment can be measured in various ways, there can be a very large number of measures for accounting rate of return.

The measures that are employed commonly in practice are:

A: $$\frac{\text{Average income after tax}}{\text{Initial investment}}$$

B : $$\frac{\text{Average income after tax}}{\text{Average investment}}$$

C: $$\frac{\text{Average income after tax but before interest}}{\text{Initial investment}}$$

D: $$\frac{\text{Average income after tax but before interest}}{\text{Average investment}}$$

E: $$\frac{\text{Average income before interest and taxes}}{\text{Initial investment}}$$

F: $$\frac{\text{Average income before interest and taxes}}{\text{Average investment}}$$

G: $$\frac{\text{Total income after tax but before depreciation} - \text{Initial investment}}{(\text{Initial investment}/2) \times \text{years}}$$

The computation of various measures of accounting rate of return is shown in Exhibit 8.10 with reference to a hypothetical project.

Exhibit 8.10 ***Various Measures of Accounting Rate of Return***

Year	Investment (book value)	Depreciation	Income Before Interest and Taxes	Interest	Income Before Tax	Tax	Income After Tax
1	1.00	0.20	0.30	0.10	0.20	0.100	0.100
2	0.80	0.20	0.35	0.10	0.25	0.125	0.125
3	0.60	0.20	0.40	0.10	0.30	0.150	0.150
4	0.40	0.20	0.40	0.10	0.30	0.150	0.150
5	0.20	0.20	0.35	0.10	0.25	0.125	0.125
Sum:	3.00	1.00	1.80	0.50	1.30	0.650	0.650
Average:	0.60	0.20	0.36	0.10	0.26	0.130	0.130

Measures

A: $\dfrac{\text{Average income after tax}}{\text{Initial investment}} = \dfrac{0.13}{1.00} = 13.0\%$

B: $\dfrac{\text{Average income after tax}}{\text{Average investment}} = \dfrac{0.13}{0.60} = 21.7\%$

C: $\dfrac{\text{Average income after tax but before interest}}{\text{Initial investment}} = \dfrac{0.13 + 0.10}{1.0} = 23.0\%$

D: $\dfrac{\text{Average income after tax but before interest}}{\text{Average investment}} = \dfrac{0.13 + 0.10}{0.60} = 38.3\%$

E: $\dfrac{\text{Average income before interest and tax}}{\text{Initial investment}} = \dfrac{0.36}{1.0} = 36\%$

F: $\dfrac{\text{Average income before interest and tax}}{\text{Average investment}} = \dfrac{0.36}{0.60} = 60.0\%$

G: $\dfrac{\text{Total income after tax but before depreciation} - \text{Initial investment}}{(\text{Initial investment}/2) \times \text{years}} = \dfrac{0.65 + 1.00 - 1.00}{\frac{1}{2} \times 5}$

$= 26.0\%$

Obviously, the higher the accounting rate of return, the better the project. In general, projects which have an accounting rate of return equal to or greater than a pre-specified cut off rate of return—which is usually between 15 percent and 30 percent—are accepted; others are rejected.

Accounting Rate of Return and Internal Rate of Return

It is very difficult to generalise if the accounting rate of return is calculated on the basis of average income over the life of the project. However, if the accounting rate of return is calculated for each year using the expected (or actual) net income, the following generalisations may be made:

- The accounting rate of return tends to understate the internal rate of return for earlier years and overstate it for later years.
- The accounting rate of return and the internal rate of return can be the same only if the depreciation schedule is equal to the economic depreciation schedule.
- Inflation and creative accounting tend to create a discrepancy between the accounting rate of return and the internal rate of return.

Evaluation

Traditionally a popular investment appraisal criterion, the accounting rate of return has the following *virtues*:

- It is simple to calculate.
- It is based on accounting information which is readily available and familiar to businessmen.
- It considers benefits over the entire life of the project.
- Since it is based on accounting measures, which can be readily obtained from the financial accounting system of the firm, it facilitates post-auditing of capital expenditures.
- While income data for the entire life of the project is normally required for calculating the accounting rate of return, one can make do even if the complete income data is not available. For example, when due to indeterminacy of project life a complete forecast of income cannot be obtained, the accounting rate of return may be calculated on the basis of income for some typical year or income for the first three to five years.

The *shortcomings* of the accounting rate of return criterion seem to be considerable:

- It is based upon accounting profit, not cash flow.
- It does not take into account the time value of money. To illustrate this point, consider two investment proposals *X* and *Y*, each requiring an outlay of Rs 100,000. Both the proposals have an expected life of four years after which their value would be nil. Relevant details of these proposals are given below:

	X				Y			
Year	*Book value*	*Depreciation*	*Profit after tax*	*Cash flow*	*Book value*	*Depreciation*	*Profit after tax*	*Cash flow*
0	100,000	0	0	(100,000)	100,000	0	0	(100,000)
1	75,000	25,000	40,000	65,000	75,000	25,000	10,000	35,000
2	50,000	25,000	30,000	55,000	50,000	25,000	20,000	45,000
3	25,000	25,000	20,000	45,000	25,000	25,000	30,000	55,000
4	0	25,000	10,000	35,000	0	25,000	40,000	65,000

Both the proposals, with an accounting rate of return (measure *A*) of 50 percent, look alike from the accounting rate of return point of view, though project *X*, because it provides benefits earlier, is much more desirable. While the payback period criterion gives no weight to more distant benefits, the accounting rate of return criterion seems to give them too much weight.

- There are, as we have seen, numerous measures of accounting rate of return. This can create controversy, confusion, and problems in interpretation.
- Accounting income (whatever particular measure of income we choose) is not uniquely defined because it is influenced by the methods of depreciation, inventory valuation, and allocation of certain costs. Working with the same basic accounting data, different accountants are likely to produce different income figures. A similar problem, though less severe, exists with respect to investment.
- The argument that the accounting rate of return measures facilitate post-auditing of capital expenditure is not very valid. The financial accounting system of a firm is designed to report events with respect to accounting periods and for profit centres but not for individual investments.
- The target or hurdle rate of return cannot be specified in relation to the goal of shareholder wealth maximisation.
- The accounting rate of return method can be highly misleading because balance sheet book values reflect neither the earning capacities of assets nor their market values. For example, consider a commercial complex constructed at a cost of Rs 20 million, 8 years ago, producing presently an income of Rs 1.8 million. While its book value presently is Rs 12 million, its fair market value is Rs 40 million. The return on investment based on the book value works out to 15 per cent (Rs 1.8 million in relation to Rs 12 million). However, if the income is related to the current value, the return on investment is just 4.5 percent. This example highlights the limitation of using book value figures. It must be stressed that the book value is not relevant as it merely represents sunk costs.

8.7 ASSESSMENT OF VARIOUS METHODS

We have discussed at length the five basic methods of evaluation. It may be helpful at this juncture to do a summary assessment of these methods on the basis of certain theoretical and practical considerations. This is done in Exhibit 8.11.

Exhibit 8.11 ***Assessment of Basic Evaluation Methods***

	Net Present Value	*Benefit Cost Ratio*	*Internal Rate of Return*	*Payback Period*	*Accounting Rate of Return*
Theoretical considerations					
1. Does the method consider all cash flows?	Yes	Yes	Yes	No	?
2. Does the method discount cash flows at the opportunity cost of funds?	Yes	Yes	No	No	No
3. Does the method satisfy the principle of value additivity?	Yes	No	No	?	?
4. From a set of mutually exclusive projects, does the method choose the project which maximises shareholder wealth?	Yes	No	No	?	?
Practical considerations					
1. Is the method simple?	Yes	Yes	Yes	Yes	Yes
2. Can the method be used with limited information?	No	No	No	Perhaps	Yes
3. Does the method give a relative measure?	No	Yes	Yes	No	Yes

8.8 INVESTMENT APPRAISAL: INDIAN PRACTICE

Let us look at investment appraisal in practice in India. Certain questions may be raised in this context:

- How much importance is assigned to economic analysis of capital expenditures in practice?
- What methods are used for analysing capital expenditures in practice and what is the rationale underlying these methods?
- In what ways can economic analysis of capital expenditures be improved in practice?

A survey was conducted by the author. Twenty firms, varying on several dimensions like industry category, size, financial performance, and capital intensity, were included in this survey. In these firms, executives responsible for capital investment evaluation and capital budget preparation were interviewed. The interviews, semi-structured in nature, were conducted to obtain answers to the questions posed above.

Importance of Economic Analysis

The nature of economic analysis of capital expenditures varies from project to project. In a few cases, elaborate analysis is carried out; in most of the cases, however, the analysis is

done in sketchy terms. On the whole, one may say that economic analysis is played in a rather low key. The reasons appear to be as follows:

- Most of the proposals are meant either for the replacement of some worn out equipment forming part of a production complex or for adding capacity at some stage of production to ensure better balancing of capacities at various stages. In these cases, it is difficult to evaluate independently the economics of proposed investments. They are usually labelled 'urgent' or 'necessary' and this prejudgment precludes further thinking.
- Project proposals are reviewed at two or three levels (in one organisation as many as five levels of review are obtained, but this is an exceptional case) before a final decision is made, and the judgment of the reviewing authorities is regarded as more important than detailed analysis.
- It is difficult to estimate accurately the costs and revenues associated with capital investments. The range of error in these estimates, it is argued, does not justify sophisticated analysis.
- In many cases only one type of equipment or machinery satisfied the specific requirements. In the absence of alternatives that can be compared, detailed analysis seems to be unwarranted.

Methods of Appraisal and Their Rationale

1. A wide variety of measures are used for evaluating investments. These include measures suggested by capital budgeting literature and several non-standard measures.
2. The most commonly used method for evaluating investments of a small size is the payback method. The following reasons have been given by managers employing this method.

   'We don't have ample funds. Most of the components of our compressor are made outside. We take up only those components which have a payback period of three years or less so that our limited funds are not locked up for long.'

   'We follow the payback period method because the shorter the payback period the higher the return.'

   'Since returns are not assured it is safer to put money in a line where it is quickly recovered.'
3. For investments of a large size, the average rate of return is sometimes used as the principal criterion and the payback period is used as a supplementary criterion. In support of the average rate of return method, one executive said:

   'Our aim is to increase profitability. Profits in relation to investment is the average rate of return. This figure tells me whether the project is good. This can be compared with the cost of money.'

Another executive, who appeared familiar with discounted cash flow techniques but who used the average rate of return method, argued as follows:

'The discounted cash flow method calls for estimates of costs and revenues over the whole project life. This is difficult. Very often we can't estimate the life. We have been using machines longer than their life by good maintenance. Changes in cost and revenues also cannot be predicted. Due to these difficulties we use the accounting rate of return method. Here we take our best estimates for 2–3 years and calculate the average return. Once the project is established the balance between cost and revenue can be maintained in normal circumstances.'

4. Discounted cash flow (DCF) techniques are gaining in importance, particularly in the evaluation of large investments. In one company where informal appraisals are used for smaller outlays, DCF analysis is being used for all independent projects which generally involve substantial outlays. The rationale of this practice was explained by one manager.

   'It is not possible to know the yield of an investment in a machine or process independently. Nor is it worthwhile to know because sponsors of such projects provide suitable justification—better quality, fewer breakdowns, etc. Yield calculations are made for independent units. They are needed for proper appraisal.'

5. Several other criteria are used for evaluating investments: profit per rupee invested, cost savings per unit of product, investment required to replace a worker. It appears that these criteria are more intelligible to operations-minded managers. Although in some cases these criteria are closely related to measures suggested in theory, it is difficult to make generalisations about their suitability. The variety of measures used by project sponsors seem to create problems of understanding and comparison for the higher executives.

6. Although specific measures of investment worth are calculated, only four firms, out of the sample of 20 firms studied, seemed to have a well-defined policy about the acceptability of investment projects based on such calculations. By and large, no fixed standards were used for acceptance/rejection of projects. The final decision rested with the top management which combined quantitative measures with subjective judgments in an unspecified manner. The difficulty of adhering rigidly to standards was expressed by three managers:

   'There are intangible factors, too, which must be considered along with the economics of the project. In view of this, standards cannot be rigidly defined. Moreover, we have to consider our liquidity. If we have sufficient funds we may accommodate more projects. If we do not have money—the problem that we have today—we may not be able to okay otherwise good investments.'

   'Our cost of money has been rising. How can we work with fixed standards?'

   'For replacement investments we have more or less a fixed standard—15 percent after tax. This is not for few projects. Here we may require 20 percent or even 25 percent depending on the circumstances.'

7. Limited funds do not appear to be a serious constraint with prosperous firms. A common refrain is: "We will get the funds if we have good projects." Other constraints, more serious than the funds constraint, seem to hinder investment activity. As one manager put it:

   'If our investment is slow, it is mainly due to governmental delays in approving the proposed collaboration—not for want of money.'

The situation with less prosperous concerns is different. Limited funds often pose a serious bottleneck with firms which have poor financial resources. In these firms investments are made only when they are unavoidable. In other words, they adopt the criterion of 'non-postponability', to use a term suggested by one manager.

Room for Improvement

On the basis of the foregoing, we make the following suggestions for improving capital budgeting in practice:

1. As far as possible the criteria of investment evaluation should be standardised. The use of many measures makes comparison difficult.
2. The concepts used in analysis must be clearly defined. Vague, qualitative phrases should be substituted by quantitative measures wherever possible. This is necessary to promote understanding and dispel confusion.
3. The characteristics of various methods must be properly understood. Wrong notions like "the inverse of payback is equal to the rate of return" and "net present value and yield are alike" must be corrected.
4. Discounted cash flow techniques should receive greater emphasis. They are theoretically superior and practically feasible. The use of these techniques compels a firm to 'look ahead' which in itself has a significant payoff. This advantage, however, can be enjoyed only if the 'look ahead' is done carefully and realistically. If it is done in a very mechanical fashion then no advantage is likely to accrue.

The argument of some executives that discounted cash flow techniques require difficult-to-obtain information and that many persons are not familiar with them, reflects inertia and a non-progressive outlook. Determined efforts to introduce discounted cash flow techniques can overcome these hurdles.

To sum up, evaluation must be carried out in explicit, well-defined, preferably standardised terms and should be based on sound economic logic. Informal and cursory treatment should give way to thorough and rigorous analysis. It must be realised that the prerogative of investment decision making has a concomitant responsibility—to base such decisions on a careful and sound evaluation.

Findings of a Recent Survey

A recent survey of capital budgeting practices in India, conducted by U.Rao Cherukeri, revealed the following:

- Over time, discounted cash flow methods have gained in importance and internal rate of return is the most popular evaluation method.
- Firms typically use multiple evaluation methods.
- Accounting rate of return and payback period are widely employed as supplementary evaluation methods.
- Weighted average cost of capital is the most commonly used discount rate and the most often used discount rate is 15 percent in post-tax terms.
- Risk assessment and adjustment techniques have gained popularity. The most popular risk assessment technique is sensitivity analysis and the most common methods for risk adjustment are shortening of the payback period and increasing the required rate of return.

8.9 INVESTMENT APPRAISAL: INTERNATIONAL PRACTICE

While a comprehensive discussion of international practice is beyond the scope of this book, an inkling of the techniques of evaluation used in the U.S. and Japan, the two largest economies of the world, will be provided here.

Evaluation Techniques in the U.S.

To learn about the methods of evaluation used by business firms in the U.S., we will review the findings of a study conducted by William Petty and David Scott.

The level of importance assigned to the five basic evaluation techniques, viz., accounting return on investment, payback period, net present value, internal rate of return, and profitability index (benefit–cost ratio) is shown in Exhibit 8.12.

Exhibit 8.12 ***Evaluation Techniques***

	Level of Importance					
Technique	*None*	*Slight*	*Moderate*	*Fair*	*High*	*No Response*
Accounting return on investment	12.35%	15.29%	17.06%	8.82%	33.53%	2.94%
Payback period	1.76	12.35	25.29	28.82	30.00	1.76
Net present value	8.82	16.47	20.59	15.29	33.20	5.29
Internal rate of return	7.65	9.41	4.71	14.71	59.41	4.12
Profitability index or benefit–cost ratio	31.17	18.82	15.29	7.65	11.18	15.88

Evaluation Techniques in Japan

Japanese firms appear to rely mainly on two kinds of analysis: (a) one year return on investment analysis, and (b) residual investment analysis. While the former needs no explanation, the latter may require some elaboration. The manner in which the residual investment analysis is done is illustrated in Exhibit 8.13. Examining this exhibit we find that the residual investment analysis is similar to the discounted payback analysis. This analysis shows how long it will take for the residual investment in the project to become zero after taking into account the time value of money. This period is conceptually equal to the discounted payback period.

Exhibit 8.13 ***Residual Investment Analysis***

Year	Cash Flow	Imputed Interest @ 10%	Adjusted Cash Flow	Residual Investment
0	1000	–	–	–
1	200	100	100	900
2	200	90	110	790
3	300	79	221	569
4	300	57	243	326
5	400	33	367	–
6	400	–	–	–
7	300	–	–	–
8	300	–	–	–

In general, it appears that Japanese firms use methods which are less complicated and sophisticated than the ones used by American firms. Why? Several reasons are offered to explain this difference: (a) Japanese managers, in general, have limited formal business training. (b) There is a great deal of consensus decision making in Japanese firms which necessarily calls for the use of relatively simpler methods. (c) Japanese firms put considerable emphasis on verbal scenario analysis (as opposed to complex calculations) and careful scrutiny of basic assumptions which seems to blend well with a healthy skepticism about the accuracy of quantitative forecasts.

SUMMARY

- A wide range of criteria has been suggested to judge the worthwhileness of investment projects. They fall into two broad categories: discounting criteria and non-discounting criteria. The important discounting criteria are: net present value, benefit-cost ratio, and internal rate of return. The major non-discounting criteria are: payback period and accounting rate of return.
- The net present value (NPV) of a project is the sum of the present values of all the cash flows—positive as well as negative—that are expected to occur over the life of the project.
- The decision rule associated with the NPV criterion is: Accept the project if the NPV is positive and reject the project if the NPV is negative.

- NPV has certain properties that make it a very attractive decision criterion: NPVs are additive; the NPV rule assumes that the intermediate cash flows of a project are reinvested at a rate of return equal to the cost of capital; NPV calculation permits time varying discount rates.
- The standard NPV method is based on the assumption that the intermediate cash flows are reinvested at a rate of return equal to the cost of capital. When this assumption is not valid, the investment rates applicable to the intermediate cash flows need to be defined for calculating the modified net present value.
- When the marginal cost of capital is constant, the optimal capital budget consists of all projects which have a positive net present value at the given marginal cost of capital. However, when the marginal cost of capital increases at discrete points as more and more financing is sought, determination of the optimal capital budget is not easy.
- The benefit cost ratio is defined as the present value of benefits (cash inflows) divided by the present value of costs (cash outflows). A project is considered worthwhile if the benefit–cost ratio is more than 1 and not worthwhile if the benefit–cost ratio is less than 1.
- The internal rate of return (IRR) of a project is the discount rate which makes its NPV equal to zero. In the NPV calculation we assume that the discount rate is known and determine the NPV. In the IRR calculation, we set the NPV equal to zero and determine the discount rate that satisfies this condition.
- The decision rule for IRR is as follows: Accept the project if its IRR is greater than the cost of capital; reject the project if its IRR is less than the cost of capital.
- The IRR and NPV rules lead to identical decisions provided two conditions are satisfied. First, the cash flows of the project must be conventional, implying that the first cash flow (initial investment) is negative and the subsequent cash flows are positive. Second, the project must be independent meaning that the project can be accepted or rejected without reference to any other project.
- There are problems in using IRR when the cash flows of the project are not conventional or when two or more projects are being compared to determine which one is the best. In the first case, it is difficult to define 'what is IRR' and in the second case IRR can be misleading. Further, IRR cannot distinguish between lending and borrowing. Finally, IRR is difficult to apply when short-term interest rates differ from long-term interest rates.
- There are two possible economic interpretations of internal rate of return: (i) The internal rate of return represents the rate of return on the unrecovered investment balance in the project. (ii) The internal rate of return is the rate of return earned on the initial investment made in the project.
- Despite NPV's conceptual superiority, managers seem to prefer IRR over NPV because IRR is intuitively more appealing as it is a percentage measure. Is there a percentage measure that

overcomes the shortcomings of the regular IRR? Yes, there is one and it is called the modified IRR or MIRR. It is calculated by solving the following equation:

$$\text{Present value of cash outflows} = \frac{\text{Terminal value of cash inflows}}{(1 + \text{MIRR})^n}$$

- The payback period is the length of time required to recover the initial cash outlay on the project.
- According to the payback criterion, the shorter the payback period, the more desirable the project. Firms using this criterion generally specify the maximum acceptable payback period.
- Payback period is widely used because it is simple, both in concept and application, and it is a rough and ready method for dealing with risk. However, it has serious limitations: it does not consider the time value of money; it ignores cash flows beyond the payback period; it is a measure of capital recovery, not profitability.
- A major shortcoming of the conventional payback period is that it does not take into account the time value of money. To overcome this limitation, the discounted payback period has been suggested. In this method, cash flows are first converted into their present values (by applying suitable discounting factors) and then added to ascertain the period of time required to recover the initial outlay of the project.
- The accounting rate of return, also called the average rate of return, is defined as

$$\frac{\text{Profit after tax}}{\text{Book value of the investment}}$$

- The accounting rate of return has certain virtues: it is simple to calculate; it is based on accounting information which is readily available and familiar to businessmen; it considers benefits over the entire life of the project. However, it has serious shortcomings as well: it is based upon accounting profit, not cash flow; it does not take into account the time value of money; it is internally inconsistent.
- The most popular methods for evaluating small sized projects are payback method and accounting rate of return method. For larger projects, IRR appears to be the most commonly used method.
- In the U.S., internal rate of return, net present value, accounting rate of return, and payback period are the most popular methods of project appraisal.
- Japanese firms appear to rely mainly on two kinds of analysis: (i) one year return on investment analysis, and (ii) residual investment analysis.

Questions

1. What is NPV?
2. What are the implications of the additivity property of NPV?
3. Discuss the general formula of NPV when discount rates vary over time.
4. What is the rationale for the NPV rule?

5. How is modified NPV calculated?
6. How would you determine the capital budget under conditions of increasing marginal cost of capital?
7. What are the limitations of NPV?
8. What are the two ways of defining the benefit–cost ratio?
9. Evaluate the benefit–cost ratio as an investment criterion.
10. What is IRR and how is it calculated?
11. Discuss the problems associated with IRR.
12. What are the redeeming qualities of IRR?
13. What does IRR mean?
14. How is modified IRR calculated?
15. Why is MIRR superior to the regular IRR?
16. What is payback period?
17. Evaluate payback as an investment criterion.
18. Why is payback so popular, despite its shortcomings?
19. What is discounted payback?
20. How is accounting rate of return calculated?
21. What are the pros and cons of accounting rate of return?
22. Assess various appraisal criteria on the basis of certain theoretical and practical considerations?
23. Discuss how investment appraisal is done in practice.
24. Describe the evaluation techniques used in the U.S. and Japan.

Problems

1. Sulabh International is evaluating a project whose expected cash flows are as follows:

Year	Cash flow
0	₹s (1000,000)
1	100,000
2	200,000
3	300,000
4	600,000
5	300,000

   (a) What is the NPV of the project, if the discount rate is 14 percent for the entire period?
   (b) What is the NPV of the project if the discount rate is 12 percent for year 1 and rises every year by 1 percent?

2. The cash flow streams for four alternative investments, A, B, C and D, are:

Year	A	B	C	D
0	Rs (200,000)	(300,000)	(210,000)	(320,000)
1	40,000	40,000	80,000	200,000
2	40,000	40,000	60,000	20,000
3	40,000	40,000	80,000	–
4	40,000	40,000	60,000	–
5	40,000	40,000	80,000	–
6	40,000	30,000	60,000	–
7	40,000	30,000	40,000	–
8	40,000	20,000	40,000	–
9	40,000	20,000	40,000	200,000
10	40,000	20,000	40,000	50,000

Calculate the payback period, net present value, internal rate of return, and benefit cost ratio for the four alternatives. Assume a discount rate of 12 percent.

3. What is the internal rate of return of an investment which involves a current outlay of Rs 300,000 and results in an annual cash inflow of Rs 60,000 for 7 years?
4. What is the internal rate of return of the following cash flow stream?

Year	Cash flow
0	Rs (3,000)
1	9,000
2	(3,000)

5. If an equipment costs Rs 500,000 and lasts 8 years, what should be the minimum annual cash inflow before it is worthwhile to purchase the equipment? Assume that the cost of capital is 10 percent.
6. How much can be paid for a machine which brings in an annual cash inflow of Rs 25,000 for 10 years? Assume that the discount rate is 12 percent.
7. The cash flows associated with an investment are given below:

Year	Cash flow
0	Rs (100,000)
1	25,000
2	40,000
3	50,000
4	40,000
5	30,000

Calculate the benefit cost ratio of this investment.

8. The cash flows associated with three projects *P*, *Q*, and *R*, are given below:

Year	Net cash flow		
	P	Q	R
0	Rs (2,000)	(2,000)	(2,000)
1	1,400	500	500
2	600	1,100	500
3	400	900	1,600

calculate the net present value of each project at discount rates of 0 percent, 5 percent, 10 percent, 15 percent, 25 percent, and 30 percent.

9. Pioneer Company is considering two mutually exclusive investments, Project *P* and Project *Q*. The expected cash flows of these projects are as follows:

Year	Project *P*	Project *Q*
0	Rs (1,000)	(1,000)
1	(1,200)	200
2	(500)	400
3	(250)	600
4	2,000	800
5	4,000	100

(a) Construct the NPV profiles for Projects *P* and *Q*.
(b) What is the IRR of each project?
(c) Which project would you choose if the cost of capital is 10 percent? 20 percent?
(d) What is each project's NPV if the cost of capital is 12 percent?

10. Your company is considering two mutually exclusive projects, *A* and *B*. Project *A* involves an outlay of Rs 100 million which will generate an expected cash inflow of Rs 25 million per year for 6 years. Project *B* calls for an outlay of Rs 50 million which will produce an expected cash inflow of Rs 13 million per year for 6 years. The company's cost of capital is 12 percent.
(a) Calculate the NPV and IRR of each project.
(b) What is the NPV and IRR of the differential project (the project that reflects the difference between Project *B* and Project *A*)

11. Your company is considering two projects, Project *M* and Project *N*, each of which requires an initial outlay of Rs 50 million. The expected cash inflows from these projects are:

Year	Project *M*	Project *N*
1	Rs 11 million	30 million
2	19	22
3	32	18
4	31	10

(a) What is the payback period for each of the projects?
(b) What is the discounted payback period for each of the projects if the cost of capital is 12 percent?
(c) If the two projects are independent and the cost of capital is 12 percent, which project(s) should the firm invest in?
(d) If the two projects are mutually exclusive and the cost of capital is 10 percent, which project should the firm invest in?

(e) If the two projects are mutually exclusive and the cost of capital is 15 percent, which project should the firm invest in?

(f) If the cost of capital is 14 percent, what is the modified IRR of each project?

12. The cash flow stream of a project is given below:

Year	Cash flow
0	Rs – 8,000
1	2,000
2	-1,000
3	10,000
4	2,000

Calculate the internal rate of return for this project. Define the unrecovered investment balance at the end of each year.

13. The following financial information is available about a project.:

Year	1	2	3	4	5	6	7	8
						(Rs in million)		
Investment	2.40	2.10	1.80	1.50	1.20	0.90	0.60	0.30
Depreciation	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Income before interest and taxes	0.60	0.65	0.70	0.70	0.70	0.65	0.60	0.50
Interest	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Income before tax	0.35	0.40	0.45	0.45	0.45	0.40	0.35	0.25
Tax	-	0.10	0.25	0.25	0.25	0.22	0.19	0.14
Income after tax	0.35	0.30	0.20	0.20	0.20	0.18	0.16	0.11

Compute the various measures of accounting rate of return.

CHAPTER 9

Project Cash Flows

From the previous discussion it is clear that the estimates of cash flows are a key element in investment evaluation. So far we assumed that cash flows were given because we wanted to focus our discussion on investment criteria. Cash flows, however, are not available on a silver platter.

Estimating cash flows—the investment outlays and the cash inflows after the project is commissioned—is the most important, but also the most difficult step in capital budgeting. Forecast errors can be quite large, particularly in gigantic, complex projects. For example, when several oil majors decided to construct the Alaska Pipeline, the initial cost estimate was about US$ 700 million. The final cost, however, was about US$ 7 billion. While this may be an extreme example, it highlights the pitfalls of forecasting.

Forecasting project cash flows involves numerous variables and many participate in this exercise. Capital outlays are estimated by engineering and product development departments; revenue projections are provided by the marketing group; and operating costs are estimated by production people, cost accountants, purchase managers, personnel executives, tax experts and others.

The role of the finance manager is to coordinate the efforts of various departments and obtain information from them, ensure that the forecasts are based on a set of consistent economic assumptions, keep the exercise focussed on relevant variables, and minimise the biases inherent in cash flow forecasting.

This chapter discusses how to "spread the numbers" or develop the cash flow forecasts in conformity with certain basic principles. It is divided into seven sections:

- Elements of the cash flow stream
- Principles of cash flow estimation
- Cash flow illustrations
- Cash flows for a replacement project

- Viewing a project from different perspectives
- How financial institutions and the Planning Commission define cash flows
- Biases in cash flow estimation.

9.1 ELEMENTS OF THE CASH FLOW STREAM

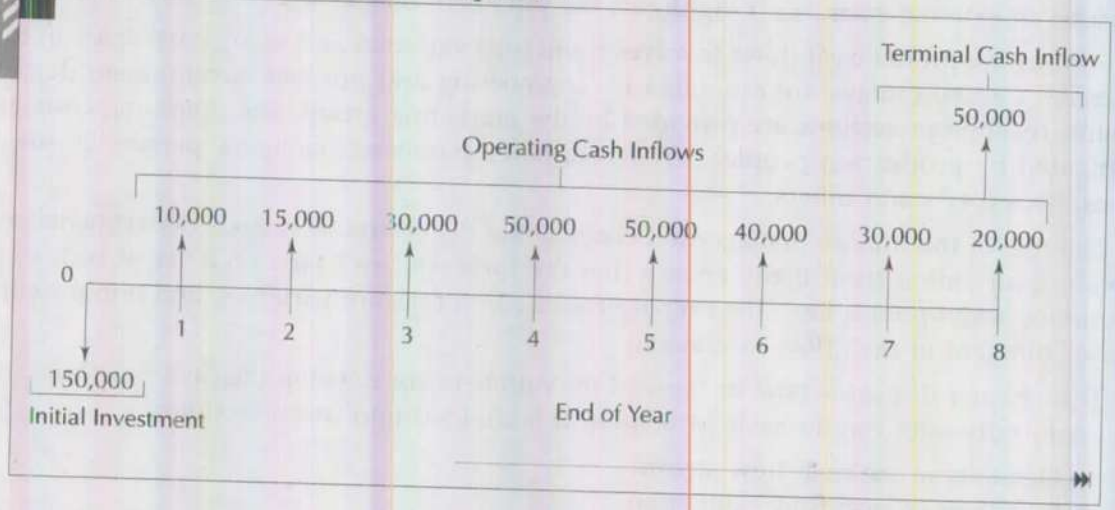
To evaluate a project, you must determine the relevant cash flows, which are the incremental after-tax cash flows associated with the project.

The cash flow stream of a conventional project—a project which involves cash outflows followed by cash inflows—comprises three basic components: (i) initial investment, (ii) operating cash inflows, and (iii) terminal cash inflow.

The initial investment is the after-tax cash outlay on capital expenditure and net working capital when the project is set up. The operating cash inflows are the after-tax cash inflows resulting from the operations of the project during its economic life. The terminal cash inflow is the after-tax cash flow resulting from the liquidation of the project at the end of its economic life.

Exhibit 9.1 depicts on a time line the cash flows for an illustrative project, with each of the cash flow components labelled.

Exhibit 9.1 ***Cash Flow Components***



Time Horizon for Analysis

How is the time horizon for cash flow analysis usually established? The time horizon for cash flow analysis is generally the minimum of the following:

Physical Life of the Plant This refers to the period during which the plant remains in a physically usable condition, i.e., the number of years the plant would perform the function for which it had been acquired. This depends on the wear and tear which the plant is subject to. Suppliers of the plant may provide information on the physical life under normal operating conditions. While the concept of physical life may be useful for determining the depreciation charge, it is not very useful for investment decision making purposes.

Technological Life of the Plant New technological developments tend to render existing plants obsolete. The technological life of a plant refers to the period of time for which the present plant would not be rendered obsolete by a new plant. It is very difficult to estimate the technological life because the pace of new developments is not governed by any law. While it is almost certain that a new development would occur when it would occur is anybody's guess. Yet an estimate of the technological life has to be made.

Product Market Life of the Plant A plant may be physically usable, its technology may not be obsolete, but the market for its products may disappear or shrink and hence its continuance may not be justified. The product market life of a plant refers to the period for which the product of the plant enjoys a reasonably satisfactory market.

Investment Planning Horizon of the Firm The time period for which a firm wishes to look ahead for purposes of investment analysis may be referred to as its investment planning horizon. It naturally tends to vary with the complexity and size of the investment. For small investments (say, installation of a lathe) it may be five years, for medium-size investments (say, expansion of plant capacity) it may be 10 years, and for large-size investments (say, setting up of a new division) it may be 15 years.

9.2 BASIC PRINCIPLES OF CASH FLOW ESTIMATION

The following principles should be followed while estimating the cash flows of a project:

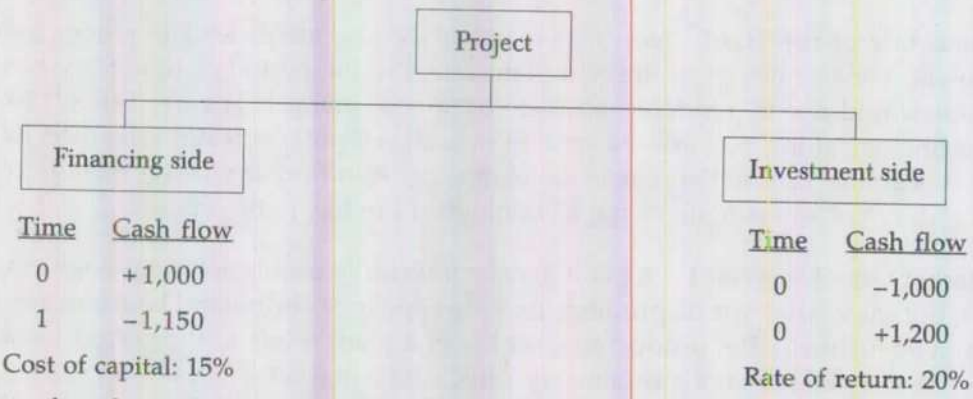
- Separation principle
- Incremental principle
- Post-tax principle
- Consistency principle

Separation Principle

There are two sides of a project, viz., the investment (or asset) side and the financing side and the cash flows associated with these sides should be separated. A simple example may be given to illustrate how this is done.

Suppose a firm is considering a one-year project that requires an investment of Rs 1,000 in fixed assets and working capital at time 0. The project is expected to generate a cash

inflow of Rs 1200 at the end of year 1—this is the only cash inflow expected from the project. The project will be financed entirely by debt carrying an interest rate of 15 percent and maturing after 1 year. Assuming that there are no taxes, the cash flows associated with the investment side of the project, the rate of return on the investment side of the project, the cash flows associated with the financing side of the project, and the cost of capital on the financing side are as follows:



Time	Cash flow
0	+1,000
1	−1,150

Cost of capital: 15%

Time	Cash flow
0	−1,000
0	+1,200

Rate of return: 20%

Note that the cash flows on the investment side of the project do not reflect financing costs (interest in our example). The financing costs are included in the cash flows on the financing side and reflected in the cost of capital figure (which is 15 percent in our example). The cost of capital is used as the hurdle rate against which the rate of return on the investment side (which is 20 per cent in our case) is judged.

The important point to be emphasised is that while defining the cash flows on the investment side, financing costs should not be considered because they will be reflected in the cost of capital figure against which the rate of return figure will be evaluated.

Operationally, this means that interest on debt is ignored while computing profits and taxes thereon. Alternatively, if interest is deducted in the process of arriving at profit after tax, an amount equal to 'Interest (1 – tax rate)' should be added to 'Profit after tax'. Note that:

Profit before interest and tax (1 – tax rate)

= (Profit before tax + Interest) (1 – tax rate)

= (Profit before tax) (1 – tax rate) + Interest (1 – tax rate)

= Profit after tax + Interest (1 – tax rate)

Thus, whether the tax rate is applied directly to the 'Profit before interest and tax' figure or whether the tax-adjusted interest, which is simply 'Interest (1 – tax rate)' is added to the 'Profit after tax' figure we get the same result.

Incremental Principle

The cash flow of a project must be measured in incremental terms. To ascertain a project's incremental cash flows you have to look at what happens to the cash flows of the firm with

the project and **without** the project. The difference between the two reflects the incremental cash flows attributable to the project. That is,

$$\begin{pmatrix}\text{Project cash flow}\\ \text{for the year } t\end{pmatrix} = \begin{pmatrix}\text{Cash flow for the firm } \textbf{with}\\ \text{the project for year } t\end{pmatrix} - \begin{pmatrix}\text{Cash flow for the firm } \textbf{without}\\ \text{the project for year } t\end{pmatrix}$$

In estimating the incremental cash flows of a project, the following guidelines must be borne in mind:

Consider All Incidental Effects In addition to the direct cash flows of the project, all its incidental effects on the rest of the firm must be considered. The project may enhance the profitability of some of the existing activities of the firm because it has a complementary relationship with them; or it may detract from the profitability of some of the existing activities of the firm because it has a competitive relationship with them—all these effects must be taken into account.

How should **product cannibalisation**—the erosion in the sales of the firm's existing products on account of a new product introduction—be handled? One can argue that the loss of profit resulting from the reduction of sales of existing products may be treated as a negative incremental effect of the new product. This may, however, lead to the possibility of rejection of the new product. If this happens, it is very likely that a competitor may steal a march on the firm and introduce a product similar to what the firm had in mind, leading to an erosion in the sales of the existing products of the firm. This is indeed a highly unwelcome scenario because the firm loses sales to a competitor rather than to itself.

Thus how the loss of sales on account of product cannibalisation is treated will depend on whether or not a competitor is likely to introduce a close substitute to the new product that is being considered by the firm.

If the firm is operating in an extremely competitive business and is not protected by entry barriers, product cannibalisation will occur anyway. Hence the costs associated with it are not relevant in incremental analysis. On the other hand, if the firm is sheltered by entry barriers like patent protection or proprietory technology or brand loyalty, the costs of product cannibalisation should be incorporated in investment analysis.

Ignore Sunk Costs A sunk cost refers to an outlay already incurred in the past or already committed irrevocably. So it is not affected by the acceptance or rejection of the project under consideration. Suppose, for example, a company is debating whether it should invest in a project. The company has already spent Rs 1 million for preliminary work meant to generate information useful for this decision. Is this Rs 1 million a relevant cost for the proposed project? Clearly not. Rs 1 million represents a sunk cost as it cannot be recovered irrespective of whether the project is accepted or not. Remember that bygones are bygones and are not relevant for decision making.

Include Opportunity Costs If a project uses resources already available with the firm, there is a potential for an opportunity cost—this is the cost created for the rest of the firm as a consequence of undertaking the project. The opportunity cost of a resource is the benefit

that can be derived from it by putting it to its best alternative use. So, to analyse the opportunity cost, ask the question: "Is there any alternative use of the resource if the project is not undertaken?" For most resources, there will be an alternative use:

- The resource may be rented out. In this case the opportunity cost is the rental revenue foregone by undertaking the project. For example, if a project uses a vacant factory building owned by the firm, the revenue that can be derived from renting out this building represents the opportunity cost.
- The resource may be sold. In this case the opportunity cost is the value realised from the sale of the resource after paying taxes. For example, if a project uses an equipment which is currently idle, its opportunity cost is its sales price, net of any tax liability.
- The resource is required elsewhere in the firm. In this case, the cost of replacing the resource represents its opportunity cost. For example, if a project requires the services of some experienced engineers from an existing division of the firm, the cost that is borne by that division to replace those engineers represents the opportunity cost.

What happens when a project uses a resource that has no current alternative use, but some potential alternative use? One example is excess capacity on some machine. Most firms find it impractical to sell or lease excess capacity, but realise that using it for a new product may exhaust capacity much earlier than otherwise. This may call for creating new capacity earlier rather than later or reducing the output of some products in future. If new capacity has to be created earlier than later, the opportunity cost is: Present value of creating capacity earlier – Present value of creating capacity later. If the output of some products is likely to be reduced in the future, the opportunity cost is the loss in cash flows that would have otherwise been generated by the sales of those products.

Question the Allocation of Overhead Costs Costs which are only indirectly related to a product (or service) are referred to as overhead costs. They include items like general administrative expenses, managerial salaries, legal expenses, rent, and so on. Accountants normally allocate overhead costs to various products on some basis like labour hours, or machine hours, or prime cost which appears reasonable. Hence when a new project is proposed, a portion of the overhead costs of the firm is usually allocated to it. The overhead allocated to it, however, may hardly have any relationship with the incremental overhead costs, if any, associated with it. For purposes of investment analysis, what matters is the incremental overhead costs (along with other incremental costs) attributable to the project and not the allocated overhead costs.

Estimate Working Capital Properly Apart from fixed assets, a project requires working capital. Outlays on working capital have to be properly considered while forecasting the project cash flows. In this context, the following points must be remembered:

- Working capital (or more precisely, net working capital) is defined as:
  [Current assets, loans, and advances] – [Current liabilities and provisions]
  Note that current liabilities and provisions, also referred to as non-interest bearing

current liabilities (NIBCLs), are deducted from current assets because they represent non-investor claims.

- The requirement of working capital is likely to change over time. When the project is set up, there is an initial investment in the working capital. This tends to change over time as the output of the project changes.
- While fixed asset investments are made during the early years of the project and depreciated over time, working capital is renewed periodically and hence is not subject to depreciation. Thus the working capital at the end of the project life is assumed to have a salvage value equal to its book value.

Post-tax Principle

Cash flows should be measured on an after-tax basis. Some firms may ignore tax payments and try to compensate this mistake by discounting the pre-tax cash flows at a rate that is higher than the cost of capital of the firm. Since there is no reliable way of adjusting the discount rate, you should always use after-tax cash flows along with after-tax discount rate. The important issues in assessing the impact of taxes are: What tax rate should be used to assess tax liability? How should losses be treated? What is the effect of noncash charges?

Tax Rate Let us examine the choices in terms of taxes. The *average tax rate* is the total tax burden as a proportion of the total income of the business. The *marginal tax rate* is the tax rate applicable to the income at margin—the next rupee of income. The marginal tax rate is typically higher than the average tax rate because tax rates are often progressive.

The income from a project typically is marginal. Put differently it is additional to the income generated by the assets of the firm already in place. Hence, the marginal tax rate of the firm is the relevant rate for estimating the tax liability of the project.

Treatment of Losses Because the firm as well as the project can incur losses, let us look at various possible combinations and the ways to deal with them. The different scenarios are summarised below:

Scenario	*Project*	*Firm*	*Action*
1	Incurs losses	Incurs losses	Defer tax savings
2	Incurs losses	Makes profits	Take tax savings in the year of loss
3	Makes profits	Incurs losses	Defer taxes until the firm makes profits
4	Makes profits	Makes profits	Consider taxes in the year of profit
Stand alone	Incurs losses	–	Defer tax saving until the project makes profits

Effect of Noncash Charges Noncash charges can have an impact on cash flows if they affect the tax liability. The most important of such noncash charges is depreciation. The tax benefit of depreciation is:

Depreciation × Marginal tax rate

The depreciation method allowed for tax purposes in India is the written down value method. Under this method the depreciation charge is calculated as follows:

$$\begin{aligned} DEP_1 &= BV_0 r \\ DEP_2 &= BV_1 r = BV_0 (1-r)\, r \\ DEP_t &= BV_{t-1} r = BV_0 (1-r)^{t-1} r \end{aligned} \qquad (9.1)$$

where DEP, BV, and r stand for depreciation charge, book value, and depreciation rate respectively.

For example, if the initial investment (BV_0) is 100 and depreciation rate (r) is 40 percent, the book value and depreciation charge will be as follows for the first three years:

Year	*Beginning book value*	*Depreciation charge*
1	100	100 (0.40) = 40
2	60	100 (1–0.40) 0.40 = 24
3	36	100 $(1-0.40)^2$ 0.40 = 14.4

Apart from land which is not subject to depreciation, the depreciation rates for various categories of assets, are prescribed under the Income Tax Act. The important rates presently are as follows:

- Buildings : 5%
- Plant and machinery : 25%
- Computers : 60%
- Vehicles on hire : 40%
- Pollution control equipment : 100%

Consistency Principle

Cash flows and the discount rates applied to these cash flows must be consistent with respect to the investor group and inflation.

Investor Group The cash flow of a project may be estimated from the point of view of all investors (equity shareholders as well as lenders) or from the point of view of just equity shareholders.

The cash flow of a project from the point of view of all investors is the cash flow available to all investors after paying taxes and meeting investment needs of the project, if any. It is estimated as follows:

Cash flows to all investors = PBIT (1 – tax rate)
+ Depreciation and noncash charges
– Capital expenditure
– Change in working capital

The cash flow of a project from the point of view of equity shareholders is the cash flow available to equity shareholders after paying taxes, meeting investment needs, and fulfilling debt-related commitments. It is estimated as follows:

Cash flow to equity shareholders= Profit after tax
+ Depreciation and other noncash charges
– Preference dividend
– Capital expenditures
– Change in working capital
– Repayment of debt
+ Proceeds from debt issues
– Redemption of preference capital
+ Proceeds from preference issue

The discount rate must be consistent with the definition of cash flow:

Cash flow	*Discount rate*
Cash flow to all investors	Weighted average cost of capital
Cash flow to equity	Cost of equity

Generally, in capital budgeting we look at the cash flow to all investors and apply the weighted average cost of capital of the firm. We will also follow this convention.

Inflation In dealing with inflation, you have two choices. You can incorporate expected inflation in the estimates of future cash flows and apply a nominal discount rate to the same. Alternatively, you can estimate the future cash flows in real terms and apply a real discount rate to the same.

Note that the following relationship holds between nominal and real values:

Nominal cash flow$_t$ = Real cash flow$_t$ (1 + Expected inflation rate)^t

Nominal discount rate = (1 + Real discount rate) (1 + Expected inflation rate) – 1

The consistency principle, in essence, suggests the following match up:

Cash flow	*Discount rate*
Nominal cash flow	Nominal discount rate
Real cash flow	Real discount rate

Generally, in capital budgeting analysis nominal cash flows are estimated and nominal discount rate is used. We will also follow this convention, unless mentioned to the contrary.

9.3 CASH FLOW ILLUSTRATIONS

To show how cash flows are determined, bearing in mind the principles discussed above, two illustrations are presented in this section.

Illustration I

Naveen Enterprises is considering a capital project about which the following information is available:

- The investment outlay on the project will be Rs 100 million. This consists of Rs 80 million on plant and machinery and Rs 20 million on net working capital. The entire outlay will be incurred at the beginning of the project.
- The project will be financed with Rs 45 million of equity capital, Rs 5 million of preference capital, and Rs 50 million of debt capital. Preference capital will carry a dividend rate of 15 percent; debt capital will carry an interest rate of 15 percent.
- The life of the project is expected to be 5 years. At the end of 5 years, fixed assets will fetch a net salvage value of Rs 30 million whereas net working capital will be liquidated at its book value.
- The project is expected to increase the revenues of the firm by Rs 120 million per year. The increase in costs on account of the project is expected to be Rs 80 million per year (This includes all items of cost other than depreciation, interest, and tax). The effective tax rate will be 30 percent.
- Plant and machinery will be depreciated at the rate of 25 percent per year as per the written down value method. Hence, the depreciation charges will be:

First year	:	Rs 20.00 million
Second year	:	Rs 15.00 million
Third year	:	Rs 11.25 million
Fourth year	:	Rs 8.44 million
Fifth year	:	Rs 6.33 million

Given the above details, the project cash flows are shown in Exhibit 9.2 .

Exhibit 9.2 *Project Cash Flows*

Rs. in million

	0	1	2	3	4	5
1. Fixed assets	(80.00)	–	–	–	–	–
2. Net working capital	(20.00)	–	–	–	–	–
3. Revenues		120	120	120	120	120
4. Costs (other than depreciation and interest)		80	80	80	80	80

			Rs. in million			
	0	1	2	3	4	5
5. Depreciation		20	15	11.25	8.44	6.33
6. Profit before tax		20	25	28.75	31.56	33.67
7. Tax		6	7.5	8.63	9.47	10.10
8. Profit after tax		14.0	17.5	20.12	22.09	23.57
9. Net salvage value of fixed assets		–	–	–	–	30.00
10. Recovery of net working capital		–	–	–	–	20.00
11. Initial outlay	(100.00)					
12. Operating cash inflow (8+5)		34.0	32.5	31.37	30.53	29.90
13. Terminal cash inflow (9 + 10)		–	–	–	–	50.0
14. Net cash flow (11+12+13)	(100.00)	34.0	32.5	31.37	30.53	79.90
Book value of Investment	100	80	65	53.75	45.31	–

Illustration II

India Pharma Ltd. is engaged in the manufacture of pharmaceuticals. The company was established in 1991 and has registered a steady growth in sales since then. Presently the company manufactures 16 products and has an annual turnover of Rs 2200 million. The company is considering the manufacture of a new antibiotic preparation, K-cin, for which the following information has been gathered:

1. K-cin is expected to have a product life cycle of five years and thereafter it would be withdrawn from the market. The sales from this preparation are expected to be as follows:

Year	*Sales (Rs in million)*
1	100
2	150
3	200
4	150
5	100

2. The capital equipment required for manufacturing K-cin is Rs 100 million and it will be depreciated at the rate of 25 percent per year as per the WDV method for tax purposes. The expected net salvage value after five years is Rs 20 million.
3. The working capital requirement for the project is expected to be 20 percent of sales. At the end of 5 years, working capital is expected to be liquidated at par, barring an estimated loss of Rs 5 million on account of bad debt. The bad debt loss will be a tax-deductible expense.

4. The accountant of the firm has provided the following cost estimates for K-cin:

Raw material cost	:	30 percent of sales
Variable labour cost	:	20 percent of sales
Fixed annual operating and maintenance cost	:	Rs 5 million
Overhead allocation (excluding depreciation, maintenance, and interest):		10 percent of sales

While the project is charged an overhead allocation, it is not likely to have any effect on overhead expenses as such.

5. The manufacture of K-cin would also require some of the common facilities of the firm. The use of these facilities would call for reduction in the production of other pharmaceutical preparations of the firm. This would entail a reduction of Rs 15 million of contribution margin.
6. The tax rate applicable to the firm is 40 percent.

Based on the above information, the cash flows for the project have been worked out in Exhibit 9.3. Few points about this exhibit are in order:

- The loss of contribution (item 7) is an opportunity cost.
- Overhead expenses allocated to the project have been ignored as they do not represent incremental overhead expenses for the firm as a whole.
- It is assumed that the level of working capital is adjusted at the beginning of the year in relation to the expected sales for the year. For example, working capital at the beginning of year 1 (i.e. at the end of year 0) will be Rs 20 million that is 20 percent of the expected revenue of Rs 100 million for year 1. Likewise, the level of working capital at the end of year 1 (i.e. at the beginning of year 2) will be Rs 30 million that is 20 percent of the expected revenue of Rs 150 million for year 2.

Exhibit 9.3 ***Cash Flows for the K-cin Project***

	Rs in million					
	0	*1*	*2*	*3*	*4*	*5*
1. Capital equipment	(100)	–	–	–	–	–
2. Level of working capital (ending)	20	30	40	30	20	0
3. Revenues	–	100	150	200	150	100
4. Raw material cost	–	30	45	60	45	30
5. Labour cost	–	20	30	40	30	20
6. Operating and maintenancece cost	–	5	5	5	5	5
7. Loss of contribution	–	15	15	15	15	15
8. Depreciation	–	25	18.8	14.1	10.5	7.9
9. Bad debt loss	–	–	–	–	–	5.0
10. Profit before tax	–	5	36.2	65.9	44.5	17.1
11. Tax	–	2	14.5	26.4	17.8	6.8
12. Profit after tax	–	3	21.7	39.5	26.7	10.3

	Rs in million					
	0	*1*	*2*	*3*	*4*	*5*
13. Net salvage value of capital equipment	–	–	–	–	–	20
14. Recovery of working capital	–	–	–	–	–	15
15. Initial investment	(100)	–	–	–	–	–
16. Operating cash inflow (12 + 8 + 9)	–	28	57.9	53.6	37.2	23.2
17. ΔWorking capital	20	10	10	(10)	(10)	–
18. Terminal cash inflow (13+14)	–	–	–	–		35
19. Net cash flow (15 + 16 – 17 + 18)	(120)	18	47.9	63.6	47.2	58.2

9.4 CASH FLOWS FOR A REPLACEMENT PROJECT

Developing cash flows for new projects or expansion projects is relatively straight forward. In such cases, the initial investment, operating cash inflows, and terminal cash inflows are the after-tax cash flows associated with the proposed project. Estimating the relevant cash flows for a replacement project is somewhat complicated because you have to determine the incremental cash outflows and inflows in relation to the existing project. The three components of the cash flow stream of a replacement project are defined as follows:

Initial Investment = (**Cost of the new asset** + **Net working capital required for the new asset**) – (**After tax salvage value realised from the old asset** + **Net working capital required for the old asset**)

Operating cash inflows = **Operating cash inflows from the new asset** – **Operating cash inflows from the old asset, had it not been replaced**

Terminal cash flow = (**After tax salvage value of the new asset** + **Recovery of net working capital associated with the new asset**) – (**After tax salvage value of the old asset, had it not been replaced** + **Recovery of net working capital associated with the old asset**)

A question often asked is: Once we have assumed that the old asset is replaced, why should we consider the operating cash inflows and terminal cash flow associated with the old asset subsequently? The answer is: If you consider the advantage derived from liquidating the old asset, you should also consider the disadvantage suffered by not having the asset in the future. To illustrate this point, let us consider a very simple example. Suppose you own a plot of land that presently has a market value of Rs 1 million. If you keep it for a year it is expected to fetch you Rs 1.2 million. You come across another plot of land that will cost you Rs 1.5 million now. If you buy this land you hope to sell it for Rs 2.0 million a year hence. You are debating whether you should replace the existing plot of land with the new plot that costs Rs 1.5 million. If you ignore taxes and assume that there is no operating cash inflow associated with both the plots of land, the cash flows of the replacement proposal are as follows:

Initial investment = Cost of the new plot – After-tax salvage value of the old plot
= Rs 1,500,000 – Rs 1,000,000
= Rs 500,000

Operating cash inflow = Operating cash inflow from the new plot – Operating inflow from the old plot
= Re 0 – Re 0
= Re 0

Terminal cash inflow = After-tax salvage value from the new plot – After-tax salvage of the old plot, had it been retained
= Rs 2,000,000 – Rs 1,200,000
= Rs 800,000

Thus the relevant cash flow stream of this replacement proposal is:

Year	*Cash Flow*
0	–Rs 500,000
1	Rs 800,000

If you don't subtract the salvage value of the existing plot a year from now, you get the following cash flow stream for the replacement proposal:

Year	*Cash Flow*
0	– Rs 500,000
1	Rs 2000,000

Clearly this is erroneous and misleading because it considers the advantage from selling the plot today but overlooks the disadvantage expected a year from now.

Illustration

Ojus Enterprises is determining the cash flow for a project involving replacement of an old machine by a new machine. The old machine bought a few years ago has a book value of

Rs 400,000 and it can be sold to realise a post tax salvage value of Rs 500,000. It has a remaining life of five years after which its net salvage value is expected to be Rs 160,000. It is being depreciated annually at a rate of 25 percent under the written down value method. The working capital required for the old machine is Rs 400,000.

The new machine costs Rs 1,600,000. It is expected to fetch a net salvage of Rs 800,000 after 5 years when it will no longer be required. The depreciation rate applicable to it is 25 percent under the written down value method. The net working capital required for the new machine is Rs 500,000. The new machine is expected to bring a saving of Rs 300,000 annually in manufacturing costs (other than depreciation). The tax rate applicable to the firm is 40 percent.

Given the above information, the incremental after-tax cash flow associated with the replacement project has been worked out in Exhibit 9.4.

Exhibit 9.4 ***Cash Flows for the Replacement Project***

Rs. In '000

Year	*0*	*1*	*2*	*3*	*4*	*5*
I. Investment Outlay						
1. Cost of new asset	(1600)	–	–	–	–	–
2. Salvage value of old asset	500	–		–	–	–
3. Increase in net working capital	(100)	–	–	–	–	–
4. Total net investment (1–2+3)	(1200)	–	–	–	–	–
II. Operating Inflows Over the Project Life						
5. After-tax savings in manufacturing costs	–	180	180	180	180	180
6. Depreciation on new machine	–	400	300	225	168.8	126.6
7. Depreciation on old machine	–	100	75	56.3	42.2	31.6
8. Incremental depreciation (6–7)	–	300	225	168.7	126.6	95
9. Tax savings on incremental depreciation (0.4 x 8)	–	120	90	67.5	50.6	38
10. Net operating cash inflow (5+9)	–	300	270	247.5	230.6	218
III. Terminal Cash Inflow						
11. Net terminal value of new machine	–	–		–	–	800

Year	0	1	2	3	4	5
12. Net terminal value of old machine	–	–	–	–	–	160
13. Recovery of incremental net working capital	–	–	–	–	–	100
14. Total terminal cash inflow(11–12 + 13)	–	–	–	–	–	740
IV. Net Cash Flow (4 + 10 + 14)	(1200)	30	270	247.5	230.6	958

9.5 VIEWING A PROJECT FROM OTHER PERSPECTIVES

There are several perspectives from which a project may be viewed. To understand them, let us look at Exhibit 9.5 which shows the investment and financing sides of a hypothetical project. From this exhibit we find that:

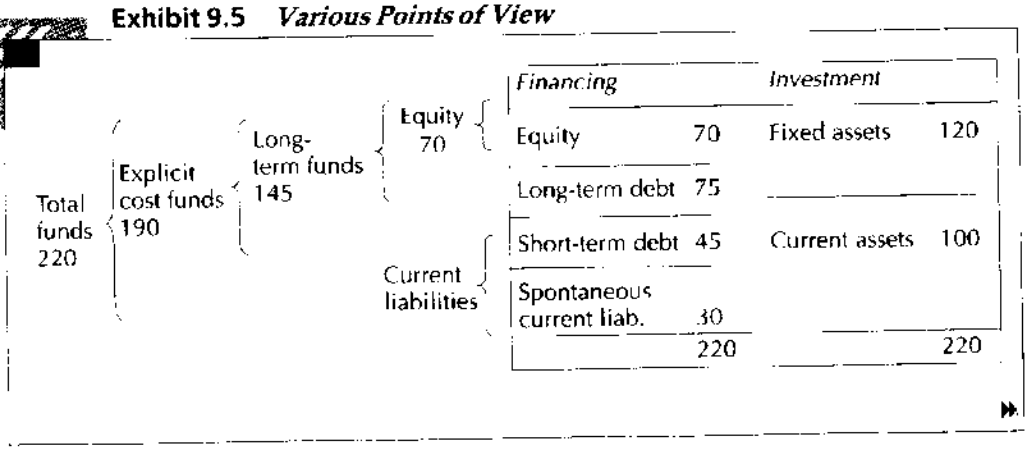
- Long-term funds comprise of equity and long-term debt.
- Current liabilities comprise short-term debt and spontaneous current liabilities (trade credit, provisions, etc.)
- Long-term funds (equity and long-term debt) plus short-term debt carry an explicit cost associated with them, whereas spontaneous current liabilities carry an implicit cost associated with them. Hence, explicit cost funds comprise long-term funds and short-term debt.
- Total funds comprise long-term funds and current liabilities.
- Fixed assets are fully supported by long-term funds.
- Current assets are partly supported by long-term funds and partly supported by current liabilities. The portion of current assets that is supported by long-term funds is called the *net working capital*.

Now, a project can be viewed from four distinct points of view. These are:

- Equity point of view
- Long-term funds point of view
- Explicit cost funds point of view
- Total funds point of view

In capital budgeting, the explicit cost funds point of view is commonly adopted — that is why our discussion so far defined cash flows from that point of view. However, one can adopt any other point of view as well. What is important is that the measures of cash flow and cost of capital must be consistent with the point of view adopted.

Exhibit 9.5 ***Various Points of View***



Since the explicit cost funds point of view has already been discussed at length, we will in this section look at how cash flows are defined from the equity point of view, the long-term funds point of view, and the total funds point of view with the help of an illustration.

Magnum Technologies Limited is evaluating an electronics project for which the following information has been assembled:

1. The total outlay on the project is expected to be Rs 50 million. This consists of Rs 30 million of fixed assets and Rs 20 million of current assets.
2. The total outlay of Rs 50 million is proposed to be financed as follows: Rs 15 million of equity, Rs 20 million of term loans, Rs 10 million of bank finance for working capital, and Rs 5 million of trade credit.
3. The term loan is repayable in five equal instalments of Rs 4 million each. The first instalment will be due at the end of the first year and the last instalment at the end of the fifth year. The levels of bank finance for working capital and trade credit will remain at Rs 10 million and Rs 5 million till they are paid back or retired at the end of five years.
4. The interest rates on the term loan and bank finance for working capital will be 15 per cent and 18 percent respectively.
5. The expected revenues from the project will be Rs 60 million per year. The operating costs, excluding depreciation, will be Rs 42 million. The depreciation rate on the fixed assets will be $33^1/_3$ percent as per the written down value method.
6. The net salvage value of fixed assets and current assets at the end of year 5 will be Rs 5 million and Rs 20 million respectively.
7. The tax rate applicable to the firm is 50 percent.

Cash Flows Relating to Equity

The equity-related cash flow stream reflects the contributions made and benefits receivable by equity shareholders. It may be divided into three components as follows:

- Initial investment : Equity funds committed to the project
- Operating cash flows : Profit after tax – Preference dividend + Depreciation + Other non-cash charges
- Liquidation and retirement cash flow (Terminal cash flow) : Net salvage value of fixed assets
  +
  Net salvage value of current assets
  –
  Repayment of term loans
  –
  Redemption of preference capital
  –
  Repayment of working capital advances
  –
  Retirement of trade credit and other dues

While the first two components, namely, 'initial investment' and 'operating cash inflows' are fairly self-explanatory, the third term, namely, 'liquidation and retirement cash flows' requires a little explanation. It represents the net cash flows accruing to equity shareholders as a result of liquidation of various assets in the project and retirement/redemption of all other sources of financing. Remember that equity shareholders have a residual interest in the project and hence what is left after meeting the claims of all other suppliers of finance belongs to the equity shareholders.

Exhibit 9.6 works out the cash flows from the equity point of view for the electronics project of Magnum Technologies Limited.

Cash Flows Relating to Long-term Funds

As discussed earlier in this chapter, the cash flow stream relating to long-term funds consists of three components as follows:

Initial investment : Long-term funds invested in the project. This is equal to:

fixed assets + working capital margin

Operating cash inflow : Profit after tax
+
Depreciation
+
Other noncash charges
+
Interest on long-term borrowings (1-tax rate)

Terminal cash flow : Net salvage value of fixed assets
+
Net recovery of working capital margin

Exhibit 9.6 *Net Cash Flows Relating to Equity*

(Rs. in million)

	Years					
	0	1	2	3	4	5
1. Equity funds	(15.0)	–	–	–	–	–
2. Revenues	–	60.0	60.00	60.00	60.00	60.00
3. Operating costs	–	42.0	42.00	42.00	42.00	42.00
4. Depreciation	–	10.0	6.67	4.44	2.96	1.98
5. Interest on working capital advance	–	1.80	1.80	1.80	1.80	1.80
6. Interest on term loan	–	3.00	2.40	1.80	1.20	0.60
7. Profit before tax	–	3.20	7.13	9.96	12.04	13.62
8. Tax	–	1.60	3.57	4.98	6.02	6.81
9. Profit after tax	–	1.60	3.56	4.98	6.02	6.81
10. Preference dividend	–	–	–	–	–	–
11. Net salvage value of fixed assets	–	–	–	–	–	5.00
12. Net salvage value of current assets	–	–	–	–	–	20.00
13. Repayment of term loans	–	4.00	4.00	4.00	4.00	4.00
14. Redemption of preference capital	–	–	–	–	–	–
15. Repayment of short-term bank borrowings	–	–	–	–	–	10.00
16. Retirement of trade creditors	–	–	–	–	–	5.00
17. Initial investment (1)	(15.00)	–	–	–	–	–
18. Operating cash inflows (9–10+4)	–	11.60	10.23	9.42	8.98	8.79
19. Liquidation and retirement cash flows (11+12–13 –14–15–16)	–	(4.00)	(4.00)	(4.00)	(4.00)	6.00
20. Net cash flow (17+18+19)	(15.00)	7.60	6.23	5.42	4.98	14.79

Exhibit 9.7 shows the cash flows relating to long-term funds for the electronics project of Magnum Technologies Limited.

Exhibit 9.7 *Net Cash Flows Relating to Long-term Funds*

(Rs in million)

	Years					
	0	1	2	3	4	5
1. Fixed assets	(30.00)	–	–	–	–	–
2. Working capital margin	(5.00)	–	–	–	–	–
3. Revenues	–	60.00	60.00	60.00	60.00	60.00
4. Operating costs	–	42.00	42.00	42.00	42.00	42.00
5. Depreciation	–	10.00	6.67	4.44	2.96	1.98
6. Interest on working capital advance	–	1.80	1.80	1.80	1.80	1.80
7. Interest on term loan	–	3.00	2.40	1.80	1.20	0.60
8. Profit before tax	–	3.20	7.13	9.96	12.04	13.62
9. Tax	–	1.60	3.57	4.98	6.02	6.81
10. Profit after tax	–	1.60	3.56	4.98	6.02	6.81
11. Net salvage value of fixed assets	–	–	–	–	–	5.00
12. Net recovery of working capital margin	–	–	–	–	–	5.00
13. Initial investment (1+2)	(35.00)	–	–	–	–	–
14. Operating cash inflow (9+5+7 (1–T))	–	13.10	11.43	10.32	9.58	9.09
15. Terminal cash flow (11+12)	–	–	–	–	–	10.00
16. Net cash flow (13+14+15)	(35.00)	13.10	11.43	10.32	9.58	19.09

Cash Flows Relating to Total Funds

The cash flow stream relating to total funds consists of three components as follows:

Initial investment : All the funds committed to the project. This is simply the total outlay on the project consisting of fixed assets as well as current assets (gross)

Operating cash inflow : Profit after tax
+
Depreciation
+
Other non-cash charges
+
Interest on long-term borrowings (1–tax rate)
+
Interest on short-term borrowings (1–tax rate)

Terminal cash flow : Net salvage value of fixed assets
+
Net salvage value of current assets

Exhibit 9.8 shows the net cash flows from the point of view of total funds for the electronics project of Magnum Technologies Limited.

Exhibit 9.8 ***Net Cash Flows Relating to Total Funds***

	Years					(Rs in million)
	0	*1*	*2*	*3*	*4*	*5*
1. Total funds	(50.00)					
2. Revenues	–	60.00	60.00	60.00	60.00	60.00
3. Operating costs	–	42.00	42.00	42.00	42.00	42.00
4. Depreciation	–	10.00	6.67	4.44	2.96	1.98
5. Interest on working capital advance	–	1.80	1.80	1.80	1.80	1.80
6. Interest on term loan	–	3.00	2.40	1.80	1.20	0.60
7. Profit before tax	–	3.20	7.13	9.96	12.04	13.62
8. Tax	–	1.60	3.57	4.98	6.02	6.81
9. Profit after tax	–	1.60	3.56	4.98	6.02	6.81
10. Net salvage value of fixed assets	–	–	–	–	–	5.00
11. Net salvage value of current assets	–	–	–	–	–	20.00
12. Initial investment (1)	(50.00)	–	–	–	–	–
13. Operating cash inflow $(9 + 4 + 6(1-t) + 5(1-t))$	–	14.00	12.33	11.22	10.48	9.99
14. Terminal cash flow (10 + 11)	–	–	–	–	–	25.00
15. Net cash flow (12 + 13 + 14)	(50.00)	14.00	12.33	11.23	10.48	34.99

9.6 HOW FINANCIAL INSTITUTIONS AND THE PLANNING COMMISSION DEFINE CASH FLOWS

Financial Institutions

In evaluating project proposals submitted to them, financial institutions define project cash flows as follows:

Cash outflows

Capital expenditure on the project (net of interest during construction)

\+

Outlays on working capital

Cash inflows

Operating inflow:	Profit after tax [1]
	+ Depreciation
	+ Interest and lease rental
Terminal inflow :	Recovery of working capital (at book value)
	+ Residual value of capital assets (land at 100% and other capital assets at 5% on initial cost)

For calculating IRR the cash flows are considered for a maximum project life of 12 years. For certain industries, which are subject to a faster rate of technological obsolescence, a shorter life is considered.

From the above, it is clear that financial institutions look at projects from the point of view of all investors. It is instructive to compare the cash flow stream defined by the financial institutions with the cash flow stream relating to all investors defined by us earlier in this chapter.

	Cash flow stream defined by financial institutions	*Cash flow stream relating to all investors*
Initial investment	Capital expenditure on the project (net of interest during construction period)	Capital expenditure on the project (net of interest during construction period)
	+	+
	Outlay on working capital	Outlay on working capital

1. If there are losses in the initial years, the tax shield arising out of losses can be added back to the cash flows only if the existing operations of the company are liable for tax of that amount. In case of new companies, tax shield cannot be added back to the cash flows.

Operating cash inflow	Profit after tax + Depreciation + Interest	Profit after tax + Depreciation + Interest (1–tax rate)[2]
Terminal cash inflow	Recovery of working capital (at book value) + Residual value of capital assets (land at 100% and capital assets at 5% of initial cost)	Recovery of working capital (at book value) + Expected net salvage value of other assets

From the above, we find that:

- The initial investment is defined identically in both the cases.
- Institutions add back interest without adjusting for taxes whereas in our definition interest is added back after adjusting for the tax factor.
- The residual value of capital assets is defined by the institutions in a very conservative and mechanistic fashion whereas in our definition it is based on expected net salvage value.

Planning Commission

As per the *Manual for Preparation of Feasibility Reports* developed by the Planning Commission, the following rules should be observed in defining costs and returns (cash flows in our terminology):

1. Interest during construction should not be allowed for in the year-wise capital expenditure figures since it is implicitly taken into account by the discounting procedure. If replacement expenditure is likely to be incurred during the life of the project it should be allowed for in the year in which it will occur.
2. Returns should be defined on a gross basis as operating revenues minus operating costs. Depreciation and financial charges on capital expenditures covered by the capital cost figures should not be deducted in defining returns. *They are allowed for implicitly in the discounting procedure.*
3. Capital cost estimates generally do not allow for funds required for working capital purposes, which are assumed to be borrowed, but only for the margin on working

2. Note that:

$$\begin{aligned} \text{PBIT}(1-T) &= (\text{PBT} + \text{I})(1-T) \\ &= \text{PBT}(1-T) + \text{I}(1-T) \\ &= \text{PAT} + \text{I}(1-T) \end{aligned}$$

capital. In this case the operati .g cost estimates must include interest payments on funds borrowed for working capital.

4. In some cases involving the use of fixed-interest term loans for capital expenditure, an internal rate of return on own funds (equity) may need to be presented. In such cases the initial capital cost figures should cover only the expenditures out of equity capital. Repayment of term loans and interest due on them should be allowed for in the subsequent years as and when they are expected to arise.
5. Costs and returns should be calculated over the entire life of the project or over 25 years whichever is less. The returns should allow for a salvage value of assets at the end of the period.

Based on the above description, the following observations may be made:

1. A project may be viewed from the point of view of equity capital or long-term funds.
2. Cost and return (benefit) streams have been defined consistently with the point of view adopted. Further, they are defined in pre-tax terms.
3. A fairly long planning horizon is envisaged. This perhaps reflects the fact that the projects considered by the Planning Commission, in general, have a long economic life.

9.7 BIASES IN CASH FLOW ESTIMATION

As cash flows have to be forecast far into the future, errors in estimation are bound to occur. Yet, given the critical importance of cash flow forecasts in project evaluation, adequate care should be taken to guard against certain biases which may lead to over-statement or under-statement of the true project profitability.

Overstatement of Profitability

Knowledgeable observers of capital budgeting believe that profitability is often overstated because the initial investment is under-estimated and the operating cash inflows are exaggerated. The principal reasons for such optimistic bias appear to be as follows:

- *Intentional overstatement* In a bid to present their projects in a favourable light, project sponsors may intentionally over-estimate the benefits and under-estimate the costs. Given the uncertainties characterising the future, project sponsors enjoy some latitude in twisting the figures the way they want.
- *Lack of experience* Inadequate experience on the part of project sponsors generally leads to over-optimistic estimates. Experience often induces conservatism that checks over-optimistic tendencies. Inexperience, on the other hand, may lead to wishful thinking.
- *Myopic euphoria* Individuals responsible for preparing forecasts may become too involved and lose their sense of proportion.The lack of objectivity in this case is neither intentional nor due to inexperience. It may simply be the effect of 'mass

psychology' as each person's favourable opinion may be reinforced and magnified by others in the group. Referred to as "risky shift" or "group polarisation effect" in social psychology, this phenomenon is widely supported by empirical studies.

- *Capital rationing* Companies typically operate under capital rationing, which may be externally determined or internally imposed. An awareness of such a constraint induces project sponsors to exaggerate the benefits of projects proposed by them. After all, every sponsor is keen that his proposal finds a place in the limited capital budget when there is competition among various claimants.

Understatement of Profitability

In the foregoing discussion, we noted the problem of optimistic bias that may lead to an over-statement of project cash flows and profitability. There can be an opposite kind of bias relating to the terminal benefit which may depress a project's true profitability. To understand this bias let us look at how the terminal cash flow is estimated in practice. Typically it is defined as:

Net salvage value of fixed assets + Net recovery of working capital margin

Generally, the net salvage value of fixed assets is put equal to 5 percent of the original cost and the net recovery of working capital margin is set equal to its original book value (under the assumption that current assets do not depreciate).

The above approach almost invariably leads to under-estimation of the terminal benefit of the project, due to the following reasons:

Salvage Values are Under-Estimated To put the net salvage value of fixed assets equal to just 5 percent (which may more or less correspond to the book value after 8 to 10 years) of the original cost is to ignore the fact that in real life situations fixed assets, even after 8 to 10 years of use, generally command a substantial market value. This is because (a) the rate of physical wear and tear is usually much less than the rate of depreciation for tax or accounting purposes and (b) the secular rate of inflation in India has been around 6 percent.

Intangible Benefits are Ignored The terminal benefits from a project cannot be equated with just the salvage values of tangible assets left in the project. Apart from investment in tangible assets for which salvage values can be estimated more easily (taking into account the factors mentioned above), major projects are designed to establish a market position, hone research and engineering capability, develop a distribution network, and build brand loyalty. To assume that these benefits are worthless beyond an arbitrarily chosen time horizon is to overlook important business realities. These benefits should not be ignored just because it is difficult to quantify them.

The Value of Future Options is Overlooked More often than not, a project has a strategic payoff in the form of new investment opportunities that may possibly open up if the project is undertaken. To illustrate, consider the case of a firm which is evaluating a proposal to

set up a project for manufacturing scooters. The long-term goal of the firm is to be a market leader in the field of two-wheelers –scooters as well as motorcycles. However, the firm considers entry into the motorcycles market to be infeasible currently as it lacks technical expertise or market image to challenge well-entrenched manufacturers in the field. Thus, the proposal to manufacture motorcycles hinges on the expertise developed and success achieved in the field of scooters. Put differently, it means that the project for manufacturing scooters has a potential payoff in terms of entry into a new field which may generate a large benefit. So, in assessing the scooter project the value of future options generated by it must be taken into account. Since analytical models for doing this are not well developed, judgmental estimation, though subjective in nature, may be done.

SUMMARY

- Estimating cash flows—the investment outlays and the cash inflows after the project is commissioned—is the most important, but also the most difficult step in capital budgeting.
- Forecasting project cash flows involves many individuals and departments. The role of the financial manager is to coordinate the efforts of the various departments and obtain information from them, ensure that the forecasts are based on a set of consistent economic assumptions, keep the exercise focussed on relevant variables, and minimise the biases inherent in cash flow forecasting.
- The cash flow stream of a conventional project—a project which involves cash outflows followed by cash inflows—comprises three basic components: (i) initial investment, (ii) operating cash inflows, and (iii) terminal cash inflow.
- The initial investment is the after-tax cash outlay on capital expenditure and net working capital when the project is set up. The operating cash inflows are the after-tax cash inflows resulting from the operations of the project during its economic life. The terminal cash inflow is the after-tax cash flow resulting from the liquidation of the project at the end of its economic life.
- The time horizon for cash flow analysis is usually the minimum of the following: physical life of the plant, product market life of the plant, and investment planning horizon of the firm.
- The following principles should be followed while estimating the cash flows of a project: separation principle, incremental principle, post-tax principle, and consistency principle.
- There are two sides of a project, viz., the investment (or asset) side and the financing side. The separation principle says that the cash flows associated with these sides should be separated. While estimating the cash flows on the investment side do not consider financing charges like interest or dividend.
- The cash flow of a project must be measured in incremental terms. To ascertain a project's incremental cash flows you have to look at what happens to the firm **with** the project and **without** the project. The difference between the two reflects the incremental cash flows attributable to the project.

- In estimating the incremental cash flows of a project bear in mind the following guidelines: (i) Consider all incidental effects. (ii) Ignore sunk costs. (iii) Include opportunity costs. (iv) Question the allocation of overhead costs. (v) Estimate working capital properly.
- Cash flows should be measured on an after-tax basis. The important issues in assessing the impact of taxes are: What tax rate should be used to assess tax liability? How should losses be treated? What is the effect of noncash charges?
- Cash flows and the discount rates applied to these cash flows must be consistent with respect to the investor group and inflation.
- The cash flow of a project may be estimated from the point of view of all investors (equity shareholders as well as lenders) or from the point of view of just equity shareholders.
- In dealing with inflation, you have two choices. You can incorporate expected inflation in the estimates of future cash flows and apply a nominal discount rate to the same. Alternatively, you can estimate the future cash flows in real terms and apply a real discount rate to the same.
- Estimating the relevant cash flows for a replacement project is somewhat complicated because you have to determine the incremental cash outflows and inflows in relation to the existing project. The three components of the cash flow stream of a replacement project are: (i) initial investment, (ii) operating cash inflows, and (iii) terminal cash flow.
- Generally, in capital budgeting we look at the cash flow to all investors (equity shareholders as well as lenders) and apply the weighted average cost of capital of the firm. A project can, of course, be viewed from other points of view like the equity point of view, long-term funds point of view, and total funds point of view. Obviously, the project cash flow definition will vary with the point of view adopted.
- Financial institutions look at projects from the point of view of all investors.
- The Planning Commission suggests that a project may be viewed from the point of view of equity capital or long-term funds.
- As cash flows have to go far into the future, errors in estimation are bound to occur. Yet, given the critical importance of cash flow forecasts in project evaluation, adequate care should be taken to guard against certain biases which may lead to overstatement or understatement of true project profitability.
- Knowledgeable observers of capital budgeting believe that profitability is often over-stated because the initial investment is under-estimated and the operating cash inflows are exaggerated. The principal reasons for such optimistic bias are intentional overstatement, lack of experience, myopic euphoria, and capital rationing.
- Terminal benefits of a project are likely to be under-estimated because salvage values are under-estimated, intangible benefits are ignored, and the value of future options is overlooked.

Questions

1. What are the three elements of the cash flow stream of a project?
2. How is the time horizon for cash flow analysis usually established?
3. What does the separation principle say?
4. Discuss the guidelines to be borne in mind while estimating the incremental cash flows of a project.
5. How will you estimate the tax impact of losses?
6. What is the formula for depreciation under the written down value method?
7. How would you define the cash inflows to all investors and the cash flows to equity shareholders?
8. Discuss the two ways of dealing with inflation.
9. What are the three components of the cash flow stream of a replacement project?
10. Define the cash flows from the point of view of equity, long-term funds, and total funds.
11. How do financial institutions define cash outflows and cash inflows for a project?
12. Describe the rules applicable to the measurement of costs and returns (cash flows) as given in the *Manual for Preparation of Feasibility Reports* developed by the Planning Commission.
13. Explain why there is often an optimistic bias with respect to estimates of initial investment and operating cash inflows.
14. Why is the terminal benefit of a project typically under-estimated?

Problems

1. Futura Limited is considering a capital project about which the following information is available.
   - The investment outlay on the project will be Rs 200 million. This consists of Rs 150 million on the plant and machinery and Rs 50 million on net working capital. The entire outlay will be incurred in the beginning.
   - The life of the project is expected to be 7 years. At the end of 7 years, fixed assets will fetch a net salvage value of Rs 48 million whereas net working capital will be liquidated at its book value.
   - The project is expected to increase the revenues of the firm by Rs 250 million per year. The increase in costs on account of the project is expected to be Rs 100 million per year (This includes all items of cost other than depreciation, interest, and tax). The tax rate is 30 percent.
   - Plant and machinery will be depreciated at the rate of 25 percent per year as per the written down method.

   (a) Estimate the post-tax cash flows of the project.

(b) Calculate the IRR of the project.

2. Modern Pharma is considering the manufacture of a new drug, Floxin, for which the following information has been gathered:
   - Floxin is expected to have a product life cycle of seven years and after that it would be withdrawn from the market. The sales from this drug are expected to be as follows:

Year	1	2	3	4	5	6	7
Sales (Rs in million)	80	120	160	200	160	120	80

   - The capital equipment required for manufacturing Floxin is Rs 120 million and it will be depreciated at the rate of 25 percent per year as per the WDV method for tax purposes. The expected net salvage value after seven years is Rs 25 million.
   - The working capital requirement for the project is expected to be 25 percent of sales. Working capital level is adjusted at the beginning of the year in relation to the adjusted sales for the year. At the end of 7 years, working capital is expected to be liquidated at par, barring an estimated loss of Rs 4 million on account of bad debt which, of course, will be a tax-deductible expense.
   - The accountant of the firm has provided the following estimates for the cost of Floxin:

Raw material cost	: 30 percent of sales
Variable manufacturing cost	: 10 percent of sales
Fixed annual operating and maintenance costs	: Rs 10 million
Variable selling expenses	: 10 percent of sales
Overhead allocation (excluding depreciation, maintenance, and interest)	: 10 percent of sales

     The incremental overheads attributable to the new products are, however, expected to be only 5 percent of sales.
   - The manufacture of Floxin will cut into the sales of an existing product thereby reducing its contribution margin by Rs 10 million per year.
   - The tax rate for the firm is 30 percent.

   (a) Estimate the post-tax incremental cash flows for the project to manufacture Floxin.
   (b) What is the NPV of the project if the cost of capital is 15 percent?

3. Teja International is determining the cash flow for a project involving replacement of an old machine by a new machine. The old machine bought a few years ago has a book value of Rs 800,000 and it can be sold to realise a post-tax salvage value of Rs 900,000. It has a remaining life of five years after which its net salvage value is expected to be Rs 200,000. It is being depreciated annually at a rate of 25 percent under the WDV method. The working capital associated with this machine is Rs 500,000.

   The new machine costs Rs 3,000,000. It is expected to fetch a net salvage value of Rs 1,500,000 after five years. The depreciation rate applicable to it is 25 percent under the WDV method. The net working capital required for the new machine is expected to bring a

saving of Rs 650,000 annually in manufacturing costs (other than depreciation). The tax rate applicable to the firm is 30 percent.

(a) Estimate the cash flow associated with the replacement project.

(b) What is the NPV of the replacement project if the cost of capital is 14 percent?

4. A machine costs Rs 100,000 and is subject to a depreciation rate of 25 percent under the WDV method. What is the present value of the tax savings on account of depreciation for a period of 5 years if the tax rate is 40 percent and the discount rate is 15 percent?

5. Mahima Enterprises is considering replacing an old machine by a new machine. The old machine bought a few years ago has a book value of Rs 90,000 and it can be sold for Rs 90,000. It has a remaining life of five years after which its net salvage value is expected to be Rs 10,000. It is being depreciated annually at the rate of 20 percent as per the WDV method.

   The new machine costs Rs 400,000. It is expected to fetch a net salvage value of Rs 25,000 after 5 years. It will be depreciated annually at the rate of 25 percent as per the WDV method. Investment in working capital will not change with the new machine. The tax rate for the firm is 35 percent. Estimate the cash flow associated with the replacement proposal, assuming that other costs remain unchanged.

6. Supreme Industries is evaluating a project for which the following information has been assembled:

   (a) The total outlay of the project is expected to be Rs 450 million. This consists of Rs 250 million of fixed assets and Rs 200 million of current assets.

   (b) The proposed scheme of financing is as follows: Rs 100 million of equity, Rs 200 million of term loans, Rs 100 million of working capital advance, and Rs 50 million of trade credit.

   (c) The term loan is repayable in 10 equal semi-annual instalments of Rs 20 million each. The first instalment will be due after 18 months. The interest rate on the term loan will be 15 percent.

   (d) The levels of working capital advance and trade credit will remain at Rs 100 million and Rs 50 million respectively till they are paid back or retired at the end of 6 years. The working capital advance will carry an interest rate of 18 percent.

   (e) The expected revenues for the project will be Rs 500 million per year. The operating costs (excluding depreciation and interest) are expected to be Rs 320 million per year. The depreciation rate on the fixed assets will be $33^1/_3$ percent as per the written down value method.

   (f) The net salvage value of fixed assets and current assets, at the end of year 6 (the project life is expected to be 6 years) will be Rs 80 million and Rs 20 million respectively.

   (g) Tax rate applicable to the firm is 50 percent.

   Define the cash flows from the point of view of (i) equity funds, (ii) long-term funds, and (iii) total funds.

CHAPTER

10

The Cost of Capital

In the previous chapter we learnt that the cash flows of a capital investment may be viewed from various points of view (the equity point of view, the long-term funds point of view, the explicit cost funds point of view, and the total funds point of view) and the discount rate applied to the cash flows must be consistent with the point of view adopted. We also mentioned that the standard practice in capital budgeting is to look at the cash flows from the point of view of explicit cost funds (referred to also as investor claims) and apply the weighted average cost of capital of the firm as the discount rate.

Having learnt how to specify the project cash flows let us now turn our attention to the weighted average cost of capital, referred to also, for the sake of simplicity, as the cost of capital.

The cost of capital is a central concept in financial management. It is used for evaluating investment projects, for determining the capital structure, for assessing leasing proposals, for setting the rates that regulated organisations like electric utilities can charge to their customers, so on and so forth.

This chapter discusses how a company's cost of capital is calculated. It is divided into nine sections:

- Some preliminaries
- Cost of debt and preference
- Cost of equity
- Determining the proportions
- Weighted average cost of capital
- Weighted marginal cost of capital
- Floatation costs and the cost of capital
- Cost of capital in practice
- How financial institutions calculate cost of capital

10.1 SOME PRELIMINARIES

Concept of Average Cost of Capital

A firm's cost of capital is the weighted average cost of various sources of finance used by it, viz., equity, preference, long-term debt, and short-term debt. Note that many companies leave out the cost of short-term debt while calculating the weighted average cost of capital (WACC). In principle, this is not correct. Investors who provide short-term debt also have a claim on the operating earnings of the firm. If a company ignores this claim, it will mistate the rate of return required on capital investments.

Suppose that a firm uses equity costing 16 per cent and debt costing 9 percent. If the proportions in which equity and debt are used are 40 percent and 60 percent respectively, its WACC will be:

$$\begin{aligned}\text{WACC} &= \text{Proportion of equity} \times \text{cost of equity} + \text{Proportion of debt} \times \text{cost of debt} \\ &= 0.40 \times 16\% + 0.6 \times 9\% \\ &= 6.4\% + 5.4\% \\ &= 11.8\%\end{aligned}$$

In general, if the firm uses n different sources of finance, its WACC:

$$\text{WACC} = \Sigma p_i r_i \qquad (10.1)$$

where p_i is the proportion of the ith source of finance and r_i is the cost of the ith source of finance

Thus, the three basic steps involved in calculating a firm's WACC are:

- Determine the cost of different components of capital
- Establish a set of weights (or proportions)
- Calculate the weighted average cost of capital.

Rationale

The rationale for using the WACC as the hurdle rate in capital budgeting is fairly straightforward. If a firm's rate of return on its investments exceeds its cost of capital, the wealth of equity stockholders is enhanced. Why? When the firm's rate of return on its investments is greater than its cost of capital, the rate of return earned on equity capital (after meeting the costs of other forms of financing) will exceed the rate of return required by equity stockholders. Hence, the wealth of equity stockholders will increase. To illustrate this point, consider a firm whose cost of equity and debt are, respectively, 14 percent and 6 percent and which employs equity and debt in equal proportions. The cost of capital for the firm, which is the weighted average cost of capital, works out to 10 percent. If the firm invests Rs 100 million, say, on a project which earns 12 percent rate of return, the rate of return on equity funds will be:

$$\frac{\text{Total return on the project} - \text{Interest on debt}}{\text{Equity fund}} = \frac{100\,(.12) - 50\,(.06)}{50} = 18\%$$

Since 18 percent exceeds the rate of return required by equity stockholders (14 percent), the market value of equity capital, reflecting the wealth of equity stockholders, increases.

Conditions for Using the Cost of Capital

Two basic conditions should be satisfied for using WACC for evaluating new investments.

- The risk of new investments is the same as the average risk of existing investments. In other words, the adoption of new investments will not change the risk complexion of the firm.
- The capital structure of the firm will not be affected by the new investments. Put differently, the firm will continue to pursue the same financing policy.

Thus, strictly speaking WACC is the right discount rate for a project that is a carbon copy of the firm's existing business. However, in practice, WACC is used as a benchmark hurdle rate that is adjusted for variations in risk and financing patterns.

In this chapter we assume that the new investments being considered by the firm do not differ from existing investments in terms of risk or financing mix. Variations in risk and financing mix will be considered in the following chapters.

10.2 COST OF DEBT AND PREFERENCE

Since debt and preference stock entail more or less fixed payments, estimating the cost of debt and preference is relatively easy.

Cost of Debt

A company raises debt finance through a variety of instruments like debentures, bank loans, and commercial paper. The cost of debt is the average rate of different kinds of debt employed by the firm. To illustrate the calculation of the average rate, let us look at the following data on the debt employed by Multiplex Limited.

Debt instrument	*Maturity value or book value*	*Market value*	*Coupon or interest rate*	*YTM or current rate*[1]
Debentures, Series *A*	Rs 200 million	Rs 185 million	11%	13%
Debentures, Series *B*	Rs 300 million	Rs 280 million	12%	14%

1. The yield to maturity (YTM) of a debt instrument is simply its internal rate of return. For example, if a Rs 100 par value debenture carrying 12% interest rate and maturing after 5 years sells for Rs 95, its YTM is the value of r in the following equation:

$$95 = \sum_{t=1}^{5} \frac{12}{(1+r)^t} + \frac{95}{(1+r)^5}$$

Term Loan	Rs 300 million	*n.a*[a]	14%	15%[b]
Commercial Paper	Rs 100 million	Rs 95 million	*n.a*[c]	10.5%

a. Term loans do not have a secondary market.
b. This is the interest rate on a new term loan.
c. Commercial paper does not carry an explicit coupon rate. Its yield is implicit in the discount of its market value over maturity value.

The average rate of debt is calculated using the market values[2] and yields to maturity of various debt instruments.

Total market value of debt = Rs 860 million[3]

$$\text{Average rate of debt} = 13\%\left(\frac{185}{860}\right) + 14\%\left(\frac{280}{860}\right) + 15\%\left(\frac{300}{860}\right) + 10.5\%\left(\frac{95}{860}\right)$$

$$= 13.75\%$$

Note that we use the yields to maturity or the current rates as they reflect the rates at which the firm can raise *new* debt. Put differently, we are interested in calculating the marginal cost of debt. Hence, coupon rates that reflect the *historical* or *embedded* interest rates at the time the debt was originally raised are not relevant for our purposes.

What we have calculated so far is the average pre-tax cost of debt. Since interest on debt is a tax-deductible expense, the pre-tax cost of debt has to be adjusted for the tax factor to arrive at the post-tax cost of debt.

After-tax cost of debt = Pre-tax cost of debt (1 – Tax rate)

The tax rate to be used in this calculation is the marginal tax rate applicable to the company. If we assume that the marginal tax rate for Multiplex Limited is 35 percent, the post-tax cost of debt for Multiplex Limited is:

After-tax cost of debt = 13.5 percent (1 – 0.35) = 8.938 percent

Cost of Preference

Preference capital carries a fixed rate of dividend and is redeemable in nature. Even though the obligation of a company towards its preference shareholders is not as firm as that towards its debenture holders, we will assume that preference dividend will be paid regularly and preference capital will be redeemed as per the original intent.

2. The rationale for using market values and not book values is explained in a subsequent section.
3. Since term loans do not have a secondary market, we have used the maturity value figure for them.

Thus, preference stock will be considered much like a bond with fixed commitments. However, preference dividend, unlike debt interest, is not a tax-deductible expense and hence does not produce any tax saving.[4]

Given the fixed nature of preference dividend and principal repayment commitment and the absence of tax deductibility, the cost of preference is simply equal to its yield. To illustrate, consider the preference stock of Multiplex Limited for which the following data is available:

Face value	: Rs 100
Dividend rate	: 11 percent
Maturity period	: 5 years
Market price	: Rs 95

The yield on this preference stock, if we apply the approximate yield formula,[5] works out to:

$$\frac{11 + (100 - 95)/5}{0.4 \times 100 + 0.6 \times 95} = 12.37 \text{ percent}$$

If a company has more than one issue of preference stock outstanding, the average yield on all preference issues may be calculated, just the way it was done for debt issues.

10.3 COST OF EQUITY

Equity finance may be obtained in two ways: (i) retention of earnings, and (ii) issue of additional equity. The cost of equity or the return required by equity shareholders is the same in both the cases. Remember that when a firm decides to retain earnings, an opportunity cost is involved. Shareholders could receive the earnings as dividends and invest the same in alternative investments of comparable risk to earn a return. So, irrespective of whether a firm raises equity finance by retaining earnings or issuing additional equity shares, the cost of equity is the same. The only difference is in floatation costs. There is no floatation cost for retained earnings whereas there is a floatation cost of 2 to 10 percent or even more for additional equity. This difference is considered separately as explained in Section 10.7. So, in our present discussion, cost of equity refers to the cost of retained earnings as well as the cost of external equity.

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4. In addition, a company in India presently has to pay 10 percent tax on dividend paid (both on preference and equity stock). We have ignored the dividend tax from our calculation.
5. The approximate yield to maturity on a fixed income instrument is:

$$\frac{\text{Annual interest or dividend} + (\text{Face value} - \text{Market price})/\text{Years to maturity}}{0.4\,\text{Face value} + 0.6\,\text{Market price}}$$

While the cost of debt and preference can be determined fairly easily, the cost of equity is rather difficult to estimate. This difficulty stems from the fact that there is no definite commitment on the part of the firm to pay dividends. However, we can come up with reasonably good estimates of the cost of equity by employing some basic principles.

The SML Approach

A popular approach to estimating the cost of equity is the security market line (SML) relationship discussed at length in Chapter 12. According to the SML, the required return on a company's equity is:

$$r_E = R_f + \beta_E \left(E(R_M) - R_f\right) \tag{10.2}$$

where r_E = required return on the equity of company
R_f = risk-free rate
β_E = beta of the equity of the company[6]
$\overline{R}_M$ = expected return on the market portfolio

To illustrate the SML approach, let us assume that $R_f = 10$ percent and $E(R_M) = 18$ percent. The required return on equity stocks of companies with different betas is given as follows:

Beta	*Required return* = $R_f + \beta_E (E(R_M) - R_f)$
0.5	10 + 0.5 (18 – 10) = 14%
1.0	10 + 1.0 (18 – 10) = 18%
1.5	10 + 1.5 (18 – 10) = 22%

To use the SML, the following inputs are required: R_f, the risk-free rate; $(E(R_M) - R_f)$ the market risk premium, and β_E, the beta of the stock.

The SML is regarded by many as a fairly rigorous and objective approach to determining the required return on equity. This approach, however, is based on the assumption that investors eliminate unsystematic risk by efficient diversification and hence require compensation only for systematic risk which is reflected in beta. Market imperfections may impede efficient diversification by investors, exposing them to unsystematic risk. When this occurs, investors will require compensation for unsystematic risk, a factor which is not found in the security market line relationship. Another shortcoming of the SML relates to the instability of the betas of individual securities. Studies have shown that individual securities have unstable betas. This makes the use of a historical beta as a proxy for the future beta somewhat questionable. Notwithstanding these shortcomings, the SML approach is a useful approach for estimating the required rate of return of equity stocks.

6. This reflects how sensitive the rate of return is on a given equity stock to changes in return on the market portfolio. The procedure for calculating beta is discussed in Chapter 12.

Bond Yield Plus Risk Premium Approach

Analysts who do not have faith in the SML approach often resort to a subjective procedure to estimate the cost of equity. They add a judgmental risk premium to the observed yield on the long-term bonds of the firm to get the cost of equity:

Cost of equity = Yield on long-term bonds + Risk premium

The logic of this approach is fairly simple. Firms that have risky and consequently high cost debt will also have risky and consequently high cost equity. So it makes sense to base the cost of equity on a readily observable cost of debt.

The problem with this approach is how to determine the risk premium. Should it be 2 percent, 4 percent, or n percent? There seems to be no objective way of determining it. Most analysts look at the operating and financial risks of the business and arrive at a subjectively determined risk premium that normally ranges between 2 percent and 6 percent. While this approach may not produce a precise cost of equity, it will give a reasonable ballpark estimate.

The Dividend Growth Model Approach

The price of an equity stock depends ultimately on the dividends expected from it:

$$P_0 = \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \dots$$

$$= \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t} \qquad (10.3)$$

where P_0 = current price of the stock

D_t = dividend expected to be paid at the end of year t

r = equity shareholders' required rate of return

If dividends are expected to grow at a constant rate of g percent per year, then Eq.(10.3) becomes:

$$P_0 = \frac{D_1}{(1+r)^1} + \frac{D_1(1+g)}{(1+r)^2} + \frac{D_1(1+g)^2}{(1+r)^3} + \dots \infty$$

This simplifies to:

$$P_0 = \frac{D_1}{r-g}$$

Solving the above equation for r, we get:

$$r = \frac{D_1}{P_0} + g = \frac{D_0 (1 + g)}{P_0} + g \tag{10.4}$$

Thus, the expected return of shareholders, which in equilibrium is also the required return, is equal to the dividend yield plus the expected growth rate.

For a publicly traded company, it is fairly easy to determine the dividend yield. However, estimating the expected growth rate, g, is difficult. You can estimate g by using the following methods:

1. You can get a handle over g by relying on analysts' forecasts for the future growth rates. Analysts' forecasts may be available from a variety of sources. Since different sources are likely to give different estimates, a simple approach may be to obtain multiple estimates and then average them.
2. You can look at dividends for the preceding 5–10 years, calculate the annual growth rates, and average them. Suppose you observe the following dividends for some stock.

Year	*Dividend*	*Rupee change*	*Growth*
1	Rs 3.00	—	—
2	Rs 3.50	Rs 0.50	16.7
3	Rs 4.00	Rs 0.50	14.3
4	Rs 4.25	Rs 0.25	6.3
5	Rs 4.75	Rs 0.50	11.8

   If you average the four growth rates, the result is 12.3 percent, so you can use this as an estimate of the expected growth rate, g.
3. You can use the retention growth rate method. Here, you first forecast the firm's average retention rate (this is simply 1 minus the dividend payout rate) and then multiply it by the firm's expected future return on equity (ROE).

   g = (Retention rate) (Return on equity)

For example, if the forecasted retention rate and return on equity are 0.60 and 15 percent, the expected growth rate is: g = (0.6) (15%) = 9 percent.

The dividend growth model is simple. It is easy to understand and easy to apply. However, there are some problems associated with it.

- First, it cannot be applied to companies that do not pay dividends or to companies that are not listed on the stock market. Even for companies that pay dividends, the assumption that dividends will grow at a constant rate may not be valid.
- Second, it does not explicitly consider risk. There is no direct adjustment for the risk associated with the estimated growth. Of course, there is an implicit adjustment for risk as the current stock price is used.

Earnings–Price Ratio Approach

According to this approach, the cost of equity is equal to:

$$E_1 / P_0 \qquad (10.5)$$

where E_1 = expected earnings per share for the next year

P_0 = current market price per share

E_1 may be estimated as: (Current earnings per share) × (1+ growth rate of earnings per share).

This approach provides an accurate measure of the rate of return required by equity investors in the following two cases:

- When the earnings per share are expected to remain constant and the dividend payout ratio is 100 per cent.
- When retained earnings are expected to earn a rate of return equal to the rate of return required by equity investors.

The first case is rarely encountered in real life and the second case is also somewhat unrealistic. Hence, the earnings–price ratio should not be used indiscriminately as the measure of the cost of equity capital.

A detailed explanation is provided in Appendix 10A.

10.4 DETERMINING THE PROPORTIONS

For calculating the WACC, we multiply the cost of each source of capital by the proportion applicable to it. Now that we know how to calculate the cost of specific sources of capital, we need to determine the proportions applicable to them. These proportions may be based on:

- Book values
- Target capital structure
- Market values

Book Value Proportions

Book value proportions are based on the values found on the balance sheet. The proportion applied to a given source of capital is simply the book value of that source of finance divided by the book value of total financing.

The *merits* of book value proportions are: (i) The calculation of proportions is very simple. (ii) When market values are not available or reliable, because the firm is not listed or the securities of the firm are not actively traded, book value proportions may perhaps provide the only usable basis for computing the weighted average cost of capital. The *disadvantages* of book value proportions are: (i) The present economic values of various sources of capital may bear no relationship to the book values. (ii) Book value proportions are not consistent with the concept of cost of capital because the latter is defined as the minimum rate of return to maintain the market value of the firm.

Target Capital Structure Proportions

The weights under this scheme are the proportions of debt, preferred stock, and equity in the target capital structure of the firm.

While this scheme is appealing as it relies on the target capital structure, there are some difficulties in using it: (i) A company may not have a well-defined target capital structure. Perhaps the changing complexion of its business or the changing conditions in the capital market make it difficult for the company to articulate its target capital structure. (ii) If the target capital structure is different from the present capital structure, it may be difficult to precisely estimate what the component capital costs would be.

Market Value Proportions

According to this scheme of weighting, the proportion applied to a source of capital is equal to the market value of that source of capital divided by the market value of all sources of capital employed by the firm.

The *advantages* of market value proportions are: (i) The best estimate of the rates for the various components of capital are those currently required on the existing securities of the firm in the market. (ii) Under the assumption that the firm's business and financial risk would remain unchanged, the cost of capital computed with the current market cost and current market value proportions is a valid measure of the minimum average rate of return required on new investments.

The *shortcomings* of market value proportions are: (i) Market values may not be available when the firm is not listed or when the securities of the firm are very thinly traded. (ii) Market values may be distorted when security prices are influenced by manipulative trading.

We recommend the use of market value weights unless market values are not available or are highly unreliable or distorted.

10.5 WEIGHTED AVERAGE COST OF CAPITAL

Given the cost of specific sources of financing and the scheme of weighting, the weighted average cost of capital (WACC) can be readily calculated by multiplying the specific cost of each source of financing by its proportion in the capital structure and adding the weighted values. In symbols, the weighted average cost of capital may be expressed as follows:

$$\text{WACC} = \frac{E}{V} r_E + \frac{P}{V} r_P + \frac{D}{V} r_D (1 - T_c) \tag{10.6}$$

where WACC = weighted average cost of capital

E = market value of equity
V = market value of the firm
r_E = cost of equity
P = market value of preference
r_P = cost of preference
D = market value of debt
r_D = cost of debt
T_c = corporate tax rate

Illustration

The cost of specific sources of capital for Bharat Nigam Limted are:

r_E = 16.0 percent

r_P = 14.0 percent

r_D = 12.0 percent

The market value proportions of equity, preference, and debt are:

$E/V = 0.60$
$P/V = 0.05$
$D/V = 0.35$

The corporate tax rate, T_C, is 30 percent.

The WACC for Bharat Nigam Limited is calculated in Exhibit 10.1.

Exhibit 10.1 ***Calculation of the WACC for Bharat Nigam Limited***

Source of Capital	Proportion (1)	Cost (2)	Weighted Cost [(1) x (2)]
Debt	0.60	16.0%	9.60%
Preference	0.05	14.0%	0.70%
Equity	0.35	8.4%	2.94%
			WACC = 13.24 %

10.6 WEIGHTED MARGINAL COST OF CAPITAL SCHEDULE

At the outset we assumed, *inter alia*, that the adoption of new investment proposals will not change either the risk complexion or the capital structure of the firm. Does it mean that the weighted average cost of capital will remain the same irrespective of the magnitude of financing? Apparently not. Generally, the weighted average cost of capital tends to rise as the firm seeks more and more capital. This happens because the supply schedule of capital

is typically upward sloping as suppliers provide more capital, the rate of return required by them tends to increase. A schedule or graph showing the relationship between additional financing and the weighted average cost of capital is called the weighted marginal cost of capital schedule.

Determining the Weighted Marginal Cost of Capital Schedule

The procedure for determining the weighted marginal cost of capital involves the following steps:

1. Estimate the *cost of each source of financing for various levels of its use* through an analysis of current market conditions and an assessment of the expectations of investors and lenders.
2. Identify the levels of total new financing at which the cost of the new components would change, given the capital structure policy of the firm. These levels, called *breaking points*, can be established using the following relationship.

$$BP_j = \frac{TF_j}{W_j} \tag{10.7}$$

where BP_j = breaking point on account of financing source j
TF_j = total new financing from source j at the breaking point
W_j = proportion of financing source j in the capital structure

3. Calculate the WACC for various ranges of total financing between the breaking points.
4. Prepare the weighted marginal cost of capital schedule which reflects the WACC for each level of total new financing.

Illustration

To illustrate the preparation of the weighted marginal cost of capital schedule, let us consider an example. Shiva Chemicals Limited wishes to use equity, preference, and debt capital in the following proportions:

Equity	: 0.45
Preference	: 0.05
Debt	: 0.50

Cost of Each Source of Finance for Various Levels of Its Use Based on the discussions with its merchant bankers and lenders, Shiva Chemicals Limited estimates that the cost of each of its three sources of financing for various levels of usage is as given in Exhibit 10.2.

Exhibit 10.2 ***Data for Calculating the Weighted Marginal Cost of Capital (WMCC) Schedule for Shiva Chemicals***

Source of Capital	Target Proportion	Range of New Financing[a] (Rs in million)	Cost
Equity	45%	0–10	1500
		10–30	16.50
		30 and above	18.00
Preference	5%	0–1	14.50
		1 and above	15.00
Debt	50%	0–15	7.50
		15–40	8.00
		40 and above	8.40

[a] These ranges are for the respective sources of financing and not for total new financing.

Breaking Points Given the target capital structure proportions and the financing ranges for each source of finance, the breaking points for each source of finance and the corresponding ranges of total new financing are given in columns 3 and 4 of Exhibit 10.3.

WACC for Various Ranges of Total New Financing An examination of column 4 of Exhibit 10.3 shows that the firm's weighted average cost of capital will change at Rs 20.00, Rs 22.22, Rs 30.00, Rs 66.67, and Rs 80.00 million of total new financing. Exhibit 10.4 shows the calculation of the weighted average cost of capital over various ranges.

Weighted Marginal Cost of Capital Schedule The weighted marginal cost of capital schedule is shown in Exhibit 10.5. It is represented graphically in Exhibit 10.6.

Exhibit 10.3 ***Determination of Breaking Points and the Resulting Ranges of Total New Financing for Shiva Chemicals Limited***

Source of Capital	Cost (%) (1)	Range of New Financing (Rs in million) (2)	Breaking Point (Rs in million) (3)	Range of Total New Financing (Rs in million) (4)
Equity	15.00	0–10	10 / 0.45 = 22.22	0–22.22
	16.50	10–30	30 / 0.45 = 66.67	22.22–66.67
	18.00	30 and above	–	66.67 and above
Preference	14.50	0–1	1 / 0.05 = 20.00	0–20.00
		1 and above	–	20.00 and above
Debt	7.50	0–15	15 / 0.50 = 30.00	0–30.00
	8.00	15–40	40 / 0.50 = 80.00	30.00–80.00
	8.40	40 and above	–	80.00 and above

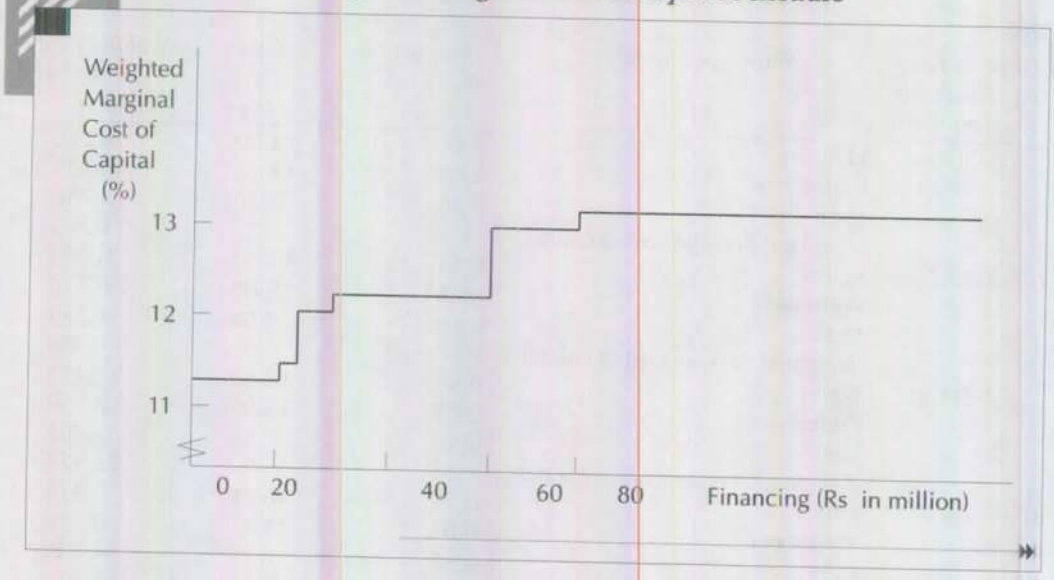
Exhibit 10.4 ***WACC for Various Ranges of Total New Financing for Shiva Chemicals Limited***

Range of Total New Financing (Rs in million)	Source of Capital (1)	Proportion (2)	Cost (%) (3)	Weighted Cost (%) [(2) x (3)] (4)
0–20.00	Equity	0.45	15.00	6.750
	Preference	0.05	14.50	0.725
	Debt	0.50	7.50	3.750
	Weighted average cost of capital			11.225
20.00–22.22	Equity	0.45	15.00	6.750
	Preference	0.05	15.00	0.750
	Debt	0.50	7.50	3.750
	Weighted average cost of capital			11.250
22.22–30.00	Equity	0.45	16.50	7.425
	Preference	0.05	15.00	0.750
	Debt	0.50	7.50	3.750
	Weighted average cost of capital			11.925
30.00–66.67	Equity	0.45	16.50	7.425
	Preference	0.05	15.00	0.750
	Debt	0.50	8.00	4.000
	Weighted average cost of capital			12.175
66.67–80.00	Equity	0.45	18.00	8.100
	Preference	0.05	15.00	0.750
	Debt	0.50	8.00	4.000
	Weighted average cost of capital			12.850
20.00–22.22	Equity	0.45	18.00	8.100
	Preference	0.05	15.00	0.750
	Debt	0.50	8.40	4.200
	Weighted average cost of capital			13.050

Exhibit 10.5 ***Weighted Marginal Cost of Capital Schedule***

Range of Total Financing (Rs in million)	Weighted Marginal Cost of Capital (%)
0–20.00	11.225
22.00–22.22	11.250
22.22–30.00	11.925
30.00–66.67	12.175
66.67–80.00	12.850
80.00 and above	13.050

Exhibit 10.6 ***Weighted Marginal Cost of Capital Schedule***



Marginal Cost of Capital and Capital Budgeting

The marginal cost of capital is the discount rate used for evaluating investments. A project is worthwhile if its net present value, discounted at the marginal cost of capital, is positive.

Constant Marginal Cost of Capital When the marginal cost of capital is constant, selecting the set of investments is a relatively straightforward task: All projects which have a positive net present value at the given marginal cost of capital would be acceptable.

Increasing Marginal Cost of Capital When the marginal cost of capital increases at discrete points as more and more financing is sought, determining the optimal capital budget is a somewhat difficult task. A precise solution to this problem is beyond the scope of this book. A procedure for reaching an approximate answer, however, is given below:

1. Determine the set of projects that has the highest net present value for each level of financing before a break in the marginal cost of capital schedule.
2. Choose the level of financing and the corresponding set of investment projects which has the highest net present value.

To illustrate, consider the example of Deodhar Corporation which has estimated that its marginal cost of capital schedule is as follows:

Level of Financing (Rs in million)	*Marginal Cost of Capital (percent)*
50	9
100	10
150	12
200	14

This firm first identifies a set of investment projects which generate the highest net present value given a capital budget constraint of Rs 50 million and a discount rate of 9 percent. It then identifies a set of investment projects which generate the highest net present value given a capital budget constraint of Rs 100 million and a discount rate of 10 percent, so on and so forth. The net present value of investment projects identified at various levels of financing is given below:

Level of Financing (Rs in million)	*Net Present Value of the Chosen Set (Rs in million)*
50	20
100	35
150	50
200	45

The highest net present value occurs when the firm raises Rs 150 million of financing.

10.7 FLOATATION COSTS AND THE COST OF CAPITAL

So far we have ignored the floatation costs. When a firm raises finance by issuing equity and debt, it almost invariably incurs floatation or issue costs, comprising of items like underwriting costs, brokerage expenses, fees of merchant bankers, advertising expenses, under-pricing cost, so on and so forth. For example, the floatation costs associated with equity issues may be 8 to 10 percent.

How should the floatation costs be handled in computing the cost of capital? One approach is to adjust the WACC to reflect the floatation costs. For example, if the WACC is 12 percent and the average floatation costs are 6 percent, the WACC may be revised as follows:

$$\text{Revised WACC} = \frac{\text{WACC}}{1 - \text{Floatation cost}} = \frac{12}{1 - .06} = 12.77 \text{ percent}$$

A better approach is to leave the WACC unchanged but to consider floatation costs as part of the project cost. A simple example may be given to illustrate this approach.

The cost of equity of Prakash Limited, an all equity firm, is 18 percent. Since the firm is financed wholly by equity, its WACC too is 18 percent. Prakash Limited is considering a Rs 200 million expansion project which will be funded by selling additional equity. Based on the advice of its merchant banker, Prakash Limited believes that its floatation costs will

be 8 percent of the amount issued. This means that the net proceeds will only be 92 percent of the amount of equity raised. What is the cost of expansion, considering the floatation costs?

Prakash Limited has to sell enough equity so that it has Rs 200 million after meeting the floatation costs. In other words,

$$\text{Rs 200 million} = (1 - .08) \times \text{Amount raised}$$

$$\text{Amount raised} = \frac{\text{Rs 200 million}}{(1 - .08)} = \text{Rs 217.39 million}$$

Prakash Limited's floatation costs are Rs 17.39 million and hence the true cost of the expansion project is Rs 217.39 million.

In the previous example, we assumed that a firm raised money only through external equity issue. What happens if the firm relies, as is very common, on a mixture of retained earnings, external equity issue, preference issue, and debt issue. In this case you have to calculate the weighted average floatation cost which is defined as follows:

$$f_A = w_r f_R + w_e f_E + w_p f_P + w_d f_D \qquad (10.8)$$

where f_A = weighted average floatation cost

w_R, w_E, w_P, and w_D = proportions of retained earnings, external equity, preference capital,and debt capital in the capital structure of the firm

f_R, f_E, f_P, and f_D = floatation costs associated with retained earnings, external equity, preference capital, and debt capital

To illustrate, consider the case of Phoenix Limited which employs retained earnings, external equity, preference capital, and debt capital in the following proportions:

$w_R = 0.2$, $w_E = 0.3$, $w_P = 0.1$, and $w_D = 0.4$. The floatation costs are as follows: $f_R = 0\%$, $f_E = 10\%$, $f_P = 5\%$, and $f_D = 4\%$. The weighted average floatation cost is:

$$f_A = (0.2)0 + (0.3)10 + 0.1(5) + 0.4(4) = 5.1\%$$

This means that for every rupee of financing needed by the firm for its investments, the firm must raise:

$$\frac{1}{1 - .051} = \text{Rs } 1.054$$

While calculating the weighted average floatation cost, use the weights in the existing capital structure (or target capital structure), even though the specific investment under consideration is financed entirely by debt or equity. The fact that a particular project can be financed with debt or equity is not relevant. If a firm has a debt-equity ratio of 3:2, for example, but chooses to finance a given project entirely with debt, it will have to raise additional equity subsequently to maintain its target debt-equity ratio. Taking this into consideration, you should always use weights in the capital structure.

Floatation Costs and NPV

To illustrate how floatation costs are incorporated in an NPV analysis, let us consider an example. Ramesh Engineering is currently at its target debt-equity ratio of 4:5. It is evaluating a proposal to expand capacity which is expected to cost Rs 4.5 million and generate after-tax cash flows of Rs 1 million per year for the next 10 years. The tax rate for the company is 25 percent. Two financing options are being looked at:

- Issue of equity stock. The required return on the company's new equity is 18 percent. The issuance cost will be 10 percent.
- Issue of debentures carrying a yield of 12 percent. The issuance cost will be 2 percent.

What is the NPV of the expansion project? Since the expansion is in the existing business of the firm, we will use the company's WACC to value it:

$$\begin{aligned}\text{WACC} &= \frac{E}{V} r_E + \frac{D}{V} r_D (1 - T_c) \\ &= \frac{5}{9} \times 18\% + \frac{4}{9} \times 12\% (1 - 0.25) \\ &= 10\% + 4\% = 14\%\end{aligned}$$

The NPV of the project ignoring the floatation costs is:

$$\begin{aligned}\text{NPV} &= \text{Present value of benefits} - \text{Investment} \\ &= \text{Rs } 1{,}000{,}000 \times \text{PVIFA (14\%, 10 years)} - \text{Rs } 4{,}500{,}000 \\ &= \text{Rs } 1{,}000{,}000 \times 5.216 - \text{Rs } 4{,}500{,}000 \\ &= \text{Rs } 716{,}000\end{aligned}$$

What will be the effect of floatation costs? Since the floatation costs of equity and debt are 10 percent and 2 percent respectively and the target debt-equity ratio is 4:5, the weighted average floatation cost, f_A, is:

$$\begin{aligned}f_A &= \frac{E}{V} \times f_E + \frac{D}{V} \times f_d \\ &= \frac{5}{9} \times 10\% + \frac{4}{9} \times 2\% \\ &= 6.44 \text{ percent}\end{aligned}$$

Note that the fact that Ramesh Engineering can finance the project entirely with equity or debt is irrelevant. What matters is the target capital structure of the firm.

Given that the expansion project needs Rs 4,500,000, the true cost, including floatation costs, is Rs 4,500,000 / $(1 - f_A)$ = Rs 4,500,000 / 0.9356 = Rs 4,809,748. Since the present value of cash inflows is Rs 5,216,000, the expansion project, after considering the floatation costs, has an NPV of: Rs 5,216,000 – Rs 4,809,748 = Rs 406,252. The project is still worthwhile.

10.8 COST OF CAPITAL IN PRACTICE

In order to understand how the cost of capital is calculated in practice, the author asked the chief finance executives of twenty large-sized business undertakings, representing a wide cross-section of industries: How do you calculate the cost of capital? The responses obtained are shown below (the lengthier ones have been paraphrased).

Nature of Industry		*Response*
Electrical	:	"We look at the profitability of investment proposals from the point of view of equity capital. Our equity dividend rate is 10 percent—this is what the government wants—so our cost of capital is 10 percent."
Chemical	:	"We do not calculate the cost of capital as it is too academic and impractical."
Tea	:	"There are three sources of capital: equity, reserves, and borrowings. The cost of equity is based on the last dividend paid and the profit before tax required to pay that dividend; the cost of reserves is taken as 18 percent gross; and the cost of borrowings from various sources is equal to the appropriate rate of interest paid. For capital expenditures for which additional equity issue is not necessary, we assume the average cost of capital to be 18 percent since it is met either from reserves or borrowings which cost more or less the same. For projects requiring equity issue the cost of capital, of course, is higher."
Fertiliser	:	"Frankly we have not tried to figure out this. And we never felt the need to know it as our investments are carefully considered by an expert board of directors."
Toothpaste	:	"Our rate of return (profitability) is very high and thus it is not necessary to calculate the cost of capital."
Aluminium	:	"We equate cost of capital with the effective rate of interest on incremental borrowing necessary to finance capital expenditures. The specific type of borrowing determines the cost of capital."
Chemical	:	"We depend mainly on retained earnings which have no cost because shareholders are satisfied with dividends."
Automobile	:	"We don't go by cost of capital. Everything is dependent on investment opportunities. The decision maker will not wait to calculate ratios if he finds the investment opportunities worthwhile based on his business judgment."

Shipping : "Our normal debt-equity ratio is 3:1. Since the cost of equity and debt in post-tax terms are 18 percent and 8 percent, respectively, our cost of capital is 10.5 percent. However, for the proposed new ship the cost is less because we plan to borrow up to 90 percent."

Leasing : "Currently our debt-equity ratio is 5:1. The pre-tax cost of debt is about 18 percent and the pre-tax cost of equity, given a dividend rate of 20 percent, is 40 percent. So our average cost of capital is: $(5/6 \times 18) + (1/6 \times 40) = 21.7$ percent."

Diversified (I) : "We measure our cost of capital in pre-tax terms. While the cost of term loans is 14 percent, the cost of equity is 20 percent (this is simply the grossing up of our equity dividend rate of 10 percent). Thus our cost of capital, given a debt-equity ratio of 1:1 is 17 percent."

Diversified (II) : "Our return on investment—net profit to total assets—has varied between 10 percent and 20 percent in the last 4 years. So we take our cost of capital as 15 percent."

Truck : "The cost of capital is calculated as the average of the cost of equity and the cost of debt. The cost of equity is the total amount of dividend for the year expressed as a percentage of the average shareholders' funds employed during the year. The cost of debt is the total amount of interest paid/payable during the year on long-term loans expressed as a percentage of average long-term funds employed during the year."

Pharmaceuticals : "If by cost of capital you mean the yardstick for evaluating investment projects, it is our average rate of return for the last five years. We define the rate of return as follows:

$$\frac{\text{Profit after tax}}{\text{Total book assets (gross of depreciation but net of current liabilities)}}$$

Diversified (III) : "We do not consciously compute the cost of capital. Rather we compare return on investment for a given project to a 'return' objective. Our objective changes from time to time as the environment changes."

Textiles : "There is a problem in calculating the cost of capital. It is deceptively simple and it can be misleading. Moreover, if our managers know it, they will beat it."

Storage Batteries	:	"All our financing is done with depreciation funds and ploughed back earnings. Depreciation is capital already in the company. Since it does not have to be raised, even in an indirect sense of retained earnings, it clearly has no cost."
Diversified (IV)	:	"In our investment decisions we do not go by numbers like cost of capital. We simply ask whether the proposed investment will improve the quality of our product and help us improve our competitive strength."
Consumer Electronics	:	"Our return on equity historically has been around 25 percent. Our cost of debt, adjusting for taxes, is about 10 percent. By averaging the two, you get 17.5 percent."
Diversified (V)	:	"We look at the target specified by our foreign principal. I am not supposed to disclose it. But that in a way is our cost of capital."

Some Misconceptions

The cost of capital is a central concept in financial management linking the investment and financing decisions. Hence it should be calculated correctly and used properly in investment evaluation. Despite this injunction, we find that several errors characterise the practical application of this important concept. The more serious misconceptions, along with suggestions to overcome them, are discussed below.

The Concept of Cost of Capital is too Academic or Impractical Some companies do not calculate the cost of capital because they regard it as 'academic' or 'impractical' or 'irrelevant' or 'imprecise'. These misgivings about cost of capital appear to be unjustified. Such reservation can be dispelled by emphasising the following points:

1. The cost of capital is an essential ingredient of discounted cash flow analysis. Since discounted cash flow analysis is now widely used, cost of capital can scarcely be considered 'academic' or 'impractical'.
2. Out of the various inputs required for discounted cash flow analysis, viz., project life, project cash flows (consisting of initial investment, operating cash flows, and terminal cash flow) and cost of capital, the last one, viz., the cost of capital can be calculated most reliably and accurately. So a concern about its imprecision seems to be misplaced.

The Cost of Equity is Equal to the Dividend Rate or Return on Equity It appears that the cost of equity is often measured incorrectly. Most commonly it is measured as the current dividend rate (dividend per share as a percentage of face value per share) or as return on equity. Only by accident do these measures represent the cost of equity correctly.

It should be clearly understood that the cost of equity is the rate of return required by equity investors given the risk they are exposed to. It has nothing to do with the current dividend rate or return on equity, which are mere historical numbers.

Retained Earnings are Either Cost Free or Cost Significantly Less than External Equity Often firms impute a negligible or low cost to retained earnings under the influence of wrong notions like "retained earnings have no cost because shareholders are satisfied with dividends" or "retained earnings are already with the firm and hence some nominal returns on them may suffice".

The error in such reasoning stems from ignoring the opportunity cost associated with retained earnings. When a firm retains a portion of its earnings, equity shareholders are denied dividends to that extent. If the same were distributed as dividends, equity shareholders can invest elsewhere to earn a rate of return comparable to the cost of equity. Hence the opportunity cost of retained earnings is more or less equal to the cost of equity funds.

Depreciation Has No Cost Similar to the misconception that retained earnings are more or less cost-free is the notion that depreciation-generated funds are also virtually cost free. Recall the observation of a participant in the survey: "Depreciation is capital already in the company. Since it does not have to be raised, even in an indirect sense of retained earnings, it clearly has no cost."

To guard against such an error, invoke the opportunity cost principle once again. Theoretically, the firm can return the depreciation-generated funds to its shareholders and lenders (the parties which provided the finance for asset acquisition) and they, in turn, can invest these funds elsewhere. Hence the opportunity cost of depreciation-generated funds is the average return the shareholders and lenders would earn on these funds by investing them elsewhere. And this would be more or less equal to the average cost of capital of the firm.

The Cost of Capital can be Defined in Terms of an Accounting-Based Measure Some companies employ an accounting-based measure like 'net profits to total assets' to define the cost of capital. This approach, however, is not correct. It looks at historical accounting information whereas what is relevant for cost of capital measurement is the opportunity cost. It must be emphasised that to measure the cost of capital we have to take into account the future burden associated with the proposed sources of financing capital investments.

If a Project is Financed Heavily by Debt, Its Weighted Average Cost of Capital (WACC) is Low The lower post-tax cost of debt induces some financial managers to believe that greater reliance on debt for a particular project reduces its WACC. This confusion is evident in observations like "The specific type of borrowing determines the cost of capital" and "For the proposed new ship the cost is less because we plan to borrow up to 90 percent".

To surmount the error in the above reasoning, remember the following:

1. WACC applies only to those projects which are identical to the firm. Since the firm is not debt-financed to the extent of 90 percent, it is wrong to use a weight of 0.9 for debt- financing in the calculation of WACC.

2. The immediate sources of funds used for a project do not necessarily determine the hurdle rate. What matters is the contribution made by the project to the firm's overall borrowing power and not which sources of funds happen to be tapped when the project is being undertaken.
3. Even if the firm is inclined and capable of going for 90 percent debt financing, on an overall basis, the component costs of equity and debt are highly unlikely to remain what they are, when the firm has 50 percent debt financing.

10.9 HOW FINANCIAL INSTITUTIONS CALCULATE COST OF CAPITAL

Financial institutions calculate cost of capital as post-tax weighted average cost of the mix of funds employed for the project.

The cost for different sources of funds are taken as follows:

- Equity share capital : 15%
- Cash accruals/Retained earnings : 15%
- Preference share capital : Preference dividend rate
- Subsidy/Incentive loans : Zero cost
- Debt : Post-tax rate of interest
  (Long-term loans, non-convertible debentures, deferred credits, bank borrowings for working capital, unsecured loans from public)
- Convertible debenture : Convertible portion at 15%
  Non-convertible portion at post-tax interest rate

For calculating the post-tax rate of interest, the interest rate is multiplied by (1–tax rate). The tax rate for this purpose is the average applicable tax rate and not the notional tax rate. The average applicable tax rate is calculated as follows:

$$\frac{\text{Total tax liability during the life of the project}}{\text{Total operating profit over the life of the project}}$$

The average applicable tax rate is generally lower than the prevailing notional tax rate because of various tax benefits available on account of incentives and losses.

Illustration

The means of financing for a project are given below:

- Equity and cash accruals : Rs 900 million
- Preference share capital (@ 10%) : Rs 100 million
- Rupee term loans from institutions (@14%) : Rs 800 million

- Non convertible debentures (@12%) : Rs 400 million
- Convertible portion of convertible debentures : Rs 100 million
- Non-convertible portion of convertible debentures : Rs 100 million
- Bank borrowing for working capital (@15%) : Rs 200 million

The average applicable tax rate for the project is estimated at 25 percent.

The cost of capital is calculated in Exhibit 10.7.

Exhibit 10.7 ***Cost of Capital Calculation***

Rs in million

Means of Financing (A)	*Amount (Rs in million) (B)*	*Cost of Funds (C)*	*Total Cost (post-tax) (D)= C × B*
1. Equity and cash accruals	900	15%	135
2. Preference share capital	100	10%	10
3. Rupee term loans (@14%)	800	10.5%	84
4. Non-convertible debentures (@12%)	400	9%	36
5. Convertible portion of convertible debentures	100	15%	15
6. Non-convertible portion of convertible debentures (@10%)	100	7.5%	7.5
7. Bank borrowing for working capital (@15%)	200	11.25%	22.5
	2600		310

The average cost of capital (post-tax) is: 310 / 2600 = 11.92%

SUMMARY

- Capital, like any other factor of production, has a cost. A company's cost of capital is the weighted average cost of the various sources of finance used by it, viz., equity, preference, long-term debt, and short-term debt.
- Note that many companies leave out the cost of short-term debt while calculating the weighted average cost of capital (WACC). In principle, this is not correct. Investors who provide short-term debt also have a claim on the operating earnings of the firm. So, if a company ignores this claim, it will mis-state the rate of return required by its investors.
- WACC is a central concept in financial management. It is used for evaluating investment projects, for determining the capital structure, for setting the rates that regulated organisations like electric utilities can charge to their customers, so on and so forth.
- In general, if a firm uses n different sources of capital its WACC is:

$$\sum p_i r_i$$

- Two basic conditions should be satisfied for using the company's WACC for evaluating new

investments: (a) The risk of new investments is the same as the average risk of existing investments. (b) The capital structure of the firm will not be affected by the new investments. Thus, strictly speaking, WACC is the right discount rate for a project that is a carbon copy of the firm's existing business. However, in practice, WACC is used as a benchmark hurdle rate that is adjusted for variations in risk and financing patterns.

- Since debt and preference stock entail more or less fixed payments, estimating the cost of debt and preference is relatively easy.
- A company raises debt finance through a variety of instruments like debentures, bank loans, and commercial paper. The cost of debt is the weighted average rate of different kinds of debt employed by it.
- The weighted average rate of debt is calculated using the market values and yields to maturity of various debt instruments. Note that we use the yields to maturity or the current rates as they reflect the rates at which the firm can raise new debt.
- Since interest on debt is a tax-deductible expense, the pre-tax cost of debt has to be adjusted for the tax factor to arrive at the post-tax cost of debt.
- Preference capital carries a fixed rate of dividend and is redeemable in nature. Given the fixed nature of preference dividend and principal repayment commitment and the absence of tax deductibility, the cost of preference is simply equal to its yield.
- Equity earnings may be obtained in two ways: (i) retention of earnings, and (ii) issue of additional equity. The cost of equity or the return required by equity shareholders is the same in both the cases. Remember that when a firm decides to retain earnings, an opportunity cost is involved.
- A popular approach to estimating the cost of equity is the security market line (SML) relationship. According to the SML, the required return on a company's equity is:

$$r_E = R_f + \beta_E[E(R_M) - R_f]$$

- Analysts who do not have faith in the SML approach often resort to a subjective procedure to estimate the cost of equity. They add a judgmental risk premium to the observed yield on the long-term bonds of the firm to get the cost of equity.
- According to the dividend growth model approach, the cost of equity is equal to:

Dividend yield + Expected growth rate in dividends

- For calculating the WACC we multiply the cost of each source of capital by the proportion applicable to it. These proportions may be based on book values or target capital structure or market values. Market value proportions are generally recommended unless market values are not available or are highly unreliable or distorted.
- WACC tends to rise as the firm seeks more and more capital. This happens because the supply schedule of the capital is typically upward sloping—as suppliers provide more capital, the rate of return required by them tends to increase.
- A schedule or graph showing the relationship between additional financing and WACC is called the weighted marginal cost of capital schedule.
- When a firm raises finance by issuing equity and debt, it almost invariably incurs floatation or issue costs, comprising items like underwriting costs, brokerage expenses, fees of

merchant bankers, under-pricing costs, so on and so forth.

- There are two ways of handling floatation costs. One approach is to adjust the WACC to reflect the floatation costs. A better approach is to leave the WACC unchanged but to consider floatation costs as part of the project cost.
- Despite the importance of cost of capital in financial management, we find that several misconceptions characterise its application in practice. The more serious ones are: (i) The cost of capital is too academic or impractical. (ii) The cost of equity is equal to the dividend rate or return on equity. (iii) Retained earnings are either cost free or cost significantly less than external equity. (iv) Depreciation has no cost. (v) The cost of capital can be defined in terms of an accounting-based measure. (vi) If a project is financed heavily by debt, its WACC is low. ■

Questions

1. What are the three steps involved in calculating a firm's WACC?
2. Discuss the conditions that should be satisfied for using a firm's WACC for evaluating new investments.
3. How is the cost of debt calculated?
4. How is the cost of preference calculated?
5. Discuss the application of security market line (SML) to the calculation of cost of equity.
6. What are the pros and cons of using the SML approach to calculate the cost of equity?
7. What are the pros and cons of using the bond yield plus risk premium approach to calculate the cost of equity?
8. How is the cost of equity calculated using the dividend growth model approach?
9. What are the pros and cons of using the dividend growth model approach to calculate the cost of equity?
10. Discuss the following bases for determining the proportions (or weights) in the WACC calculation: book values, target capital structure, and market values.
11. Explain the procedure for determining the weighted marginal cost of capital.
12. How would you handle the floatation costs in computing the cost of capital?
13. What are the common misconceptions surrounding cost of capital in practice? How would you dispel them?
14. How do financial institutions calculate cost of capital? ■

Problems

1. Abascus Limited issued 15-year, 14 percent bonds five years ago The bond which has a face value of Rs 100 is currently selling for Rs 108.
   a. What is the pre-tax cost of debt?
   b. What is the after-tax cost of debt? (Assume a 35 percent tax rate.)
2. Omega Enterprises issued 10-year, 9 percent preference shares four years ago. The preference share which has a face value of Rs 100 is currently selling for Rs 92. What is the cost of the preference shares?
3. Rao Corporation has a target capital structure of 60 percent equity and 40 percent debt. Its cost of equity is 18 percent and its pre-tax cost of debt is 13 percent. If the relevant tax rate is 35 percent, what is Rao Corporation's WACC?
4. Unix Limited's equity beta is 1.2. The market risk premium is 7 percent and the risk-free rate is 10 percent. Unix has a debt equity ratio of 2:3. Its pre-tax cost of debt is 14 percent. If the tax rate is 35 percent, what is the WACC?
5. Azeez Corporation's WACC is 12 percent and its tax rate is 35 percent. Azeez's pre-tax cost of debt is 14 percent and its debt-equity ratio is 1:1. The risk-free rate is 11 percent and the market risk premium is 8 percent. What is the beta of Azeez's equity?
6. Satish Kumar, CEO of Vanguard Enterprises, is trying to figure out the cost of debt and equity.
   a. Vanguard's balance sheet has a total debt of Rs 200 million and Vanguard's total interest burden for the forthcoming year will be Rs 24 million. Satish argues, "We owe Rs 200 million and we will pay Rs 24 million interest. So the cost of our debt is 12 percent (24/200)." What is the flaw in this argument?
   b. Vanguard's equity currently sells for Rs 100 per share and the dividend per share will probably be Rs 6. Satish reasons "Since we plan to pay a dividend of Rs 6 per share which has a market price of Rs 100, our cost of equity is 6 percent." What is the error in this reasoning?
7. Samanta Company has 20 million equity shares outstanding. The book value per share is Rs 40 and the market price per share is Rs 120. Samanta has two debenture issues outstanding. The first issue has a face value of Rs 300 million, 12 percent coupon, and sells for 90 percent of its face value. It will mature in 5 years. The second issue has a face value of Rs 200 million, 14 percent coupon, and sells for 102 percent of its face value. It will mature in 6 years. Samanta also has a bank loan of Rs 200 million on which the interest rate is 15 percent.
   a. What are Samanta's capital structure weights on a book value basis and on a market value basis?
8. Suman Corporation manufactures speciality chemicals. Its debt-equity ratio is 0.8. Its WACC is 15 percent and its tax rate is 30 percent.
   a. If Suman's cost of equity is 20 percent, what is its pre-tax cost of debt?

b. If Suman can issue debt at an interest rate of 13 percent, what is its cost of equity?

9. Panyam Company's capital structure in terms of market value is:

Debt	Rs 30 million
Equity	Rs 60 million

The company plans to maintain this market-value capital structure. The company has a plan to invest Rs 15 million next year. This will be financed as follows:

Retained earnings	Rs 5 million
Additional equity	Rs 5 million
Debt	Rs 5 million

The company's equity stock presently sells for Rs 30 per share. The next dividend expected is Rs 3.00. The expected rate of dividend growth is 5 percent. Additional equity can be issued at Rs 25 per share (net). The interest rate applicable to additional debt would be as follows:

First Rs 2.5 million	14 percent
Next Rs 2.5 million	15 percent

The tax rate for the firm is 60 percent.

Required: (a) At what amounts of new capital will there be breaks in the marginal cost of capital schedule?

(b) What will be the marginal cost of capital in the interval between each of the breaks?

10. Susheel Corporation has the following book value capital structure:

Equity capital (10 million shares, Rs 10 par)	Rs 100 million
Preference capital, 11 percent (100,000 shares, Rs 100 par)	Rs 10 million
Retained earnings	Rs 120 million
Debentures 13.5 percent (500,000 debentures, Rs 100 par)	Rs 50 million
Term loans, 12 percent	Rs 80 million
	Rs 360 million

The next expected dividend per share is Rs 1.50. The dividend per share is expected to grow at the rate of 7 percent. The market price per share is Rs 20.00. Preference stock, redeemable after 10 years, is currently selling for Rs 75.00 per share. Debentures, redeemable after 6 years, are selling for Rs 80.00 per debenture. The tax rate for the company is 50 percent.

(a) Calculate the average cost of capital using
   (i) book value proportions, and
   (ii) market value proportions

(b) Define the marginal cost of capital schedule for the firm if it raises Rs 100 million next year, given the following information:
   (i) the amount will be raised from equity and debt in equal proportions

(ii) the firm expects to retain Rs 15 million earnings next year;
(iii) the additional issue of equity stock will fetch a net price per share of Rs 16.00;
(iv) the debt capital raised by way of term loans will cost 14 percent for the first Rs 25 million and 15 percent for the next Rs 25 million.

11. Microelectronics Corporation is currently at its target debt-equity ratio of 0.5:1. It is considering a proposal to expand capacity which is expected to cost Rs 500 million and generate after-tax cash flows of Rs 130 million per year for the next eight years. The tax rate for the firm is 30 percent. Mahesh, the CFO of the company, has considered two financing options: (i) Issue of equity stock. The required return on the company's new equity is 20 percent and the issuance cost will be 12 percent. (ii) Issue of debentures at a yield of 13 percent. The issuance cost will be 3 percent.
    (a) What is the WACC for Microelectronics?
    (b) What is Microelectronic's weighted average floatation cost?
    (c) What is the NPV of the proposal after taking into account the floatation costs?

APPENDIX 10A

EARNINGS–PRICE (E/P) RATIO AS A MEASURE OF COST OF EQUITY

E/P ratio measures the cost of equity capital in the following cases:

Case A Future earnings are constant and the payout ratio is 100 percent.

Case B The firm invests in projects that earn a rate of return of r_E, (the cost of equity capital) forever on the equity portion of financing.

Case A The cost of equity is the value of r_E, in the equation.

$$P = \sum_{t=1}^{\infty} \frac{D_t}{(1+r_E)^t} \qquad (10A.1)$$

When future earnings are constant and the payout ratio is 100 percent

$$E_1 = E_2 = E_3 = \ldots E = D_1 = D_2 = \ldots D \qquad (10A.2)$$

Putting future earnings as E gives:

$$P = \sum_{t=1}^{\infty} \frac{E}{(1+r_E)^t} \qquad (10A.3)$$

This leads to:

$$r_E = E/P \qquad (10A.4)$$

Case B For the sake of simplicity, let us assume that the firm has an all-equity capital structure and the retention ratio is b (a constant) in each period.

Since reinvested funds earn a rate of return of r_E percent, earnings, retained earnings, and dividends will be as given in Exhibit 10A.1.

Exhibit 10.A.1 ***Earnings, Retained Earnings, and Dividends***

Year	Earnings	Retained Earnings	Dividends
0	E_0	$E_0\, b$	$E_0 (1 - b)$
1	$E_0 + E_0\, b\, r_E = E_0 (1 + b\, r_E)$	$E_0 (1 + b\, r_E) b$	$E_0 (1 + b\, r_E)\ (1 - b)$
2	$E_0 (1 + b\, r_E) + E_0 (1 + b\, r_E)\, b\, r_E$ $= E_0 (1 + b\, r_E)^2$	$E_0 (1 + b\, r_E)^2 b$	$E_0 (1 + b\, r_E)^2 (1 - b)$
	.	.	.
	.	.	.
	.	.	.
n	$E_0 (1 + b\, r_E)^n$	$E_0 (1 + b\, r_E)^n b$	$E_0 (1 + b\, r_E)^n (1 - b)$

The cost of equity is the value of r_E in the following equation:

$$P = \sum_{t=1}^{\infty} \frac{D_t}{(1 + r_E)^t} \tag{10A.5}$$

Given the value of D_t in Exhibit 10A.1, we get:

$$P = \sum_{t=1}^{\infty} \frac{E_0 (1 + b\, r_E)^t\ (1 - b)}{(1 + r_E)^t}$$

$$= \sum_{t=1}^{\infty} E_0 (1 - b) \frac{(1 + b\, r_E)^t}{(1 + r_E)^t}$$

$$= \frac{E_0 (1 - b)(1 + b\, r_E)}{r_E (1 - b)} \tag{10A.6}$$

Hence $r_E = E_1 / P$ (10A.7)

APPENDIX 10B

COST OF DEPRECIATION-GENERATED FUNDS

Generally, depreciation-generated funds represent a very important source of funds. For purposes of capital budgeting, what cost should be imputed to such funds? The cost to be imputed to such funds should be more or less the average cost of capital to the firm. The rationale behind this argument is that the firm could theoretically return the depreciation-generated funds to its shareholders and lenders (the parties which provided the finance

for asset acquisition) and they in turn can invest the funds elsewhere. Hence the opportunity cost of depreciation-generated funds is the average return the shareholders and lenders would earn on these funds by investing them elsewhere. And this would be more or less comparable to the average cost of capital to the firm.

Since the cost of depreciation-generated funds is more or less equal to the average cost of capital of the firm, it does not matter if we exclude it from the cost of capital computation. This is clear from the following analysis, where, for the sake of simplicity, we assume that there are only two sources of finance, debt and equity, in addition to depreciation-generated funds.

The weighted average cost of capital when depreciation-generated funds are not explicitly considered is:

$$WACC = W_E r_E + W_D r_D (1 - T_C) \quad (10B.1)$$

where

$WACC$ = weighted average cost of capital

W_E = weight associated with equity

r_E = cost of equity

W_D = weight associated with debt

r_D = cost of debt

T_C = corporate tax rate

The WACC when depreciation-generated funds are explicitly considered is:

$$WACC = W_E' r_E + W_D' r_D (1 - T_C) + W_{DEP} r_{DEP} \quad (10B.2)$$

where

W_E' = weight associated with equity

r_E = cost of equity

W_D' = weight associated with debt

r_D = cost of debt

T_C = corporate tax rate

W_{DEP} = weight associated with depreciation-generation funds

r_{DEP} = cost of depreciation-generated funds

Note that as the sum of the weights in each of the Eqs (10B.1) and (10B.2) is necessarily 1, the following conditions are satisfied:

$$W_E + W_D = 1 \quad (10B.3)$$

$$W_E' + W_D' + W_{DEP} = 1 \quad (10B.4)$$

Comparing Eqs (10B.3) and (10B.4), we find that W_E and W_D in Eq. (10B.3) get reduced to W_E' and W_D' in Eq. (10B.4). These reductions are caused to accommodate W_{DEP} in Eq

(10B.4). Since the reductions in W_E and W_D will be in the same proportions (that means if W_E reduces by x percentage W_D will also reduce by x percentage) to accommodate W_{DEP}, we get the following relationships:

$$W_E' = W_D(1 - W_{DEP}) \quad (10B.5)$$

$$W_D' = W_E(1 - W_{DEP}) \quad (10B.6)$$

As the cost of depreciation-generated funds is equal to WACC (i.e. r_{DEP} = WACC), Eq (10B.2) can be re-written as:

$$\text{WACC} = W_E' r_E + W_D' r_D (1 - T_C) + W_{DEP}\,\text{WACC} \quad (10B.7)$$

Juggling Eq. (10B.7) a bit, we get:

$$\text{WACC} = \frac{W_E'}{(1 - W_{DEP})} r_E + \frac{W_D'}{(1 - W_{DEP})} r_D (1 - T_C) \quad (10B.8)$$

As $W_E = W_E'/(1 - W_{DEP})$ [This is derived from Eq. (10B.5)]

and $W_D = W_D'/(1 - W_{DEP})$ [This is derived from Eq. (10B.6)]

Eqs (10B.8) and (10B.1) are identical. Thus, depreciation-generated funds need not enter the calculation of WACC. Hence, we can employ Eq. (10B.1) for calculating WACC.

Depreciation-generated funds, of course, do affect the cost of capital schedule. If we look at Exhibit 10.5 in Chapter 10 we find that the cost of capital schedule begins to increase when the total amount of funds raised exceeds Rs 20 million. If depreciation-generated funds are considered, the first segment in the cost of capital schedule will be extended by the amount of depreciation-generated funds. In that example, if depreciation-generated funds are Rs 5 million, the cost of capital schedule will rise at Rs 25 million rather that at Rs 20 million. The implications of this are as follows:

(a) When gross capital expenditure (which includes replacement as well as expansion investments) are considered, the schedule should include depreciation-generated funds.

(b) When net capital expenditures are considered, the schedule should not include depreciation-generated funds.

CHAPTER

11

Risk Analysis of Single Investments

Risk is inherent in almost every business decision. More so in capital budgeting decisions as they involve costs and benefits extending over a long period of time during which many things can change in unanticipated ways.

For the sake of expository convenience, we have assumed so far that all the investments being considered for inclusion in the capital budget had the same risk as those of the existing investments of the firm. Hence the average cost of capital was used for evaluating every project. Investment proposals, however, differ in risk. A research and development project may be more risky than an expansion project and the latter tends to be more risky than a replacement project. In view of such differences, variations in risk need to be evaluated explicitly in capital investment appraisal.

Risk analysis is one of the most complex and slippery aspects of capital budgeting. Many different techniques have been suggested and no single technique can be deemed as best in all situations. The variety of techniques suggested to handle risk in capital budgeting fall into two broad categories: (i) Techniques that consider the stand-alone risk of a project. (ii) Techniques that consider the risk of a project in the context of the firm or in the context of the market.

This chapter discusses different techniques that consider the stand-alone risk of a project, examines ways of managing risk, explores various approaches to project selection under risk, and describes risk analysis in practice. It is divided into eleven sections as follows:

- Sources, measures, and perspectives on risk
- Sensitivity analysis
- Scenario analysis
- Break-even analysis
- Hillier model
- Simulation analysis
- Decision tree analysis
- Managing risk

- Project selection under risk
- Risk analysis in practice
- How financial institutions analyse risk

11.1 SOURCES, MEASURES, AND PERSPECTIVES ON RISK

Sources of Risk

There are several sources of risk in a project. The important ones are project-specific risk, competitive risk, industry-specific risk, market risk, and international risk.

Project-specific risk The earnings and cash flows of the project may be lower than expected because of an estimation error or due to some other factors specific to the project like the quality of management.

Competitive risk The earnings and cash flows of the project may be affected by the unanticipated actions of the competitors.

Industry-specific risk Unexpected technological developments and regulatory changes, that are specific to the industry to which the project belongs, will have an impact on the earnings and cash flows of the project as well.

Market risk Unanticipated changes in macroeconomic factors like the GDP growth rate, interest rate, and inflation have an impact on all projects, albeit in varying degrees.

International risk In the case of a foreign project, the earnings and cash flows may be different than expected due to the exchange rate risk or political risk.

Measures of Risk

Risk refers to variability. It is a complex and multi-faceted phenomenon. A variety of measures have been used to capture different facets of risk. The more important ones are: range, standard deviation, coefficient of variation, and semi-variance.

To illustrate the calculation of these measures, consider a capital investment whose net present value has the following distribution.

NPV	*Probability*
200	0.3
600	0.5
900	0.2

The expected *NPV* works out to:

$$E(NPV) = \sum_{i=1}^{3} p_i NPV_i$$

$$= 0.3 \times 200 + 0.5 \times 600 + 0.2 \times 900 = 540$$

Now let us look at the various measures of risk.

Range Obviously the simplest measure of risk, the range of a distribution is the difference between the highest value and the lowest value. The range of the above distribution is: 900 – 200 = 700.

Standard Deviation The standard deviation of a distribution is:

$$\sigma = [\, \Sigma\, p_i\, (\, X_i - \overline{X}\,)^2\,]^{1/2} \qquad (11.1)$$

where σ = standard deviation

p_i = probability associated with the ith value

X_i = ith value

$\overline{X}$ = expected value

The standard deviation of the *NPV* distribution presented above is:

$$\sigma = [\, 0.3\, (200 - 540)^2 + 0.5\, (600 - 540)^2 + 0.2\, (900 - 540)^2]^{1/2}$$

$$= [\, 62{,}500]^{1/2} = 250$$

The square of standard deviation is called variance

$$\text{Variance} = \sigma^2$$

The variance of the above distribution is 62,500.

Coefficient of Variation One problem with standard deviation (or variance) is that it is not adjusted for scale. If you go only by standard deviation, an investment with an expected net present value of Rs 10 million and a standard deviation of Rs 100,000 would be considered more risky than an investment with an expected net present value of Rs 1 million and a standard deviation of Rs 90,000.

The coefficient of variation (*CV*) adjusts standard deviation for scale. It is defined as:

$$CV = \frac{\text{Standard deviation}}{\text{Expected value}}$$

The coefficient of variation for the investment in our illustration is:

$$CV = \frac{250}{540} = 0.46$$

Semi-Variance There is yet another problem with standard deviation (or variance). It considers all deviations, positive as well as negative, from the expected value in the same way. Since investors are concerned about only negative deviations, semi-variance seems to be a more suitable measure of risk.

The semi-variance is computed the way the variance is computed, except that only outcomes below the expected value are taken into account. It is defined as:

$$SV = \sum p_i d_i'^2 \tag{11.2}$$

where d_i' is equal to d_i if $d_i < 0$ and is equal to 0 if $d_i \geq 0$

The semi-variance for the investment in our illustration is:

$$SV = 0.3\ (200 - 540)^2 = 34{,}680$$

The semi-standard deviation is the square root of semi-variance. The semi-standard deviation for the investment in our illustration is:

Semi-standard deviation = (Semi-variance)^{½}

$$= (34680)^{½} = 186.2$$

The Principal Measure Despite the limitations pointed out, standard deviation is the most commonly used measure of risk in finance. The main reasons for using standard deviation are as follows: (i) If a variable is normally distributed, its mean and standard deviation contain all the information about its probability distribution. (ii) If the utility of money is represented by a quadratic function (a function commonly suggested to represent diminishing marginal utility of wealth), then the expected utility is a function of the mean and standard deviation. (iii) Standard deviation is analytically easily tractable.

Use of Subjective Probabilities For measuring the expected value and dispersion of a variable, its probability distribution is required. In some cases the probability distribution can be defined with a fairly high degree of objectivity on the basis of past evidence. A wildcatter, for example, may be able to define with a high degree of objectivity the probabilities associated with certain states of nature if sufficient records for similar ventures are available. Since such a probability distribution is substantially based on objective facts, it may be referred to as '*objective*' probability distribution.

However, in most real-life situations, such objective evidence may not be available for defining probability distributions. In such cases, knowledgeable persons may pool their experience and judgment to define the probability distribution. Since there is likely to be a high element of subjectivity in these distributions, such distributions are generally referred to as '*subjective*' probability distributions.

Perspectives on Risk

Regardless of the risk measure employed, there are different perspectives on risk. You can view a project from at least three different perspectives. These are:

Stand-alone risk This represents the risk of a project when it is viewed in isolation.

Firm risk Also called *corporate risk*, this reflects the contribution of a project to the risk of the firm.

Systematic risk This represents the risk of a project from the point of view of a diversified investor. It is also called *market risk*.

This chapter focuses on stand-alone risk and the following chapter examines firm risk and market risk. There are several reasons for starting with single investment risk analysis, which are:

- The proponent of a capital investment in a large organisation often does not have information about all the projects of the firm to measure the contribution of his proposed investment to the riskiness of the firm as a whole.
- The proponent of a capital investment is likely to be judged on the performance of that investment. Hence he will naturally be concerned about its stand-alone risk and not about its contribution to the risk of the firm or the risk of a diversified investor.
- Analysis of the stand-alone risk of an investment is often a prerequisite for evaluating the contribution of an investment to the risk of the firm and the risk of a diversified investor.
- In most firms, the capital budgeting committee considers investment proposals one at a time. The committee often does not have the time or information or expertise to fully consider the interactions of the investments with the other investments of the firm or its shareholders.

11.2 SENSITIVITY ANALYSIS

Since the future is uncertain, you may like to know what will happen to the viability of the project when some variable like sales or investment deviates from its expected value. In other words, you may want to do a "what if" analysis or sensitivity analysis.

To understand the nature of a sensitivity analysis, let us consider an example. Suppose you are the financial manager of Naveen Flour Mills. Naveen is considering setting up a new flour mill near Bangalore. Based on Naveen's previous experience, the project staff of Naveen has developed the figures shown in Exhibit 11.1. (Note that the salvage value has been assumed to be nil.)

Exhibit 11.1 ***Cash Flow Forecast for Naveen's Flour Mill Project***

		(Rs in '000)
	Year 0	*Years 1–10*
1. Investment	(20,000)	
2. Sales		18,000
3. Variable costs ($66^2/_3$% of sales)		12,000
4. Fixed costs		1,000
5. Depreciation		2,000
6. Pre-tax profit		3,000
7. Taxes		1,000
8. Profit after taxes		2,000
9. Cash flow from operation		4,000
10. Net cash flow	(20,000)	4,000

Since the cash flow from operations is an annuity, the *NPV* of the flour mill project is:

$-20{,}000{,}000 + 4{,}000{,}000 \times PVIFA(r = 12\%, n = 10)$

$-20{,}000{,}000 + 4{,}000{,}000\ (5.650)$

$= 2{,}600{,}000$

The *NPV* based on the expected values of the underlying variables looks positive. You are, however, aware that the underlying variables can vary widely and hence you would like to explore the effect of such variations on the *NPV*. So you define the optimistic and pessimistic estimates for the underlying variables. These are shown in the left hand columns of Exhibit 11.2. With this information, you can calculate the *NPV* for the optimistic and pessimistic values of each of the underlying variables.

Exhibit 11.2 ***Sensitivity of NPV to Variations in the Value of Key Variables***

Rs in million

	Range			*NPV*		
Key Variable	*Pessimistic*	*Expected*	*Optimistic*	*Pessimistic*	*Expected*	*Optimistic*
Investment (Rs in million)	24	20	18	−0.65	2.60	4.22
Sales (Rs in million)	15	18	21	−1.17	2.60	6.40
Variable costs as a percent of sales	70	66.66	65	0.34	2.60	3.73
Fixed costs	1.3	1.0	0.8	1.47	2.60	3.33

To do this, vary one variable at a time. For example, to study the effect of an adverse variation in sales (from the expected Rs 18 million to the pessimistic Rs 15 million), you maintain the values of the other underlying variables at their expected levels. (This means that the investment is held at Rs 20 million, variable costs as a proportion of sales are held at $66^2/_3$ percent, fixed costs are held at Rs 1 million, so on and so forth.)

The *NPV* when the sales are at their pessimistic level and other variables at their expected level is shown on the right side of Exhibit 11.2. Likewise you can calculate the effect of variations in the values of the other underlying variables. The *NPV*s for the pessimistic, expected, and optimistic forecasts are shown on the right side of Exhibit 11.2.

Evaluation

A very popular method for assessing risk, sensitivity analysis has certain *merits*:

- It shows how robust or vulnerable a project is to changes in values of the underlying variables.
- It indicates where further work may be done. If the net present value is highly sensitive to changes in some factor, it may be worthwhile to explore how the variability of that critical factor may be contained.

- It is intuitively a very appealing as it articulates the concerns that project evaluators normally have.

Notwithstanding its appeal and popularity, sensitivity analysis suffers from several *shortcomings*:

- It merely shows what happens to *NPV* when there is a change in some variable, without providing any idea of how likely that change will be.
- Typically, in sensitivity analysis only one variable is changed at a time. In the real world, however, variables tend to move together.
- It is inherently a very subjective analysis. The same sensitivity analysis may lead one decision maker to accept the project while another may reject it.

11.3 SCENARIO ANALYSIS

In sensitivity analysis, typically one variable is varied at a time. If variables are interrelated, as they are most likely to be, it will be helpful to look at some plausible scenarios, each scenario representing a consistent combination of variables.

Procedure

The steps involved in scenario analysis are as follows:

1. Select the factor around which scenarios will be built. The factor chosen must be the largest source of uncertainty for the success of the project. It may be the state of the economy or interest rate or technological development or response of the market.
2. Estimate the values of each of the variables in investment analysis (investment outlay, revenues, costs, project life, and so on) for each scenario.
3. Calculate the net present value and/or internal rate of return under each scenario.

Illustration

Zen Enterprises is evaluating a project for introducing a new product. Depending on the response of the market—the factor which is the largest source of uncertainty for the success of the project—the management of the firm has identified three scenarios:

Scenario 1 : The product will have a moderate appeal to customers across the board at a modest price.

Scenario 2 : The product will have a strong appeal to a large segment of the market which is highly price-sensitive.

Scenario 3 : The product will appeal to a small segment of the market which will be willing to pay a high price.

Exhibit 11.3 shows the net present value calculation for the project.

Exhibit 11.3 ***Net Present Value Calculation for Three Scenarios***

(Rs in million)

	Scenario 1	*Scenario 2*	*Scenario 3*
Initial investment	200	200	200
Unit selling price (in rupees)	25	15	40
Demand (in units)	20	40	10
Revenues	500	600	400
Variable costs	240	480	120
Fixed costs	50	50	50
Depreciation	20	20	20
Pre-tax profit	190	50	210
Tax @ 50%	95	25	105
Profit after tax	95	25	105
Annual cash flow	115	45	125
Project life	10 years	10 years	10 years
Salvage value	0	0	0
Net present value (at a discount rate of 15 percent)	377.2	25.9	427.4

Best and Worst Case Analysis

In the above illustration, an attempt was made to develop scenarios in which the values of the variables were internally consistent. For example, high selling price and low demand typically go hand in hand. Firms often do another kind of scenario analysis called the best case and worst case analysis. In this kind of analysis the following scenarios are considered:

Best Scenario	High demand, high selling price, low variable cost, and so on.
Normal Scenario	Average demand, average selling price, average variable cost, and so on.
Worst Scenario	Low demand, low selling price, high variable cost, and so on.

The objective of such a scenario analysis is to get a feel of what happens under the most favourable or the most adverse configuration of key variables, without bothering much about the internal consistency of such configurations.

Evaluation

Scenario analysis may be regarded as an improvement over sensitivity analysis because it considers variations in several variables together.

However, scenario analysis has its own *limitations*:

- It is based on the assumption that there are few well-delineated scenarios. This may not be true in many cases. For example, the economy does not necessarily lie in three discrete states, viz., recession, stability, and boom. It can, in fact, be anywhere on the continuum between the extremes. When a continuum is converted into three discrete states some information is lost.

- Scenario analysis expands the concept of estimating the expected values. Thus in a case where there are 10 inputs, the analyst has to estimate 30 expected values (3 × 10) to do the scenario analysis.

11.4 BREAK-EVEN ANALYSIS

In sensitivity analysis we ask what will happen to the project if sales decline or costs increase or something else happens. As a financial manager, you will also be interested in knowing how much should be produced and sold at a minimum to ensure that the project does not 'lose money'. Such an exercise is called *break-even analysis* and the minimum quantity at which loss is avoided is called the break-even point. The break-even point may be defined in accounting terms or financial terms.

Accounting Break-even Analysis

Suppose you are the financial manager of Naveen Flour Mills. Naveen is considering setting up a new flour mill near Bangalore. Based on Naveen's previous experience, the project staff of Naveen has developed the figures shown in Exhibit 11.4.

Note that the ratio of variable costs to sales is 0.667 (12/18). This means that every rupee of sales makes a contribution of Rs 0.333. Put differently, the contribution margin ratio is 0.333. Hence the break-even level of sales will be:

$$\frac{\text{Fixed costs + Depreciation}}{\text{Contribution margin ratio}} = \frac{1+2}{0.333} = \text{Rs 9 million}$$

Exhibit 11.4 *Cash Flow Forecast for Naveen's Flour Mill Project*

		(Rs in '000)
	Year 0	Years 1–10
1. Investment	(20,000)	
2. Sales		18,000
3. Variable costs ($66^2/_3$% of sales)		12,000
4. Fixed costs		1,000
5. Depreciation		2,000
6. Pre-tax profit		3,000
7. Taxes		1,000
8. Profit after taxes		2,000
9. Cash flow from operation		4,000
10. Net cash flow	(20,000)	4,000

By way of confirmation, you can verify that the break-even level of sales is indeed Rs 9 million.

	Rs in million
Sales	9
Variable costs	6
Fixed costs	1
Depreciation	2
Profit before tax	0
Tax	0
Profit after tax	0

A project that breaks even in accounting terms is like a stock that gives you a return of zero per cent. In both the cases you get back your original investment but you are not compensated for the time value of money or the risk that you bear. Put differently, you forego the opportunity cost of your capital. Hence a project that merely breaks even in accounting terms will have a negative *NPV*.

Financial Break-even Analysis

The focus of financial break-even analysis is on *NPV* and not accounting profit. At what level of sales will the project have a zero *NPV* ?

To illustrate how the financial break-even level of sales is calculated, let us go back to the flour mill project. The annual cash flow of the project depends on sales as follows:

1. Variable costs : 66.67 percent of sales
2. Contribution : 33.33 percent of sales
3. Fixed costs : Rs 1 million
4. Depreciation : Rs 2 million
5. Pre-tax profit : (.333 × Sales) – Rs 3 million
6. Tax (at 33.3%) : .333(.333 Sales – Rs 3 million)
7. Profit after tax : .667 (.333 × Sales – Rs 3 million)
8. Cash flow (4 + 7) : Rs 2 million + .667 (.333 × Sales – Rs 3 million)
   = 0.222 Sales

Since the cash flow lasts for 10 years, its present value at a discount rate of 12 percent is:

$$\begin{aligned} PV \text{ (cash flows)} &= 0.222 \text{ Sales} \times PVIFA \text{ (10 years, 12\%)} \\ &= 0.222 \text{ Sales} \times 5.650 \\ &= 1.255 \text{ Sales} \end{aligned}$$

The project breaks even in *NPV* terms when the present value of these cash flows equals the initial investment of Rs 20 million. Hence, the financial break-even occurs when

$$\begin{aligned} PV \text{ (cash flows)} &= \text{Investment} \\ 1.255 \text{ Sales} &= \text{Rs 20 million} \\ \text{Sales} &= \text{Rs 15.94 million} \end{aligned}$$

Thus, the sales for the flour mill must be Rs 15.94 million per year for the investment to have a zero *NPV*. Note that this is significantly higher than Rs 9 million which represents the accounting break-even sales.

11.5 HILLIER MODEL

Under certain circumstances, the expected net present value and the standard deviation of the net present value may be obtained through analytical derivation. Two cases of such analysis are discussed here: (i) no correlation among cash flows, and (ii) perfect correlation among cash flows.

Uncorrelated Cash Flows

When the cash flows of different years are uncorrelated, the cash flow for year t is independent of the cash flow for the year $t-r$. Put differently, there is no relationship between cash flows from one period to another. In this case the expected net present value and the standard deviation of the net present value are defined as follows:

$$\overline{NPV} = \sum_{t=1}^{n} \frac{\overline{A}_t}{(1+i)^t} - I \qquad (11.3)$$

$$\sigma\,(NPV) = \sum_{t=1}^{n} \left[\frac{\sigma_t^2}{(1+i)^{2t}} \right]^{1/2} \qquad (11.4)^1$$

where $\overline{NPV}$ = expected net present value

$\overline{A}_t$ = expected cash flow for year t

i = risk-free interest rate

I = initial outlay

$\sigma(NPV)$ = standard deviation of the net present value

σ_t = standard deviation of the cash flow for year t

Note that in the above formulae the discount rate is the risk-free interest rate because we try to separate the time value of money and the risk factor. The risk of the project, reflected in $\sigma(NPV)$, is considered in conjunction with $\overline{NPV}$ computed with the risk-free discount rate. If $\overline{NPV}$ is computed using a risk-adjusted discount rate and then if this is viewed along with $\sigma(NPV)$, the risk factor would be counted twice.

1. In Eqs (11.3) and (11.4) we have assumed that the initial investment is known with certainty. The formula can, however, be easily modified to consider the variability of I.

Example A project involving an outlay of Rs 10,000 has the following benefits associated with it:

Year 1		Year 2		Year 3	
Net cash flow	*Probability*	*Net cash flow*	*Probability*	*Net cash flow*	*Probability*
Rs 3,000	0.3	Rs 2,000	0.2	Rs 3,000	0.3
5,000	0.4	4,000	0.6	5,000	0.4
7,000	0.3	6,000	0.2	7,000	0.3

The cash flows of different years are uncorrelated. Calculate $\overline{NPV}$ and $\sigma(NPV)$, assuming that i = 6 percent

$$\overline{NPV} = \sum_{t=1}^{3} \frac{\bar{A}_t}{(1+i)^t} - I$$

$$= \frac{5,000}{(1.06)} + \frac{4,000}{(1.06)^2} + \frac{5,000}{(1.06)^3} - 10,000$$

$$\sigma(NPV) = \left[\sum_{t=1}^{3} \frac{\sigma_t^2}{(1+i)^{2t}}\right]^{1/2}$$

$$= \left[\frac{2,400,000}{(1.06)^2} + \frac{1,600,000}{(1.06)^4} + \frac{2,400,000}{(1.06)^6}\right]^{1/2} = \text{Rs } 2,258$$

Perfectly Correlated Cash Flows

If cash flows are perfectly correlated, the behaviour of cash flows in all periods is alike. This means that if the actual cash flow in one year is α standard deviations to the left of its expected value, cash flows in other years will also be α standard deviations to the left of their respective expected values. Put in other words, cash flows of all years are linearly related to one another. The expected value and the standard deviation of the net present value, when cash flows are perfectly correlated, are as follows:

$$\overline{NPV} = \sum_{t=1}^{n} \frac{\bar{A}_t}{(1+i)^t} - I \tag{11.5}$$

$$(NPV) = \sum_{t=1}^{n} \frac{\sigma_t}{(1+i)^t} \tag{11.6}$$

Example An investment project involves a current outlay of Rs 10,000. The mean and standard deviation of the cash flows, which are perfectly correlated, are as follows

Year	$\bar{A}_t$	σ_t
1	Rs 5,000	1,500
2	3,000	1,000
3	4,000	2,000
4	3,000	1,200

Calculate $\overline{NPV}$ and $\sigma(NPV)$, assuming a risk-free interest rate of 6 percent.

$$\overline{NPV} = \sum_{t=1}^{4} \frac{\bar{A}_t}{(1+i)^t} - I$$

$$= \frac{5,000}{(1.06)} + \frac{4,000}{(1.06)^2} + \frac{5,000}{(1.06)^3} + \frac{3,000}{(1.06)^4} - 10,000$$

$$= \text{Rs } 3,121$$

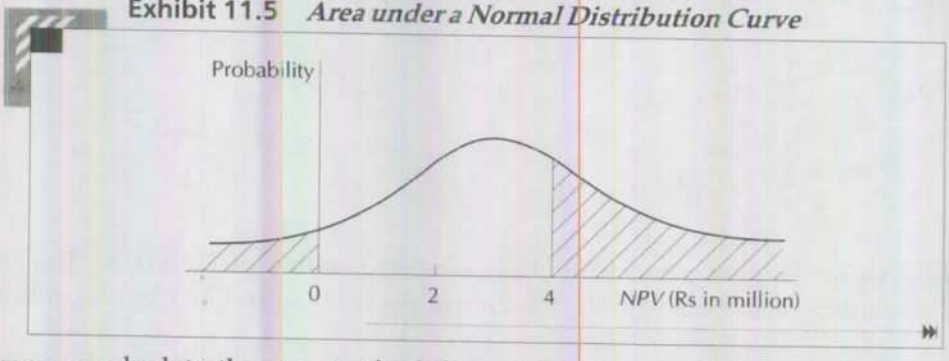
$$\sigma(NPV) = \sum_{t=1}^{4} \frac{\sigma}{(1+i)^t}$$

$$= \frac{1,500}{(1.06)} + \frac{1,000}{(1.06)^2} + \frac{2,000}{(1.06)^3} + \frac{1,200}{(1.06)^4} = \text{Rs } 4,935$$

Standardising the Distribution

Knowledge of $\overline{NPV}$ and $\sigma(NPV)$ is very useful for evaluating the risk characteristics of a project. If the *NPV* of a project is approximately normally distributed, we can calculate the probability of *NPV* being less than or more than a certain specified value. This probability is obtained by finding the area under the probability distribution curve to the left or right of the specified value. Suppose the probability distribution of *NPV* is as shown in Exhibit 11.5. If we want to calculate the probability distribution curve to the left of 0, this is indicated by the shaded region on the left. If we are interested in finding the probability that *NPV* exceeds a certain value, say Rs 4 million, we calculate the area under the probability distribution curve to the right of Rs 4 million—this area is shown as the shaded region on the right.

Exhibit 11.5 ***Area under a Normal Distribution Curve***



How can we calculate the area to the left or right of a specified point? To calculate the area to the left or right of a specified point, we use the following procedure:

Step 1 Standardise the difference between the specified point and $\overline{NPV}$ To do this the difference between the specified point and $\overline{NPV}$ is divided by $\sigma(NPV)$. The standardised difference may be referred to as Z. The purpose of standardisation is to transform the actual distribution of NPV into a standard normal distribution. The standard normal distribution has a mean of 0 and standard deviation of 1. Exhibit 11.6 shows the standard normal distribution and Exhibit 11.7 gives cumulative probability.

Exhibit 11.6 ***Standard Normal Distribution***

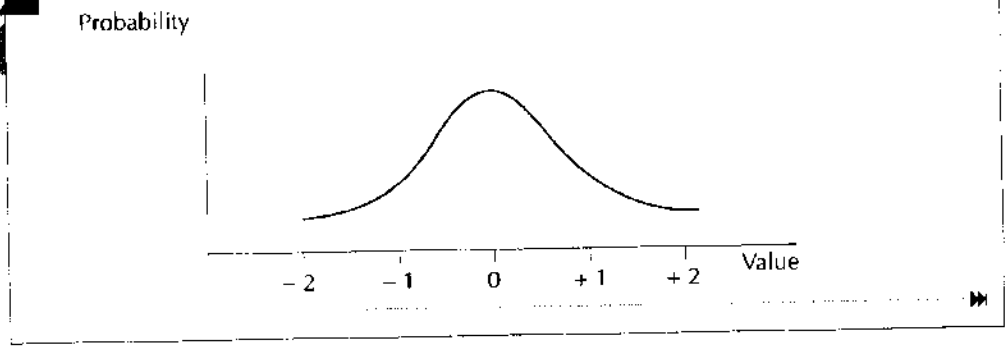


Exhibit 11.7 ***Cumulative Probability up to Z for Standard Normal Distribution***

Z	*Cumulative Probability*	*Z*	*Cumulative Probability*
–3.0	0.001	0.2	0.579
–2.8	0.003	0.4	0.655
–2.6	0.005	0.6	0.726
–2.4	0.008	0.8	0.788
–2.2	0.014	1.0	0.841
–2.0	0.023	1.2	0.885
–1.8	0.036	1.4	0.919
–1.6	0.055	1.6	0.945
–1.4	0.081	1.8	0.964
–1.2	0.115	2.0	0.977
–1.0	0.159	2.2	0.986
–0.8	0.212	2.4	0.992
–0.6	0.274	2.6	0.995
–0.4	0.345	2.8	0.997
–0.2	0.421	3.0	0.999
–0.0	0.500		

Step 2 Refer to the standard normal distribution table and find the probability to the left (or right depending on our interest) of the Z value obtained in Step 1.

To illustrate the above procedure suppose that a project's $\overline{NPV}$ and $\sigma(NPV)$ are Rs 96,000 and Rs 60,000 respectively and we want to find the probability that *NPV* will be less than 0. This may be done as follows.

Step 1 The standardised difference between the specified point ($NPV = 0$) and $\overline{NPV} = 96{,}000$ is

$$= \frac{0 - 96{,}000}{60{,}000} = -1.6$$

Step 2 The cumulative probability up to $Z = -1.6$ as seen from the standard normal distribution is .055. This means that there is a 5.5 percent chance that *NPV* will be equal to or less than 0.

11.6 SIMULATION ANALYSIS

Sensitivity analysis indicates the sensitivity of the criterion of merit (*NPV*, *IRR*, or any other) to variations in basic factors and provides information of the following type: If the quantity produced and sold decreases by 1 percent, other things being equal, the *NPV* falls by 6 percent. Such information, though useful, may not be adequate for decision making. The decision maker would also like to know the likelihood of such occurrences. This information can be generated by simulation analysis which may be used for developing the probability profile of a criterion of merit by randomly combining values of variables which have a bearing on the chosen criterion.

Procedure

The steps involved in simulation analysis are as follows:

1. Model the project. The model of the project shows how the net present value is related to the parameters and the exogenous variables. (Parameters are input variables specified by the decision maker and held constant over all simulation runs. Exogenous variables are input variables which are stochastic in nature and outside the control of the decision maker.)
2. Specify the values of the parameters and the probability distributions of the exogenous variables.
3. Select a value, at random, from the probability distributions of each of the exogenous variables.
4. Determine the net present value corresponding to the randomly generated values of the exogenous variables and the pre-specified parameter values.
5. Repeat steps (3) and (4) a number of times to get a large number of simulated net present values.
6. Plot the frequency distribution of the net present value.

Illustration

In real life situations, simulation is done only on the computer because of the computational tedium involved. However, to give you an idea of what goes on in simulation, we will work with a simple example where simulation has been done manually.

Zenith Chemicals is evaluating an investment project whose net present value has been modelled as follows:

$$NPV = \sum_{t=1}^{n} \frac{\text{Annual Cash Flow}}{(1 + \text{Risk} - \text{Free Rate})} - \text{Initial Investment} \qquad (11.7)$$

In the *NPV* model embodied in Eq.(11.7), the risk-free rate and the initial investment are parameters with the following values: risk-free rate = 10 percent and initial investment = Rs 13,000. The annual cash flow and the project life (n) are stochastic exogenous variables with the following distributions:

Annual Cash Flow

Value	Probability
Rs 1,000	0.02
1,500	0.03
2,000	0.15
2,500	0.15
3,000	0.30
3,500	0.20
4,000	0.15

Project Life

Value	Probability
3 years	0.05
4	0.10
5	0.30
6	0.25
7	0.15
8	0.10
9	0.03
10	0.02

The firm wants to perform 10 manual simulation runs for this project. To perform the simulation runs, we have to generate values, at random, for the two exogenous variables: annual cash flow and project life. For this purpose, we have to (i) set up the correspondence between the values of the exogenous variables and the random numbers, and (ii) choose some random number generating device. Exhibit 11.8 shows the correspondence between the various variables and two-digit random numbers. Exhibit 11.9 presents a table of random digits that will be used for obtaining two-digit random numbers.[2]

Now we are ready for simulation. In order to obtain random numbers from Exhibit 11.9 we may begin anywhere at random in the table and read any pair of adjacent columns (since we are interested in a two-digit random number) and read column-wise or row-wise.

For our example, let us use the first two columns of Exhibit 11.9. Starting from the top, we will read down the column. For the first simulation run we need two two-digit random numbers, one for the annual cash flow and the other for the project life. These numbers are 53 and 97 and the corresponding values for the annual cash flow and project life are Rs 3,000 and 9 years respectively. We go further in this manner. Exhibit 11.10 shows the random numbers so obtained and the result of simulation.

2. Extracted from Rand Corporation, *A Million Random Digits with 100,000 Normal Deviates*, Glencoe, Illinois: The Free Press.

Exhibit 11.8 ***Correspondence between Values of Exogenous Variables and Two Digit Random Numbers***

Annual Cash Flow				Project Life			
Value	Probability	Cumulative probability	Two digit random numbers	Value	Probability	Cumulative probability	Two-digit random numbers
Rs				Years			
1,000	.02	.02	00 to 01	3	.05	.05	00 to 04
1,500	.03	.05	02 to 04	4	.10	.15	05 to 14
2,000	.15	.20	05 to 19	5	.30	.45	15 to 44
2,500	.15	.35	20 to 34	6	.25	.70	45 to 69
3,000	.30	.65	35 to 64	7	.15	.85	70 to 84
3,500	.20	.85	65 to 84	8	.10	.95	85 to 94
4,000	.15	1.00	86 to 99	9	.03	.98	95 to 97
				10	.02	1.00	98 to 99

Exhibit 11.9 ***Random Numbers***

53479	81115	98036	12217	59526
97344	70328	58116	91964	26240
66023	38277	74523	71118	84892
99776	75723	03172	43112	83086
30176	48979	92153	38416	42436
81874	83339	14988	99937	13213
19839	90630	71863	95053	55532
09337	33435	53869	52769	18801
31151	58925	40823	41330	21093
67619	52515	03037	81699	17106

Exhibit 11.10 ***Simulation Results***

Run	Annual Cash Flow		Project Life		Net present value
	Random number	Corresponding value of annual flow	Random number	Corresponding value of project life	
1	53	3,000	97	9	4277
2	66	3,500	99	10	8506
3	30	2,500	81	7	(829)
4	19	2,000	09	4	(7660)
5	31	2,500	67	6	(2112)
6	81	3,500	70	7	4039
7	38	3,000	75	7	1605
8	48	3,000	83	7	1605
9	90	4,000	33	5	2163
10	58	3,000	52	6	66

Obtaining Probability Distributions of Basic Variables

Defining the probability distributions of basic variables is an important step in simulation. In defining these distributions it must be borne in mind that often it is impossible to find the true distributions. The distributions that are defined in practice are based on the judgment of experts. Great care should be exercised in translating the judgment of experts into probability distributions.

Two approaches may be used for obtaining probability distributions. These may be called the *'portrait'* approach and the *'building block'* approach.

The portrait approach is similar to the portrait method used for identifying suspects. According to this approach a standard probability distribution (normal, beta, chi-square, poisson, uniform, exponential, or any other) is drawn up, usually by a statistician, on the basis of the judgment expressed by the expert (informant). This is shown to the expert for his comments. The expert may suggest changes if the distribution does not conform with his judgment. For example, he may suggest that the probabilities at the tails should be greater or the probability of the modal value should be higher. The statistician modifies the earlier distribution to incorporate these changes till the expert is satisfied that the probability distribution represents his judgment well.

This method suffers from a major limitation. The expert may accept a smooth distribution because he may be beguiled by the appearance of smooth curves and charmed by complicated formulae.

In the second approach, the probability distribution is defined by the expert. He attempts to quantify his judgment by a procedure which is as follows: (i) he chooses the range encompassing possible values; (ii) he divides the range into intervals which he thinks have different probabilities associated with them; (iii) he assigns probabilities to these intervals such that $\sum p_i = 1$; (iv) he may divide intervals into sub-intervals if he feels that the probabilities within an interval are different; and (v) he continues this process till he arrives at a distribution which represents his judgment well.

This process often leads to a step rectangular distribution and has the following advantages: (i) the expert has complete freedom in expressing his judgment; and (ii) it squares well with the principle of using all available information, no more no less.

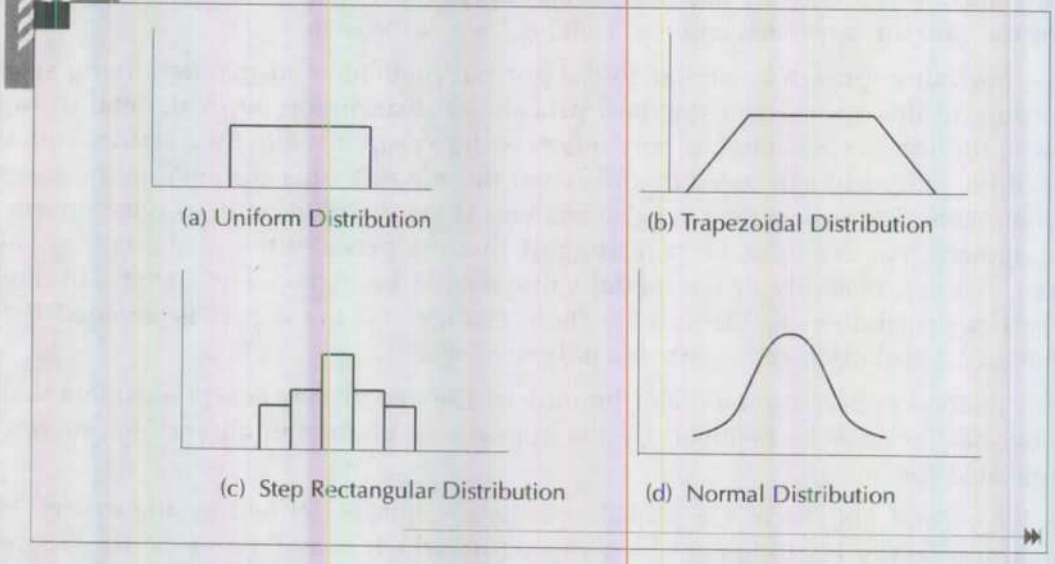
Some Commonly Used Distributions

Defining probability distributions for the variables which reflect expert judgment is a very critical element of risk analysis. It is also regarded as one of the most troublesome aspects of risk analysis. In this context we may ask: How useful are certain distributions in reflecting expert judgments? To answer this question, we will look at the following distributions and consider their utility:

- Uniform distribution
- Trapezoidal distribution
- Step rectangular distribution
- Normal distribution

These distributions are shown graphically in Exhibit 11.11.

Exhibit 11.11 ***Some Probability Distributions***



Uniform Distribution This distribution may be employed where the expert, because of vagueness in his judgment, is unable to differentiate between values within the range of the variable. Such a distribution, however, makes very little sense. For example, it may be absurd to claim that the project has an equal probability of costing anywhere between Rs 20 million and Rs 30 million, but will not under any circumstance cost Rs 19.99 million or Rs 30.01 million. Hence, the uniform distribution should be used only for variables which are not critical or when the appraiser wants to play safe by over-estimating the probability of extreme values in the range of the variables.

Trapezoidal Distribution Under normal circumstances, a variable lies in a small range around its best estimate. Under unusual circumstances, of course, it may fall outside this range. However, the likelihood of a value tends to diminish the farther the value is from the range in which it would normally fall. The trapezoidal distribution represents these possibilities rather well. Hence, it appears to reflect a large class of subjective judgments quite satisfactorily.

Step Rectangular Distribution A commonly used distribution in practice, the step rectangular distribution may be viewed as a refinement over the trapezoidal distribution. It

enables the expert to divide the range of possible values into a few intervals and assign different probabilities to these intervals.

Normal Distribution This is a very important theoretical distribution. However, it is of limited use in risk analysis wherein the variations that are sought to be captured are caused neither by statistical errors nor random disturbances.

Problem of Correlation

We considered an example in which it was assumed that the probability distributions of various factors affecting the *NPV* were independent. In practice, correlations may exist among the distribution of several factors. For example, the number of units sold may be correlated with the price per unit.

When such a dependency exists, the factors which are correlated should be considered together. For this purpose, the joint probability distribution of correlated factors has to be developed. This adds immensely to the problem of estimation.

In this context we must consider the choice relating to the level of disaggregation. The nature of this choice may be illustrated with an example. In an investment project the cost of production may be considered at different levels of details as shown in Exhibit 11.12. Now the problem is: To which level of detail should we go? Should we define the probability distribution of cost of production without explicitly considering the probability distribution of various elements like cost of raw materials, cost of fuels and utilities, cost of manpower? Or, should we consider explicitly the distributions of these elements? Should we go further and consider explicitly the distributions of sub-elements like cost of imported raw materials, so on and so forth?

Ideally, the greater the degree of disaggregation, the better it is because it contributes to clarity of judgment. However disaggregated analysis calls for considering correlations explicitly, which is often a difficult task. By limiting the degree of disaggregation we consider correlations implicitly. If we choose to define the probability distribution of cost of production, without doing disaggregated analysis, we do not have to consider explicitly the correlations between, say, cost of raw material and cost of fuel. The distribution of cost of production would implicitly consider this.

The choice of the level of aggregation or disaggregation would be finally based on the trade-off between the advantages of clarity of judgment and the complexities of disaggregated analysis. Since the influence of correlations is more significant than that of the shape of any particular distribution, it may be preferable to limit disaggregation.

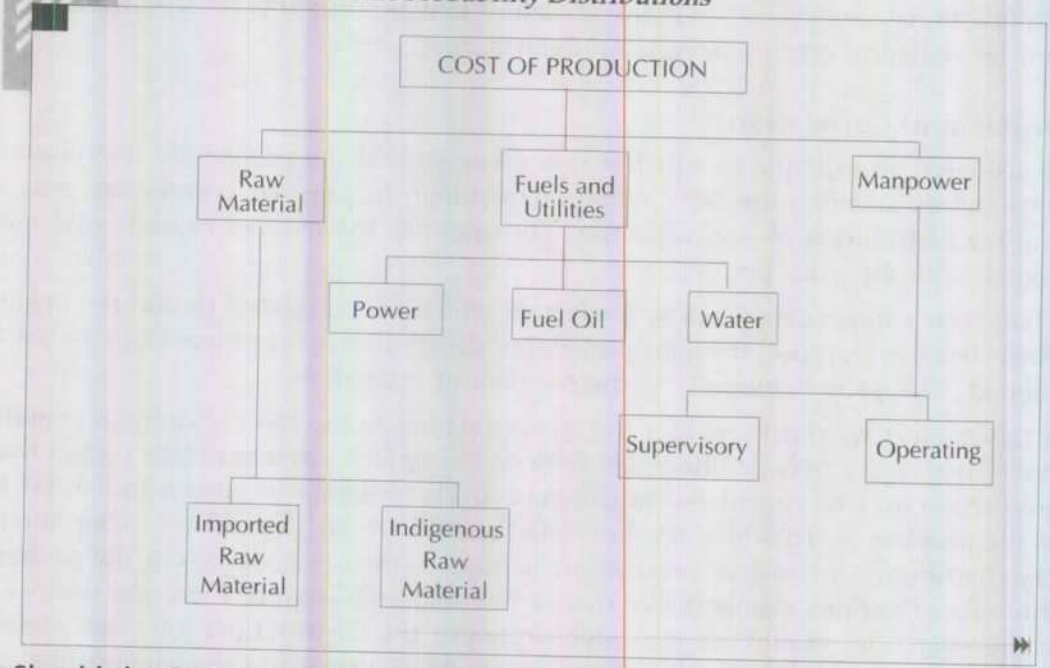
Issues in Applying Simulation

Some of the important issues in the application of simulation are:

- What should the output be?
- Is project variability enough?

- How should the extreme values be used?
- How should the results of simulation be used?

Exhibit 11.12 ***Some Probability Distributions***



What Should the Output Be? Typically the output of simulation is the probability distribution of the internal rate of return or net present value. The problem with the probability distribution of the internal rate of return is that it only shows what the risk will be in the long run. It does not reflect the risk borne by investors in the capital market, which is captured by the distributions of successive one-period rates of return investors will earn, when investment is made in the project.

Is the probability distribution of the net present value a better alternative? Here there is a problem about the discount rate to be used in the net present value calculation. If the cost of capital (which reflects the risk factor) is used as the discount rate, any further risk adjustment would mean double counting. If the risk-free rate of interest is used as the discount rate, then the underlying assumption is that the uncertainty about the project's cash flows would be resolved almost immediately. Since uncertainty is not resolved in this manner, the meaning of the simulated probability distribution is somewhat unclear.

In view of the problems associated with the distributions of the internal rate of return and net present value, it perhaps makes sense to look at the distributions of cash flows (or earnings). If a project has an expected economic life of eight years, the project evaluator may examine eight separate cash flow distributions. These distributions may be scaled by their respective expected values for comparisons to be made between the projects.

Is Project Variability Enough? According to the Capital Asset Pricing Model (this model is discussed in the following chapter), what matters is the systematic (non-diversifiable) risk of an investment and not its unsystematic (diversifiable) risk. Simulation can provide information on the total risk (which consists of systematic risk plus unsystematic risk), but it cannot separately show the systematic risk. Hence, a user of simulation must regard total risk as a proxy for systematic risk. Even though this is a strong assumption, it may not be unreasonable because empirical studies show a fairly reliable association between systematic risk and various measures of earnings volatility. Further, systematic risk tends to be proportional to total risk for firms operating in a single homogeneous industry.

How Should the Extreme Values be Interpreted? The proponents of simulation argue that, *inter alia*, it helps in answering questions like "What is the probability that *NPV* would be less than zero?" or "What is the probability that *IRR* would be less than *x* per cent?" These questions can be answered satisfactorily when the "tails" of the simulated distribution are reliable. However, the tails tend to be the least reliable part of the simulated distribution.

There is yet another, and perhaps more fundamental, problem in interpreting the tails of the simulated distribution. When a simulation model is constructed, it is assumed that the management will follow a strategy based on the general business conditions it expects to encounter. Hence, the model cranks out numbers on the basis of "business-as-usual" strategy even when it runs into surprises. In real life situations, however, managements modify their strategies to cope with surprises. When adverse developments occur, new actions are likely to be initiated. In extreme cases, the project may be abandoned to save future losses. Thus, the tails of the simulated distribution, which are important elements in risk assessment, are likely to reflect unrealistic management strategies.

How Should the Results of Simulation be Used? Hertz[3] advocated simulation on the grounds that a probability distribution of the criterion of merit (*NPV* or *IRR*) leads to better decisions. This implies that a decision maker is able to reach a decision on the basis of the probability distribution. Not many executives, however, may be capable of reviewing the probability distribution of a project's *NPV* or *IRR* and deciding confidently whether the project is worthwhile or not. (Of course, there will be some projects which will be sure winners and some projects which will be losers -in these cases, however, simulation itself may be redundant.) A better approach to use the results of simulation may call for a two-stage decision making process, namely:

Stage 1 Review the probability distributions of the project (i.e., probability distributions of cash flows, *IRR*, etc.) along with other factors and make an assessment.

3. David B. Hertz, "Risk Analysis in Capital Investment," *Harvard Business Review* (Jan—Feb 1964), pp 95–106.

Stage 2 Define the appropriate discount rate to be employed on the basis of the business risk assessment in Stage 1.

World Bank's Experience

It may be instructive here to review the experience of the World Bank. The following are its summary remarks on simulation:

1. Simulation is a powerful technique which permits use of a great deal of information which would otherwise be lost.
2. It is a highly efficient medium of communication.
3. It is not a technique which replaces skilled judgment. On the contrary, it often requires the use of far more judgment than in the traditional analysis.
4. Despite the method's value, the treatment of correlations between variables remains a major problem. It is clear that results can be completely misleading if correlations are not handled properly.

Evaluation

An increasingly popular tool of risk analysis, simulation offers certain *advantages*:

- Its principal strength lies in its versatility. It can handle problems characterised by (a) numerous exogenous variables following any kind of distribution, and (b) complex interrelationships among parameters, exogenous variables, and endogenous variables. Such problems often defy the capabilities of analytical methods.
- It compels the decision maker to explicitly consider the interdependencies and uncertainties characterising the project.

Simulation, however, is a controversial tool which suffers from several *shortcomings* which are as follows:

- It is difficult to model the project and specify the probability distributions of exogenous variables.
- Simulation is inherently imprecise. It provides a rough approximation of the probability distribution of the net present value (or any other criterion of merit). Due to its imprecision, the simulated probability distribution may be misleading when a tail of the distribution is critical.
- A realistic simulation model, likely to be complex, would most probably be constructed by a management scientist, not the decision maker. The decision maker, unable to understand the model, may not use it.
- To determine the net present value in a simulation run the risk-free discount rate is used. This is done to avoid prejudging risk which is supposed to be reflected in the dispersion of the distribution of the net present value. Thus the measure of the net present value takes a meaning, very different from its usual one, that is difficult to interpret.

11.7 DECISION TREE ANALYSIS

The scientists at Pharmalab have come up with a new molecule. The firm is ready for pilot production which is estimated to cost Rs 8 million and take one year. If the results of the pilot production are encouraging, the next step would be to test market the product. This will cost Rs 3 million and take two months. Based on the outcome of the test marketing, a manufacturing decision may be taken. The firm may, however, skip the test marketing phase and take a decision whether it should manufacture the product or not. If the firm decides to manufacture the product commercially, it is confronted with two options: a small plant or a large plant. This decision hinges mainly on the size of the market. While the level of demand in the short-run may be gauged by the results of the test market, the demand in the long-run would depend on how satisfied the initial users are.

If the firm builds a large plant initially, it can cater to the needs of the market when demand growth is favourable. However, if the demand turns out to be weak, the plant would operate at a low level of capacity utilisation. If the firm builds a small plant, to begin with, it need not worry about a weak market and the consequent low level capacity utilisation. However, if the market turns out to be strong it will have to build another plant soon (and thereby incur a higher total outlay) in order to save itself from competitive encroachment.

To analyse situations of this kind where sequential decision making in the face of risk is involved, decision tree analysis is a useful tool. This section discusses the technique of decision tree analysis.

Steps in Decision Tree Analysis

The key steps in decision tree analysis are:

1. Identifying the problem and alternatives
2. Delineating the decision tree
3. Specifying probabilities and monetary outcomes
4. Evaluating various decision alternatives

Identifying the Problem and Alternatives To understand the problem and develop alternatives, information from different sources—marketing research, engineering studies, economic forecasting, financial analysis, etc.—has to be tapped. Imaginative effort must be made to identify the nature of alternatives that may arise as the decision situation unfolds itself and assess the kinds of uncertainties that lie ahead with respect to market size, market share, prices, cost structure, availability of raw material and power, technological changes, competitive action, and governmental regulation.

Recognising that risk and uncertainty are inherent characteristics of investment projects, persons involved in analysing the situation must be encouraged to freely express their

doubts, uncertainties, and reservations and motivated to suggest contingency plans and identify promising opportunities in the emerging environment.

Delineating the Decision Tree The decision tree, exhibiting the anatomy of the decision situation, shows:

- The decision points (also called decision forks) and the alternative options available for experimentation and action at these decision points.
- The chance points (also called chance forks) where outcomes are dependent on a chance process and the likely outcomes at these points.

The decision tree reflects in a diagrammatic form the nature of the decision situation in terms of alternative courses of action and chance outcomes which have been identified in the first step of the analysis.

A decision tree can easily become very complex and cumbersome if an attempt is made to consider the myriad possible future events and decisions. Such a decision tree, however, is not likely to be a very useful tool of analysis. Over-elaborate, it may obfuscate the critical issues. Hence an effort should be made to keep the decision tree somewhat simple so that the decision makers can focus their attention on major future alternatives without being drowned in a mass of trivia. One must remember the advice of Brealey and Myers: "Decision trees are like grapevines; they are productive only if vigorously pruned."[3]

Specifying Probabilities and Monetary Values for Outcomes Once the decision tree is delineated, the following data have to be gathered:

- Probabilities associated with each of the possible outcomes at various chance forks.
- Monetary value of each combination of decision alternative and chance outcome.

The probabilities of various outcomes may sometimes be defined objectively. For example, the probability of a good monsoon may be based on objective, historical data. More often, however, the possible outcomes encountered in real life are such that objective probabilities for them cannot be obtained. How can you, for example, define objectively the probability that a new product like an electric mc ed will be successful in the market? In such cases, probabilities have to be necessarily defined subjectively. This does not, however, mean that they are drawn from a hat. To be useful they have to be based on the experience, judgment, intuition, and understanding of informed and knowledgeable executives. Assessing the cash flows associated with various possible outcomes, too, is a difficult task. Again, the judgment of experts play an important role.

Evaluating the Alternatives Once the decision tree is delineated and data about probabilities and monetary values gathered, decision alternatives may be evaluated as follows:

1. Start at the right-hand end of the tree and calculate the expected monetary value at various chance points that come first as we proceed leftward.

3. Brealey R. and Myers S., *Principles of Corporate Finance*, New York; McGraw-Hill Company, 1981, p. 212.

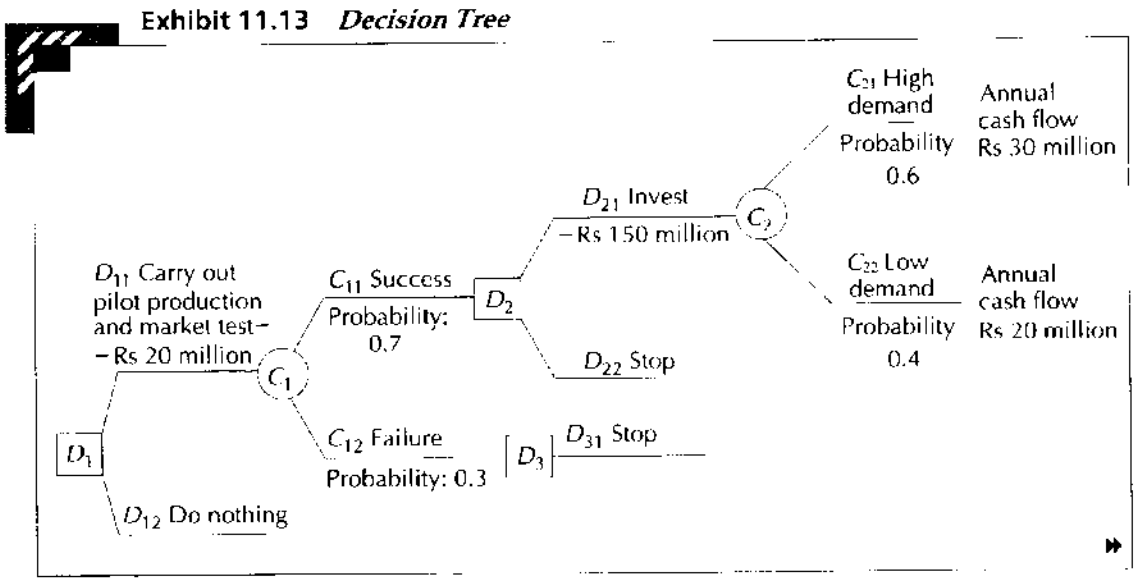
2. Given the expected monetary values of chance points in Step 1, evaluate the alternatives at the final stage decision points in terms of their expected monetary values.
3. At each of the final stage decision points, select the alternative which has the highest expected monetary value and truncate the other alternatives. Each decision point is assigned a value equal to the expected monetary value of the alternative selected at that decision point.
4. Proceed backward (leftward) in the same manner, calculating the expected monetary value at chance points, selecting the decision alternative which has the highest expected monetary value at various decision points, truncating inferior decision alternatives, and assigning values to decision points, till the first decision point is reached.

A Simple Example

The scientists at Spectrum have come up with an electric moped. The firm is ready for pilot production and test marketing. This will cost Rs 20 million and take six months. Management believes that there is a 70 percent chance that the pilot production and test marketing will be successful. In the case of success, Spectrum can build a plant costing Rs 150 million. The plant will generate an annual cash inflow of Rs 30 million for 20 years if the demand is high or an annual cash inflow of Rs 20 million if the demand is low. High demand has a probability of 0.6; low demand has a probability of 0.4. What is the optimal course of action using decision tree analysis?

The decision tree for the electric moped project of Spectrum is shown in Exhibit 11.13:

Exhibit 11.13 ***Decision Tree***



The optimal course of action is determined as follows:

1. Start at the right-hand end of the tree and calculate the expected monetary value (*EMV*) at chance point C_2 that comes first as we proceed leftward.

   $EMV\ (C_2) = 0.6\ [30 \times PVIFA\ (20, 12\%)] + 0.4\ [20 \times PVIFA\ (20, 12\%)]$

   = Rs 194.2 million

2. Evaluate the *EMV* of the decision alternatives at D_2 the last stage decision point.

Alternative	*EMV*
D_{21} (Invest Rs 150 million)	Rs 44.2 million
D_{22} (Stop)	0

3. Select D_{21} and truncate D_{22} as $EMV\ (D_{21}) > EMV\ (D_{22})$
4. Calculate the *EMV* at chance point C_1 that comes next as we roll backwards.

   $EMV\ (C_1) = 0.7\ [44.2] + 0.3\ [0]$

   = Rs 30.9 million

5. Evaluate the *EMV* of the decision alternatives at D_1 the first stage decision point

Alternative	*EMV*
D_{11} (Carry out pilot production and market test at a cost of Rs 20 million)	Rs 10.9 million
D_{12} (Do nothing)	0

Based on the above evaluation, we find that the optimal decision strategy is as follows: Choose D_{11} (carry out pilot production and market test) at the decision point D_1 and wait for the outcome at the chance point C_1. If the outcome at C_1 is C_{11} (success), invest Rs 150 million; if the outcome at C_1 is C_{12} (failure) stop.

A Tougher Example

A wildcatter, evaluating a particular basin, is considering three alternatives: (i) He may drill. (ii) He may conduct a seismic experiment costing Rs 20,000 to find the nature of the underlying soil structure and decide on that basis. (iii) He may not do anything.

If he drills, he is likely to find one of the following oil-bearing states: dry, wet, or soaking. A dry well hardly yields anything; a wet well provides a moderate quantity of oil; a soaking well generates a substantial quantity of oil.

If he conducts a seismic experiment, he can learn about the underlying soil structure before deciding whether to drill or not. The underlying soil structure in this case may be one of the following types: no structure, open structure, or closed structure. If no structure is discovered, the prospects of finding oil are bleak, if an open structure is found the prospects of finding oil are fair, and if a closed structure is discovered the prospects of finding oil are bright.

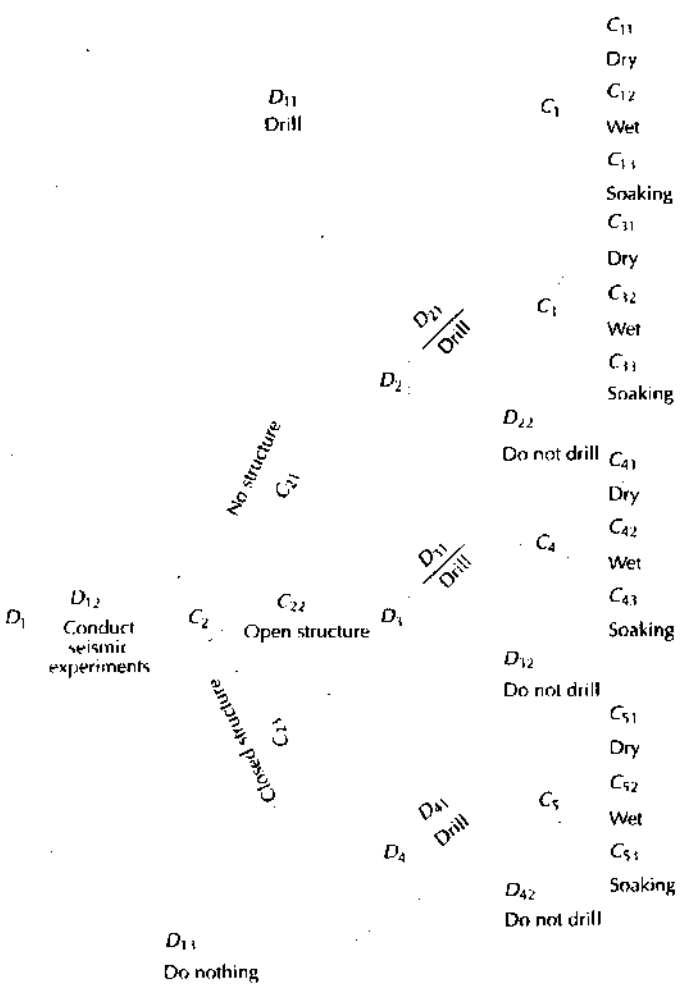
The decision tree corresponding to this situation is shown in Exhibit 11.14. It may be noted that, as a convention, a decision fork is represented by a square and a chance fork by a circle.

With the decision tree delineated, the next phase of analysis calls for gathering information about probabilities and monetary values associated with various outcomes in the decision tree. The wildcatter reviews his experiences, analyses statistics relating to oil discoveries, and consults geological experts. He comes up with the following information:

Probability for Various Oil Bearing States If he drills without conducting seismic experiments then the probabilities for various oil bearing states are:

Oil bearing state	*Probability*
Dry	0.50
Wet	0.25
Soaking	0.25

Exhibit 11.14 ***Decision Tree***



Probabilities for Various Soil Structures If he conducts a seismic experiment he is likely to find the underlying geological structures with probabilities mentioned against them:

Geological structure	*Probability*
No structure (NS)	0.40
Open structure (OS)	0.30
Closed structure (CS)	0.30

Relationship between the Underlying Geological Structures and Oil Bearing States The relationship between the underlying geological structures and oil-bearing states expressed in terms of joint probabilities is as follows:

	Underlying Geological Structure			
Oil-bearing State	*No structure*	*Open structure*	*Closed structure*	*Marginal probability of state*
Dry	0.32	0.15	0.03	0.50
Wet	0.04	0.10	0.11	0.25
Soaking	0.04	0.05	0.16	0.25
Marginal probability of geological structure	0.40	0.30	0.30	1.00

Monetary Values of Outcomes The net present value of cash flows, calculated at 12 percent discount rate, associated with the three states for five years (which is the maximum duration of oil drilling) is given below:

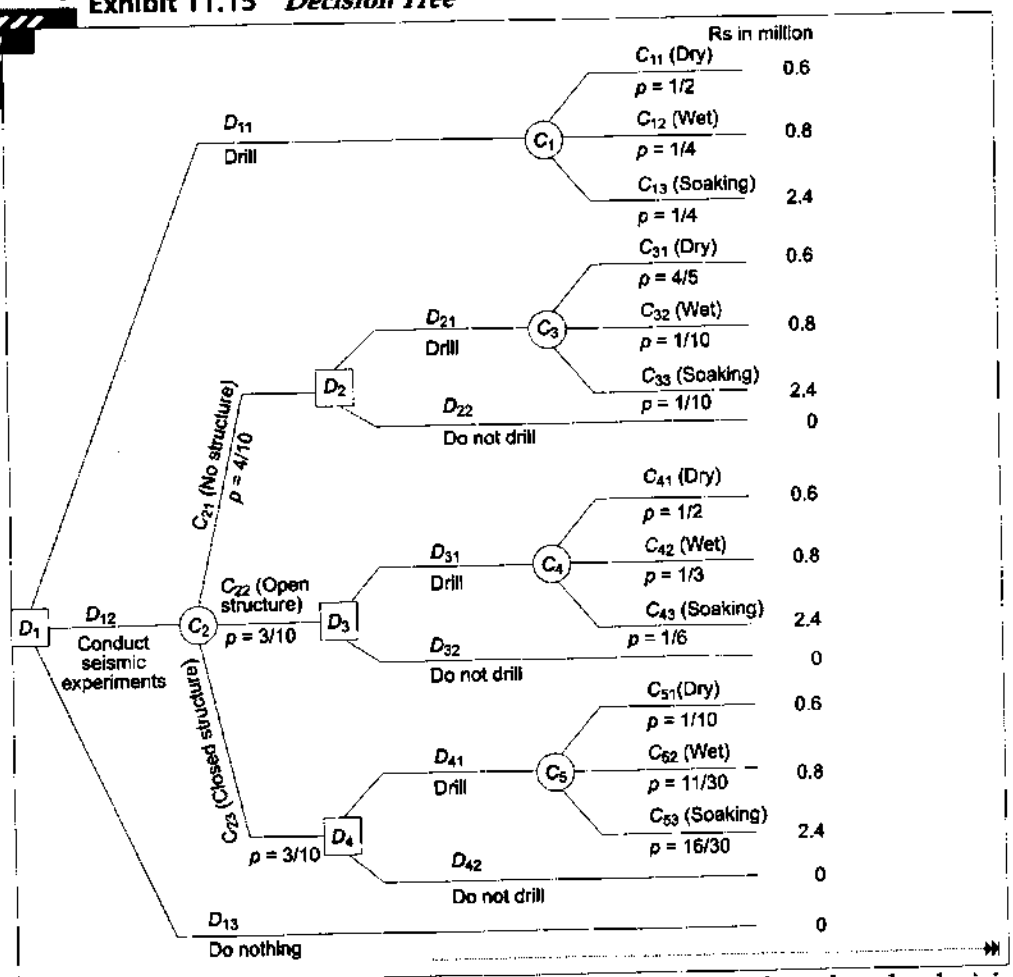
State	*Net present value (Rs in million)*
Dry	–0.6
Wet	0.8
Soaking	2.4

Exhibit 11.15 shows the decision tree incorporating the information regarding probabilities and monetary values of outcomes. With this decision tree we evaluate the alternative courses of action as follows:

1. Starting at the right-hand end of the tree, the expected monetary values (*EMV*s) at chance forks C_1, C_3, C_4, and C_5, which come first as we proceed leftwards, are determined:
   EMV (C_1) = Rs 0.5 million *EMV* (C_3) = – Rs 0.16 million
   EMV (C_4) = Rs 0.367 million *EMV* (C_5) = Rs 1.513 million
2. Given the expected monetary values, the alternatives at the last stage decision points and their expected monetary values are defined as follows:

D_2	D_{21} (Drill)	−0.16
	D_{22} (Do not drill)	0
D_3	D_{31} (Drill)	0.367
	D_{32} (Do not drill)	0
D_4	D_{41} (Drill)	1.513
	D_{42} (Do not drill)	0

Exhibit 11.15 ***Decision Tree***



3. On the basis of the above information, the alternatives selected at the decision points D_2, D_3, and D_4 are D_{22} (do not drill), D_{31} (drill), and D_{41} (drill) respectively. The values assigned to the decision points D_2, D_3, and D_4 are 0, Rs 0.367 million, and Rs 1.513 million respectively.
4. Proceeding leftward the expected monetary value at chance fork C_2 is calculated. Expected monetary value at C_2

$= 0.4 \times 0 + 0.3 \times 3.67 + 0.3 \times 1.513$
$=$ Rs 0.564 million.

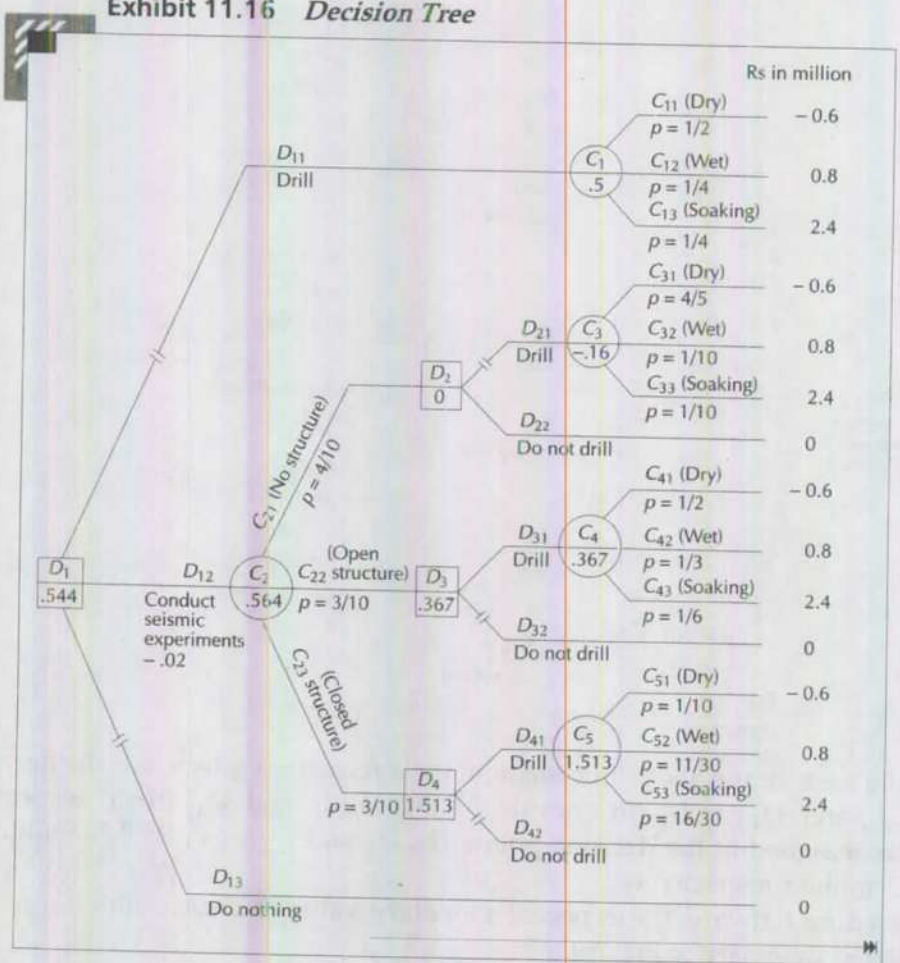
5. Moving leftwards the first stage decision point is reached. The alternatives and their expected monetary values, at this decision point, are:

Alternatives	*Expected monetary value (Rs in million)*
D_{11} (Drill)	0.5
D_{12} (Conduct seismic experiments)	0.544
D_{13} (Do nothing)	0

Looking at the expected monetary values we find that D_{12} (conduct seismic experiments) is the most desirable alternative at the first-stage decision point.

Exhibit 11.16 shows the decision tree with expected values at chance points and decision points.

Exhibit 11.16 *Decision Tree*



Based on the above evaluation of alternatives we find that the optimal decision strategy is as follows:

Choose D_{12} (conduct seismic experiment) at decision point D_1 and wait for the outcome at chance point C_2. If the outcome at C_2 is C_{21} (no structure), then choose C_{22} (do not drill); if the outcome at C_2 is C_{22} (open structure), then choose D_{31} (drill); if the outcome at C_2 is C_{23} (closed structure), then choose D_{41} (drill).

Following the above decision strategy, the decision maker may, depending on the outcome at chance points, traverse paths as shown in Exhibit 11.17.

Exhibit 11.17 ***Paths, Possibilities, and Net Present Values***

Path	*Probability*	*Net Present Value (Rs)*
$D_{12} \rightarrow C_{21} \rightarrow D_{22}$	0.40	–20,000
$D_{12} \rightarrow C_{22} \rightarrow D_{31} \rightarrow C_{41}$	0.15	–620,000
$D_{12} \rightarrow C_{22} \rightarrow D_{31} \rightarrow C_{42}$	0.10	780,000
$D_{12} \rightarrow C_{22} \rightarrow D_{31} \rightarrow C_{43}$	0.05	2,380,000
$D_{12} \rightarrow C_{23} \rightarrow D_{41} \rightarrow C_{51}$	0.03	–620,000
$D_{12} \rightarrow C_{23} \rightarrow D_{41} \rightarrow C_{52}$	0.11	780,000
$D_{12} \rightarrow C_{23} \rightarrow D_{41} \rightarrow C_{53}$	0.16	2,380,000

The mean and standard deviation of the above distribution are:

$\overline{NPV}$ = Rs 544,000, $\quad \sigma(NPV)$ = Rs 1,044,367.

Evaluation

Decision trees are useful for analysing a project that has the following characteristics:

- Decisions on continuing the project are made in well-defined stages.
- The outcomes at each stage fall into few broad classes.
- The probabilities and the cash flows associated with various outcomes can be specified at the beginning of the project. This means that the firm has an experience of doing similar projects in the past.

Obviously, decision tree analysis requires enormous information before it can be applied. The oil drilling project is one case where the required information may be available. However, it may be much more difficult to apply decision tree analysis to a project where the product or service is new and the firm has very little information on how the market will respond to it. Decision trees are also not easy to apply when investments are gradually made over a period of time rather than in a few well-defined stages.

11.8 MANAGING RISK

Managers are not merely content with measuring risk. They want to explore ways and means of mitigating risk. Some of the ways of doing this are discussed below. These risk

reduction strategies have a cost associated with them, and whether they are profitable in a given situation will depend on the circumstances.

Fixed and Variable Cost A common way to modify the risk of an investment is to change the proportion of fixed and variable costs. For example, in the early 1980s Ford Motor Company restructured its operations. Essentially it decided to buy most of its components from outside suppliers instead of manufacturing them in-house. This decreased its fixed costs and increased its variable costs. The net effect was that its break-even level declined.

Pricing Strategy Pricing strategy is used by many firms to manage risk. A lower price increases potential demand, but also raises the break-even level. This is the reason why publishers first bring out a hard-cover edition at a higher price and then introduce a soft-cover edition at a lower price.

Sequential Investment If you are not sure about the market response to your product or service, you may start small and later expand as the market grows. This strategy may entail higher capital cost per unit because capacity is created in stages. However, it reduces risk exposure. You can employ decision tree analysis to hammer out the optimal sequence of investment in the face of risk.

Improving Information An African proverb says "Don't test the depth of a river with both feet". You may like to gather more information about the market and technology before taking the plunge. Additional study often improves the quality of forecasts but involves direct costs (the cost of the study) as well as opportunity costs of delayed action. You have to weigh the costs and benefits of further study and decide how much of additional information should be gathered.

Financial Leverage We discussed how reducing the proportion of fixed operating costs lowers risk. Likewise reducing the dependence on debt lowers risk. Remember that debt entails a definite contractual commitment whereas equity carries no fixed burden. Hence if the operating risk of the project is high, it makes sense to go for a low level of financial leverage.

Insurance You can get an insurance cover against a variety of risks like physical damage, theft, loss of key person, and so on. Insurance is a pure antidote for such risks. Of course, to protect yourself against such risks you have to pay the insurance premium.

Long-term Arrangements One way to mitigate risk is to enter into long-term arrangements with suppliers, employees, lenders, and customers. A long-term contract with suppliers ensures availability of inputs at a predictable price; a long-term wage contract with employees removes uncertainty about employee cost; a long-term debt contract reduces risk about interest rate; finally, a long-term sales contract with customers eliminates revenue risk.

Often long-term contracts are indexed. This means that the prices are periodically adjusted in line with the movement of some index which essentially reflects inflation. For

example, a supply contract may have an escalator clause that links the supply price to some price index like the Wholesale Price Index. Price indexing protects both the buyer and seller against inflation risk because indexing ensures that the real price (price in terms of purchasing power) is constant.

Strategic Alliance When the resources required for a project or the risks inherent in a project are beyond the capacity of a single company, a strategic alliance may be the way out. A strategic alliance, also referred to as a joint venture, represents a partnership between two or more independent companies which join hands to achieve a common purpose. It is usually organised as a newly created company, though the partners may choose any other form of organisation. Typically, the partners partake in the equity of the common enterprise, contribute resources (technology, facilities, distribution networks, brands, key manpower, and so on), and share management and control. The massive resource requirements and huge risks in modern enterprises have compelled many traditional rivals to work together. Competitors are beginning to cooperate leading to a phenomenon called as 'cooptition'.

Derivatives Derivative instruments like options and futures can be used for managing risk. An option gives its owner the right to buy or sell an underlying asset on or before a given date at a predetermined price. An option to buy is a call option. Options give flexibility which is very valuable in volatile markets. For example, a call option embedded in a debt instrument gives the issuing firm the right to prematurely redeem (buy back) the debt instrument at a certain price. Such an option is very valuable when the interest rate falls.

A futures contract is an agreement between two parties to exchange an asset for cash at a predetermined future date for a price that is specified today. Futures contracts eliminate price risk. For example, a refinery may buy an oil futures contract for its oil requirement. Doing so entitles the refinery to get delivery of oil at a specified future date at a price that is fixed today.

11.9 PROJECT SELECTION UNDER RISK

Once information about expected return (measured as net present value, or internal rate of return, or some other criterion of merit) and variability of return (measured in terms of range or standard deviation or some other risk index) has been gathered, the next question is: Should the project be accepted or rejected? There are several ways of incorporating risk in the decision process, namely, judgmental evaluation, payback period requirement, risk profile method, certainty equivalent method, and risk adjusted discount rate method.

Judgmental Evaluation

Often managers look at the risk and return characteristics of a project and decide judgmentally whether the project should be accepted or rejected, without using any formal

method for incorporating risk in the decision making process. The decision may be based on the collective view of some group like the capital budgeting committee, or the executive committee, or the board of directors. If judgmental decision making appears highly subjective or haphazard, consider how most of us make important decisions in our personal life. We rarely use formal selection methods or quantitative techniques for choosing a career or a spouse or an employer. Instead, we rely on our judgment.

Payback Period Requirement

In many situations companies use *NPV* or *IRR* as the principal selection criterion, but apply a payback period requirement to control for risk. Typically, if an investment is considered more risky, a shorter payback period is required even if the *NPV* is positive or the *IRR* exceeds the hurdle rate. This approach assumes that risk is a function of time.

Ordinarily it is true that the farther a benefit lies in the future, the more uncertain it is likely to be because economic and competitive conditions tend to change over time. However, risk is influenced by things other than the mere passage of time. Hence the payback period requirement may not be an adequate method for risk adjustment or control.

Risk Profile Method

To use this method, we first transform the probability distribution of the net present value, an absolute measure, into the probability distribution of profitability index, a relative measure. To illustrate this transformation, let us consider the probability distribution of the net present value of a project, which involves an investment outlay of Rs 100,000, shown in Exhibit 11.18. Since the profitability index is a linear transformation of the net present value, the shape of its probability distribution is identical to that of the probability distribution of the net present value. The probability distribution of the profitability index for our project is shown in Exhibit 11.19. It should be noted that the x axis of Exhibit 11.19 shows the profitability index values corresponding to the net present values shown on the axis of Exhibit 11.18.

Exhibit 11.18 *Probability Distribution of Net Present Value*

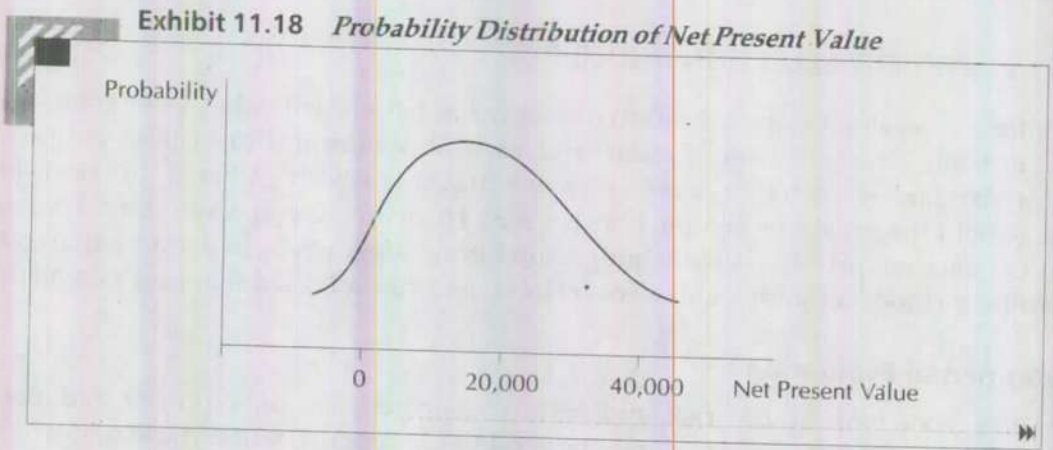
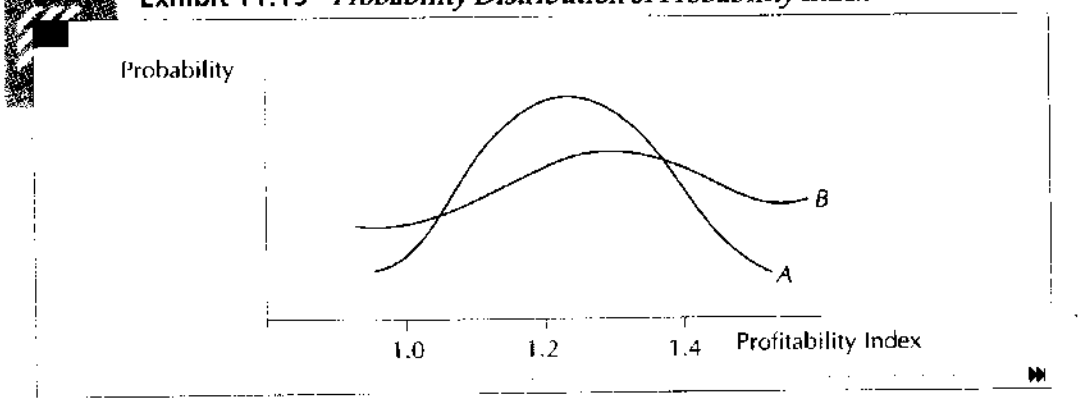


Exhibit 11.19 ***Probability Distribution of Probability Index***



Having transformed the probability distribution of the net present value into the probability distribution of the profitability index, we compare the dispersion of the profitability index of the project with the maximum risk profile acceptable to the management for the expected profitability index of the project. Suppose the maximum risk profile acceptable to the management when the expected profitability index is 1.20 is as shown by curve *B* in Exhibit 11.19. Comparing the dispersions of the profitability distributions *A* and *B* shown in the Exhibit 11.19, we find the risk of the project is less than the maximal risk acceptable to the management for the given level of expected profitability index. Hence the project is deemed worthwhile.

Note that the higher the expected value of profitability index, the greater the dispersion that is acceptable to the management. This is quite understandable. If the expected profitability index is high, the probability that the net present value is negative (profitability index is less than 1) is negligible even if the dispersion is wide.

Risk Adjusted Discount Rate Method

The risk adjusted discount rate method calls for adjusting the discount rate to reflect project risk. If the risk of the project is equal to the risk of the existing investments of the firm, the discount rate used is the average cost of capital of the firm; if the risk of the project is greater than the risk of the existing investments of the firm, the discount rate used is higher than the average cost of capital of the firm; if the risk of the project is less than the risk of the existing investments of the firm the discount rate used is less than the average cost of capital of the firm. The risk adjusted discount rate is:

$$r_k = i + n + d_k \tag{11.8}$$

where r_k = risk adjusted discount rate for project k
i = risk free rate of interest
n = adjustment for the firm's normal risk
d_k = adjustment for the differential risk of project k

It may be noted that $(i+n)$ measures the firm's cost of capital. d_k may be positive or negative depending on how the risk of the project under consideration compares with the existing risk of the firm.

The adjustment for the differential risk of project k, quite understandably, depends on the management's perception of the project risk and the management's attitude towards risk (risk-return preference). A large pharmaceutical concern, for example, uses the following risk adjusted discount rates for various types of investments.

Investment Category	*Risk-adjusted Discount Rate*
Replacement investments	Cost of capital
Expansion investments	Cost of capital + 3%
Investments in related lines	Cost of capital + 6%
Investments in new lines	Cost of capital + 10%

Once the project's risk adjusted discount rate (r_k) is specified, the project is accepted if its net present value, calculated as follows, is positive.

$$NPV = \sum_{t=1}^{n} \frac{\overline{A}_t}{(1+r_k)^t} - I \qquad (11.9)$$

where NPV = net present value of project k
$\overline{A}_t$ = expected cash flow for year t
r_k = risk adjusted discount rate for project k

Example The expected cash flows of a project, which involves an investment outlay of Rs 1,000,000, are as follows:

Year	*Cash flow*
1	Rs 200,000
2	300,000
3	400,000
4	300,000
5	200,000

The risk adjusted discount rate for this project is 18 percent. Is the project worthwhile? The net present value of the project, using the risk adjusted discount rate is:

$$NPV = \frac{200,000}{(1.18)} + \frac{300,000}{(1.18)^2} + \frac{400,000}{(1.18)^3} + \frac{300,000}{(1.18)^4} + \frac{200,000}{(1.18)^5} - 1,000,000$$
$$= -\text{ Rs } 129,440$$

Since the net present value is negative the project is not worthwhile.

The risk adjusted discount rate is commonly employed in practice. Firms use different discount rates, presumably related to the risk factor, for different types of investment projects. The discount rate is generally low for routine replacement investments, moderate for expansion investments, and high for new investments.

Despite its popularity, the risk adjusted discount rate method suffers from two serious limitations: (i) It is difficult to estimate d_k consistently—often it is determined in an extremely ad hoc and arbitrary manner. (ii) This method assumes that risk increases with time at a constant rate. This assumption may not be valid.

Certainty Equivalent Method

Before describing the certainty equivalent method let us understand the concept of certainty equivalent coefficient. Suppose someone presents you with a lottery the outcome of which has the following probability distribution.

Outcome	*Probability*
Rs 1,000	0.3
Rs 5,000	0.7

You are further asked: How much of a certain amount would you accept in lieu of this lottery? Let us say that your reply is: Rs 3,000. This amount– Rs 3,000—represents the certainty equivalent of the above lottery which has an expected value of Rs 3,800 (Rs 1,000 × 0.3 + Rs 5,000 × 0.7) and a given distribution. The factor 3,000/3,800 (= 0.79) is called the certainty equivalent coefficient. It reflects primarily two things: variability of outcomes and your attitude towards risk. Certainty equivalent coefficients transform expected values of uncertain flows into their certainty equivalents.

Under the certainty equivalent method, the net present value is calculated as follows:

$$NPV = \sum_{t=1}^{n} \frac{\alpha_t \overline{A}_t}{(1+i)^t} - I \tag{11.10}$$

where NPV = net present value
$\overline{A}_t$ = expected cash flow for year t
α_t = certainty equivalent coefficient for the cash flow of year t
i = risk-free interest rate
I = initial investment (about which it is assumed that there is no uncertainty)

Example Vazeer Hydraulics Limited is considering an investment proposal involving an outlay of Rs 4,500,000. The expected cash flows and certainty equivalent coefficients are:

Year	*Expected cash flow*	*Certainty equivalent coefficient*
1	Rs 1,000,000	0.90
2	1,500,000	0.85
3	2,000,000	0.82
4	2,500,000	0.78

The risk-free interest rate is 5 percent. Calculate the net present value of the proposal. The net present value is equal to:

$$\frac{1{,}000{,}000\,(0.90)}{(1.05)} + \frac{1{,}500{,}000\,(0.85)}{(1.05)^2} + \frac{2{,}000{,}000\,(0.82)}{(1.05)^3} + \frac{2{,}500{,}000\,(0.78)}{(1.05)^4} - 4{,}500{,}000$$

= Rs 534,570

The value of the certainty equivalent coefficient usually ranges between 0.5 and 1. A value of 1 implies that the cash flow is certain or the management is risk neutral. In industrial situations, however, cash flows are generally uncertain and managements usually risk-averse. Hence the certainty equivalent coefficients are typically less than 1. An illustrative table of certainty equivalent coefficients for different types of investments is shown below:

	Certainty equivalent coefficients			
	Year 1	Year 2	Year 3	Year 4
Replacement investments	0.92	0.87	0.84	0.80
Expansion investments	0.89	0.85	0.80	0.75
New product investments	0.85	0.80	0.74	0.68
Research and development investments	0.75	0.70	0.64	0.58

The certainty equivalent method is conceptually superior to the risk adjusted discount rate method because it does not assume that risk increases with time at a constant rate. Each year's certainty equivalent coefficient is based on the level of risk characterising its cash flow. Despite its conceptual soundness it is not as popular as the risk adjusted discount rate method. This is perhaps because it is inconvenient and difficult to specify a series of certainty equivalent coefficients but seemingly simple to adjust the discount rate. Notwithstanding this practical difficulty, the merits of the certainty equivalent method must not be ignored.

11.10 RISK ANALYSIS IN PRACTICE[4]

Several methods are used in practice to incorporate the risk factor into the capital expenditure analysis. The most common ones are discussed here.

Conservative Estimation of Revenues

In many cases the revenues expected from a project are conservatively estimated to ensure that the viability of the project is not easily threatened by unfavourable circumstances. The capital budgeting systems often have built-in devices for conservative estimation. This is indicated by the following remarks made by two executives:

"We ask the project sponsor to estimate revenues conservatively. This checks the optimism common among project sponsors."

"The capital budgeting committee requires justification for revenue figures given by those who propose capital expenditures. This has a sobering effect on them."

4. The discussion in this section is based on a survey conducted by the author which covered 20 firms. The findings of this survey are reported in "Risk analysis in Capital Expenditures", *Indian Management*, October 1975.

Safety Margin in Cost Figures

A margin of safety is generally included in estimating cost figures. This varies between 10 percent and 30 percent of what is deemed as normal cost. The size of the margin depends on what management feels about the likely variation in cost. The following observation suggests this:

> "In estimating the cost of raw material we add about 20 to 25 percent to the current prices as the raw material price is not stable and often we pay a high price to get it. For labour cost we add about 10 to 12 percent as this is the annual increase."

Flexible Investment Yardsticks

The cut-off point of an investment varies according to the judgment of the management about the riskiness of the project. In one company replacement investments are okayed if the expected post-tax return exceeds 15 percent but new investments are undertaken only if the expected post-tax return is greater than 20 percent. Another company employs a short payback period of three year for new investments. Its decision rule was stated by its financial controller as follows:

> "Our policy is to accept a new project only if it has a payback period of three years. We have never, as far as I know, deviated from this. The use of a short payback period automatically weeds out risky projects."

Acceptable Overall Certainty Index

Some companies calculate what may be called the overall certainty index, based on a few crucial factors affecting the success of the project.

The calculation of an overall certainty index may be illustrated by an example drawn from a large engineering concern. The overall index for a capital expenditure considered by this firm was calculated as follows:

	Certainty index %
Raw material availability	70
Power availability	60
Freedom from competition	80
Overall certainty $\frac{70 + 60 + 80}{3}$ =	70

This company accepted the project because it regarded a 70 percent level of overall certainty as satisfactory.

Judgment on Three Point Estimates

In some companies three estimates are developed for one or more aspects of the proposed investments. The top management or the board of directors decides on the basis of such information. Two examples of this are given as follows:

In a pharmaceutical company sponsors are required to give three estimates of rate of return: most pessimistic, most likely, and most optimistic.

In a shipping company three estimates, labelled high, medium, and low respectively, are developed for proposed investments.

Evaluation

The methods of conservative estimation of revenues, safety margin in cost figures, and flexible investment yardstick, in common practice, do not generally employ explicitly defined probability distributions, which seem alien to current practices. They are based on subjective, implicit evaluations. The three point estimates method is based on three points in the range of variation and provides some idea of probability distribution. The overall certainty index method is based on two-level discrete probability distributions of important factors affecting the outcome of the investments. However, the manner in which these probabilities are used for developing the overall certainty index of a project whose success is dependent on the attainment of three states A, B and C, is $p(A) \times p(B/A) \times p(C/A \& B)$ and not $[p(A) + p(B) + p(C)]/3$ as defined by the overall certainty index method used in practice.

Room for Improvement

A significant improvement in the analysis of the risk factor in practice can be brought about if probability distributions of the key factors underlying investments are developed and information is communicated in this form. This means the use of (i) subjectively understood phrases like the 'most likely return', 'low chances of failure' and (ii) single point estimates will have to be replaced by probability distributions. This has certain advantages:

1. *It would alleviate ambiguity in communication* When judgments about uncertainty are transmitted in qualitative phrases, they are likely to be interpreted in a sense different from what the communicator has in mind because of the vagueness of communication. Such vagueness is reduced if judgments are quantified in terms of probability distribution.
2. *It would reduce bias in reporting* When managers and other informants are asked to provide a single point estimate (a common practice) they often tend to underestimate revenues and overestimate costs when performance evaluation emphasises negative variations. If there is no performance evaluation, revenues may be overestimated and costs underestimated for projecting a favourable picture of a project. Such tendencies may be checked to some extent if managers and other informants are asked to provide probability distributions instead of single point estimates.

3. *It utilises more information* When an expert, say, a market analyst, is asked to give an estimate of market demand in terms of a single number, he has to necessarily discard a good deal of his knowledge about the market which otherwise can be communicated in the form of a probability distribution.
4. *It is convenient* With experience it is easy to express judgments in probabilistic terms than in terms of a single point estimate. Often experts find it convenient to communicate their judgment in terms of a probability distribution rather than in the form of a single point estimate.

11.11 HOW FINANCIAL INSTITUTIONS ANALYSE RISK

To evaluate the risk dimensions of a project, financial institutions calculate several indicators, the most important ones being the break-even point, the debt service coverage ratio, and the fixed assets coverage ratio. In addition, they carry out sensitivity analysis.

Break-Even Point

The break-even point for a project is calculated with reference to the year when the project is expected to reach its target (or expected) level of capacity utilisation, which is usually the third or the fourth operating year. Further, it is calculated in terms of capacity utilisation. So it is called break-even point capacity utilisation (*BEPCU*).

To illustrate the calculation of *BEPCU*, consider the following data for the third year of a project, when it is expected to reach the target capacity utilisation of 70 percent. (The installed capacity of this project is 2880 tonnes per annum and 70 percent of this is 2016 tonnes per annum.)

A. Variable Costs	(Rs in million)
• Raw materials and consumables	137.2
• Power, fuel, and water	24.7
• Variable selling expenses and royalty payments linked to sales	19.2
• Interest on working capital loans	10.8
• Other variable expenses	5.0
	196.9
B. Fixed and Semi-fixed Costs	
• Salaries and wages	22.0
• Repairs and maintenance	2.0
• Administrative and miscellaneous expenses	2.5
• Fixed selling expenses	6.3
• Fixed royalty and know-how payments	3.0
• Interest on term debt	12.0
• Depreciation and amortisations	7.5
	55.3

C. Sales Realisation	265.6
D. Contribution	68.7

$$BEPCU\ (\%) = \frac{\text{Fixed costs and semi} - \text{fixed costs} \times \text{Percentage capacity utilisation}}{\text{Contribution}}$$

$$= \frac{55.3}{68.7} \times 70\% = 56.3\%$$

The cash *BEPCU*, is calculated using the above formula without including depreciation and amortisation as part of the fixed costs.

$$\text{Cash } BEPCU\ (\%) = \frac{47.8}{68.7} \times 70\% = 48.7\%$$

Debt Service Coverage Ratio

The debt service coverage ratio (*DSCR*) is defined as:

$$DSCR = \frac{\text{Profit after tax} + \text{Depreciation and Amortisation} + \text{Interest on term debt} + \text{Lease rentals}}{\text{Repayment of term debt} + \text{Interest on term debt} + \text{Lease rentals}}$$

The average *DSCR* is computed by taking the total of all values of the numerator and denominator for the entire period of the proposed term loans, commencing from the year in which commercial production starts and not by taking the *DSCR*s for each year.

The calculation of *DSCR* is illustrated by an example given in Exhibit 11.20.

Exhibit 11.20 ***Debt Service Coverage Ratio***

Year	1	2	3	4	5	6	7	8	9	10
A. Total Cash Accrual										
1. Profit after tax	0.27	0.81	1.35	1.13	0.99	0.99	0.99	1.01	1.02	1.04
2 Depreciation	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
3 Interest on term loan	1.18	1.18	1.07	0.93	0.78	0.64	0.48	0.33	0.19	0.04
Total (Rs in million)	2.15	2.69	3.12	2.76	2.47	2.33	2.17	2.04	1.91	1.78
B. Debt Service										
1 Interest on term loan	1.18	1.18	1.07	0.93	0.78	0.63	0.48	0.33	0.19	0.04
2 Repayment of term loan	–	0.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.4
Total (Rs in million)	1.18	1.58	1.87	1.73	1.58	1.43	1.28	1.13	0.99	0.44

$$\text{Average } DSCR = \frac{\text{Total cash accrual over the 10 year period}}{\text{Total debt service burden over the 10 year period}} = \frac{23.42}{13.21} = 1.77$$

Sensitivity Analysis

Financial institutions carry out sensitivity analysis to assess the impact of adverse changes in the operating conditions of the project on its viability. The standard sensitivity analysis involves assessing the impact of 10 per cent adverse variation in selling price, quantity, and operating costs on the internal rate of return (*IRR*), debt service coverage ratio (*DSCR*), and break-even point (*BEPCU %*).

Example Here is the sensitivity analysis done for a port project.

Case 1 : Fall in cargo handling and storage charges by 10%. (This is akin to a fall in selling price.)

Case 2 : Fall in cargo by 10%. (This is akin to a fall in quantity.)

Case 3 : Increase in operating costs by 10%.

Case 4 : Combined effect of all the three factors.

The table showing the sensitivity of *IRR*, *DSCR*, and *BEP %* to the above cases is shown below:

	Revenue (3rd year)	*Op.Profit (3rd year)*	*IRR%*	*DSCR*	*BEPCU%*	
	(Rs in mln.)	(Rs in mln)	After Tax	Avg.	Gross	Cash
Base Case	1215.0	566.8	39.89	4.00	39.00	21.13
Case 1	1086.9	438.8	35.24	3.46	44.57	24.15
Case 2	1150.1	519.6	38.02	3.76	40.91	22.17
Case 3	1215.0	538.7	38.82	3.88	40.31	22.11
Case 4	1028.5	371.5	32.50	3.13	48.37	26.53

SUMMARY

- Risk is inherent in almost every business decision. More so in capital budgeting decisions as they involve costs and benefits extending over a long period of time during which many things can change in unanticipated ways.
- Investment proposals differ in risk. A research and development project is typically more risky than an expansion project and the latter tends to be more risky than a replacement project.
- The variety of techniques developed to handle risk in capital budgeting fall into two broad categories: (i) Approaches that consider the stand-alone risk of a project (sensitivity analysis, scenario analysis, break-even analysis, Hillier model, simulation analysis, and decision tree analysis). (ii) Approaches that consider the contextual risk of a project (corporate risk analysis and market risk analysis).

- Sensitivity analysis or "what if" analysis answers questions like: "What happens to *NPV* or *IRR* if sales decline by 5 percent or 10 percent from their expected level?"
- In sensitivity analysis, typically one variable is varied at a time. If variables are interrelated, as they are most likely to be, it is helpful to look at the implications of some plausible scenarios, each scenario representing a consistent combination of variables. Firms often do another kind of scenario analysis called the **best case** and **worst case** analysis.
- As a financial manager, you would be interested in knowing how much should be produced and sold at a minimum to ensure that the project does not 'lose money'. Such an exercise is called break-even analysis and the minimum quantity at which loss is avoided is called the break-even point. The beak-even point may be defined in accounting terms or financial terms.
- Under certain circumstances, the expected *NPV* and the standard deviation of *NPV* may be obtained through analytical derivation, as proposed by H.S. Hillier.
- Sensitivity analysis indicates the sensitivity of the criterion of merit (*NPV*, *IRR* or any other) to variations in basic factors. Though useful, such information may not be adequate for decision making. The decision maker would also like to know the likelihood of such occurrences. This information can be generated by simulation analysis which may be used for developing the probability profile of a criterion of merit by randomly combining values of variables that have a bearing on the chosen criterion.
- Decision tree analysis is a useful tool for analysing sequential decisions in the face of risk. The key steps in decision tree analysis are: (i) Identification of the problem and alternatives. (ii) Delineation of the decision tree. (iii) Specification of probabilities and monetary outcomes. (iv) Evaluation of various decision alternatives.
- A project's corporate risk is its contribution to the overall risk of the firm. Put differently, it reflects the impact of the project on the risk profile of the firm's total cash flows. On a stand-alone basis a project may be very risky but if its returns are not highly correlated—or, even better, negatively correlated—with the returns on the other projects of the firm, its corporate risk tends to be low.
- Once information about expected return (measured as *NPV* or *IRR* or some other criterion of merit) and variability of return (measured in terms of range or standard deviation or some other risk index) has been gathered, the next question is: Should the project be accepted or rejected? There are several ways of incorporating risk in the decision process, namely, judgmental evaluation, payback period requirement, risk profile method, risk adjusted discount rate method, and certainty equivalent method.
- Often managers look at the risk and return characteristics of a project and decide judgmentally whether the project should be accepted or rejected. Although judgmental decision making may appear highly subjective or haphazard, this is how most of us make important decisions in our personal life.
- In many situations companies use *NPV* or *IRR* as the principal selection criterion, but apply a payback period requirement to control for risk. If an investment is considered more risky,

a shorter payback period is required.

- Under the risk profile method, the probability distribution of *NPV*, an absolute measure, is transformed into the probability distribution of profitability index, a relative measure. Then, the dispersion of the profitability index is compared with the maximum risk profile acceptable to the management for the expected profitability index of the project.
- The risk adjusted discount rate method calls for adjusting the discount rate to reflect project risk. If the project risk is the same as the risk of the existing investments of the firm, the discount rate used is the *WACC* of the firm; if the project risk is greater (lesser) than the existing investments of the firm, the discount rate used is higher (lower) than the *WACC* of the firm.
- Under the certainty equivalent method, the expected cash flows of the project are converted into their certainty equivalents by applying suitable certainty equivalent coefficients. Then, the risk-free rate is applied for discounting purposes.
- The methods of risk analysis commonly used in practice are: (i) conservative estimation of revenues, (ii) safety margin in cost figures, (iii) flexible investment yardsticks, (iv) acceptable overall certainty index, and (iv) judgment on three point estimates.
- The analysis of risk factors in practice can be improved if the probability distributions of the key factors underlying an investment project are developed and information is communicated in that form.

Questions

1. List the techniques of risk analysis.
2. Discuss the steps involved in sensitivity analysis.
3. What are the pros and cons of sensitivity analysis?
4. Discuss the steps involved in scenario analysis.
5. What is the best and worst case analysis?
6. What are the pros and cons of scenario analysis?
7. How is accounting break-even analysis done?
8. How is financial break-even analysis done?
9. If cash flows of different years are perfectly uncorrelated, how is the standard deviation of *NPV* defined by the Hillier model?
10. If cash flows of different years are perfectly correlated, how is the standard deviation of *NPV* defined by the Hillier model?
11. Discuss the procedure for simulation analysis.
12. What are the pros and cons of simulation?
13. Discuss the steps involved in decision tree analysis.
14. What are the pros and cons of decision tree analysis?
15. What is the corporate risk of a project?
16. Discuss the following ways of incorporating risk in the investment decision making process: judgmental evaluation, payback period requirement, and risk profile method.

17. Discuss the risk adjusted discount method.
18. Explain the certainty equivalent method.
19. Critically comment on the methods of risk analysis commonly used in practice.
20. What are the advantages of employing the probability distributions of key factors underlying investment decisions.

Problems

1. You are the financial manager of Hindustan Extrusion Products Limited (HEPL) a highly profitable company. HEPL is planning to set up an extrusion plant at Indore. Your project staff has developed the following cash flow forecast for the extrusion plant project.

Cash Flow Forecast for HEPL's Extrusion Plant

	Year 0	*Rs in million Years 1–10*
Investment	(250)	
Sales		200
Variable costs (60% of sales)		120
Fixed costs		20
Depreciation		25
Pre-tax profit		35
Taxes		10
Profit after taxes		25
Cash flow from operations		50
Net cash flow		50

What is the *NPV* of the extraction plant project? Assume that the cost of capital is 13 percent. The range of values that the underlying variables can take is shown below:

Underlying Variable	*Pessimistic*	*Expected*	*Optimistic*
Investment (Rs in million)	300	250	200
Sales (Rs in million)	150	200	275
Variable cost as a percent of sales	65	60	56
Fixed costs (Rs in million)	30	20	15
Cost of capital (%)	14	13	12

(a) Calculate the effect of variations in the values of the underlying variables on *NPV*.

(b) Calculate the accounting break-even point and the financial break-even point. Assume: (i) useful life = 10 years, (ii) salvage value = 0, (iii) depr'n rate of 10% (SLM).

2. Ajeet Corporation is considering the risk characteristics of a certain project. The firm has identified that the following factors, with their respective expected values, have a bearing on the *NPV* of this project.

	(Rs)
Initial investment	30,000
Cost of capital	10%
Quantity manufactured and sold annually	1,400
Price per unit	30
Variable cost per unit	20
Fixed costs	3,000
Depreciation	2,000
Tax rate	50%
Life of the project	5 years
Net salvage value	Nil

Assume that the following underlying variables can take the values as shown below:

Underlying variable	*Pessimistic*	*Optimistic*
Quantity manufactured and sold	800	1800
Price per unit	20	50
Variable cost per unit	15	40

(a) Calculate the sensitivity of the net present value to variations in (a) quantity manufactured and sold, (b) price per unit, and (c) variable cost per unit.

(b) Calculate the accounting break-even point and the financial break-even point.

3. A project involving an outlay of Rs 10 million has the following benefits associated with it.

Year 1		*Year 2*		*Year 3*	
Cash Flow (Rs in mln)	*Prob.*	*Cash Flow (Rs in mln)*	*Prob.*	*Cash Flow (Rs in mln)*	*Prob.*
4	0.4	5	0.4	3	0.3
5	0.5	6	0.4	4	0.5
6	0.1	7	0.2	5	0.2

Assume that the cash flows are independent. Calculate the expected net present value and the standard deviation of net present value assuming that i = 10 percent.

4. Janakiram is considering an investment which requires a current outlay of Rs 25,000. The expected value and standard deviation of cash flows are:

Year	*Expected Value*	*Standard Deviation*
1	Rs 12,000	Rs 5,000
2	10,000	6,000
3	9,000	5,000
4	8,000	6,000

The cash flows are perfectly correlated. Calculate the expected net present value and standard deviation of net present value of this investment, if the risk-free interest rate is 8 percent.

5. Ujwal Lamps Company is considering an investment project which has an estimated life of

four years. The cost of the project is Rs 10,000 and the possible cash flows are given below:

Year 1		Year 2		Year 3		Year 4	
Cash Flow (Rs in mln)	Prob.	Cash Flow (Rs in mln)	Prob.	Cash Flow (Rs in mln)	Prob.	Cash Flow	Prob.
2,000	0.2	3,000	0.4	4,000	0.3	2,000	0.2
3,000	0.5	4,000	0.3	5,000	0.5	3,000	0.4
4,000	0.3	5,000	0.3	6,000	0.2	4,000	0.2

The cash flows of various years are independent and the risk-free discount rate (post-tax) is 6 percent.

(a) What is the expected *NPV*?

(b) If the *NPV* is approximately normally distributed, what is the probability that the *NPV* will be zero or less?

(c) What is the probability that the profitability index will be greater than 1.2?

6. Bidhan Corporation is considering the risk characteristics of a project. The firm has identified that the following factors have a bearing on the *NPV* of this project:

Initial investment	(I)
Cost of capital	(r)
Quantity manufactured and sold annually	(Q)
Price per unit	(P)
Variable cost per unit	(V)
Fixed costs	(F)
Depreciation	(D)
Tax rate	(T)
Life of the project	(n)
Net salvage value	(S)

The relationship between these factors and *NPV* is as follows:

$$NPV = \sum_{t=1}^{n} \frac{[Q(P-V)-F-D](1-T)+D}{(1+r)^t} + \frac{S}{(1+r)^n} - I$$

The management of the firm feels that I, r, F, D, T, n, and S, not subject to much variation, may be deemed as constant at the following levels:

I	=	30,000
r	=	10 percent
F	=	3,000
D	=	2,000
T	=	0.5
n	=	5
S	=	0

The probability distributions for Q, P, and V have been defined as follows:

Q		*P*		*V*	
Value	*Prob.*	*Value*	*Prob.*	*Value*	*Prob.*
800	0.10	Rs 20	0.4	Rs 15	0.3
1000	0.10	30	0.4	20	0.5
1200	0.20	40	0.1	40	0.2
1400	0.30	50	0.1	—	—
1600	0.20	—	—	—	—
1800	0.10	—	—	—	—

(a) Using a random number table, obtain 50 simulated values of *NPV*.
(b) Calculate the mean and standard deviation of *NPV* from the simulated values.

7. Consider the data given in problem 6. Carry out a sensitivity analysis with reference to quantity (*Q*) and price (*P*).
8. After carefully assessing the risk-preference of its management, the Tristar Shipping Company has determined the maximum risk profiles—these show the maximum standard deviation of profitability acceptable for a particular expected value of profitability index. The maximum risk profiles are:

Expected Profitability Index	*Maximum Standard Deviation*
1.0	0.00
1.05	0.03
1.10	0.08
1.15	0.16
1.20	0.25
1.25	0.30

The company is considering an investment proposal involving an outlay of Rs 5 million. The distribution of the net present value is as follows:

Net Present Value	*Probability*
Rs - 500,000	0.02
0	0.03
500,000	0.10
1,000,000	0.40
1,500,000	0.30
2,000,000	0.15

Should the company accept the investment proposal?

9. Kejriwal Company is considering two mutually exclusive investments *A* and *B*. Investment *A* requires an outlay of Rs 10,000 and generates a net cash flow of Rs 3,000 for six years. Investment *B* requires an outlay of Rs 30,000 and generates a net cash flow of Rs 11,000 for five years. The required rates of return on these investments are 12 percent (for *A*) and 14 percent (for *B*). Which of the two should the firm choose?
10. The expected cash flows of a project are as follows:

Year	Cash Flow
0	Rs (30,000)
1	7,000
2	8,000
3	9,000
4	10,000
5	8,000

The certainty equivalent factor behaves as per the following equation: $\alpha_t = 1 - 0.06t$. Calculate the net present value of the project if the risk-free rate of return is 8 percent.

APPENDIX 11A

RULES RELATING TO EXPECTED VALUES AND VARIANCES

Certain rules relating to expected values and variances are giver below:

Rule 1 If c is a constant, its expected value is c.

This is because a constant is a degenerate random variable which always takes the same value, the expected value.

Rule 2 If c is a constant and Y a random variable, then

$$E(cY) = cE(Y) \tag{11A.1}$$

This is because

$$E(cY) = \sum cY_i p(Y_i) = c \sum Y_i p(Y_i)$$
$$= cE(Y)$$

Rule 3 If a and b are constants and Y a random variable, then

$$E(a + bY) = a + bE(Y) \tag{11A.2}$$

This can be obtained by combining rules 1 and 2.

Rule 4 If X and Y are random variables

$$E(X + Y) = E(X) + E(Y) \tag{11A.3}$$

This is because

$$E(X + Y) = \Sigma(X_i + Y_j)\, p(X_i, Y_j)$$
$$-\infty \leq i, j \leq \infty$$
$$= \sum_i \sum_j X_i\, p(X_i, Y_j)$$

$$+ \sum_j \sum_i Y_j p(X_i, Y_j)$$

$$= \sum_i X_i \sum_j p(X_i, Y_j)$$

$$= \sum_j Y_j \sum_i p(X_i, Y_j)$$

$$= \sum_i X_i p(X_i) + \sum_j Y_j p(Y_j)$$

$$= E(X) + E(Y)$$

The generalised form of this rule is

$$E(X_1 + X_2 + X_3 + \ldots + X_n) = E(X_1) + E(X_2) + \ldots E(X_n) \quad (11A.4)$$

Rule 5 If c is a constant, its variance is zero.

This is again because a constant is a degenerate random variable which always takes the same value, the expected value. Hence the deviation is always zero, making variance zero.

Rule 6 If c is a constant and Y a random variable then

$$\text{Var}(cY) = c^2 \text{ Var}(Y) \quad (11A.5)$$

This is because

$$\begin{aligned}\text{Var}(cY) &= E[(cY) - E(cY)]^2 \\ &= E[(cY - cE(Y))]^2 \\ &= E[c\{Y - E(Y)\}]^2 \\ &= c^2 E[Y - E(Y)]^2 \\ &= c^2 \text{ Var}(Y)\end{aligned}$$

Rule 7 If a and b are constants and Y a random variable then

$$\text{Var}(a + bY) = b^2 \text{ Var}(Y) \quad (11A.6)$$

This can be obtained by combining Rules 5 and 6.

Rule 8 If X and Y are random variables, then

$$\text{Var}(X + Y) = \text{Var}(X) + \text{Var}(Y) + 2 \text{ Cov}(X, Y) \quad (11A.7)$$

This is because

$$\begin{aligned}\text{Var}(X + Y) &= E[X + Y - E(X + Y)]^2 \\ &= E[X + Y - E(X) - E(Y)]^2 \\ &= E[X - E(X) + Y - E(Y)]^2 \\ &= E[\{X - E(X)\} + \{Y - E(Y)\}]^2 \\ &= E[X - E(X)]^2 + E\{Y - E(Y)\}^2 \\ &\quad + 2E[X - E(X)][Y - E(Y)]\end{aligned}$$

$$= \text{Var}(X) + \text{Var}(Y) + 2\,\text{Cov}(X, Y)$$

The generalised form of this rule is

$$\begin{aligned}
&\text{Var}(X_1 + X_2 + \ldots + X_n) \\
&= \text{Var}(X_1) + \text{Var}(X_2) + \ldots + \text{Var}(X_n) \\
&\quad + 2\,\text{Cov}(X_1, X_2) + 2\,\text{Cov}(X_1, X_3) + \ldots + 2\,\text{Cov}(X_{n-1}, X_n) \\
&= \sum_{i=1}^{n} \text{Var}(X_i) \\
&\quad + \sum_{j<i}^{n} \sum_{i}^{n} \text{Cov}(X_i, X_j)
\end{aligned} \qquad \text{(11A.8)}$$

APPENDIX 11B
APPLIED UTILITY THEORY

If the risk attitude of the top management (the group that often makes decisions regarding investments) can be translated into a utility curve, the risk factor can be incorporated in the final decision in a fairly simple and consistent manner.

A utility function describes a person's risk attitude just as subjective probabilities describe a person's judgment about probabilities. The utility function shows the utiles (an arbitrary measure of satisfaction) associated with different monetary outcomes. Normally utiles are shown on the vertical axis and monetary returns are shown on the horizontal axis. An illustrative utility function is given in Exhibit 11B.1.

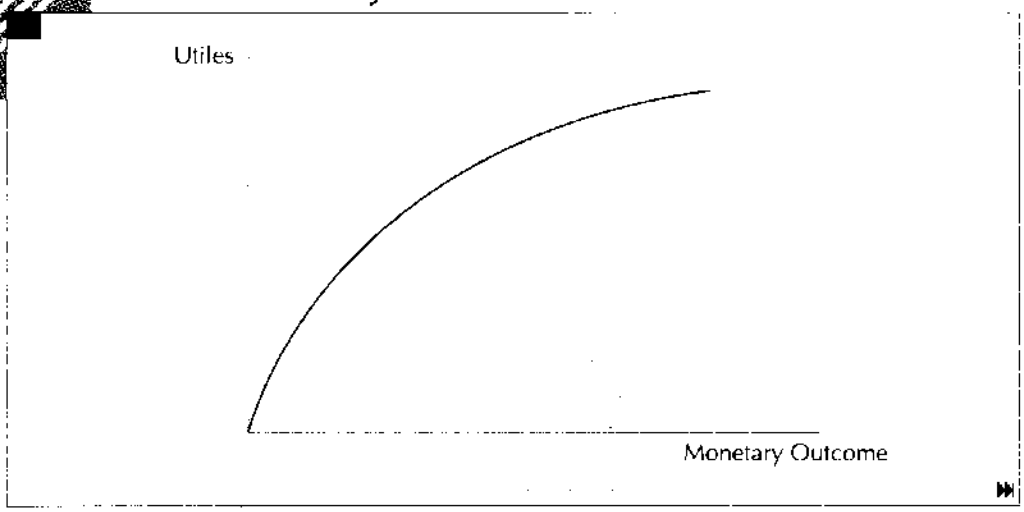
OBTAINING THE UTILITY FUNCTION

How can a person's utility function be obtained? Neumann and Morgenstern[2] have suggested a method which is as follows:

1. Find the range of the monetary outcomes that a person regards as relevant. The end points of this range may be designated as A and B.
2. Assign a utility of 0 to A (the lowest outcome) and a utility of 1 to B (the highest outcome).

2. Neumann J. Von and Morgenstern O., *Theory of Games and Economic Behaviour*, Princeton, N.J: Princeton University Press, 1944.

Exhibit 11B.1 ***Utility Function***



3. Determine the utility associated with any intermediate value by the following process:
   (i) Present the individual with two alternatives. The first alternative consists of the intermediate value X, the utility of which is to be determined. The second alternative consists of a lottery which has two possible outcomes, A and B, with probabilities p_1 and p_2 attached to them ($p_1 + p_2 = 1$).
   (ii) Ask the individual to choose one of the alternatives presented in (i) above.
   (iii) If the individual chooses the first alternative, revise the second alternative such that it becomes more attractive. This means the value of p_2 should be increased. If the individual chooses the second alternative, revise it such that it becomes less attractive. This means the value of p_2 should be decreased and the value of p_1 should be increased.
   (iv) Ask the individual to choose after the revision of lottery as per step (iii). Continue this till the individual becomes indifferent to both alternatives.
   (v) When the individual becomes indifferent to both alternatives the utility of X is simply the value of p_2.
4. Obtain the utility values of several intermediate outcomes and plot the utility function.

An example may be given to illustrate the above procedure. The relevant range for an individual is –Rs 10,000 and Rs 50,000. The utility of –Rs 10,000 is put as 0 and that of Rs 50,000 is put as 1. We wish to find the individual's utility for Rs 10,000. We present him with two alternatives:

Alternative 1 : A certain gain of Rs 10,000.

Alternative 2 : A lottery which has two possible outcomes—Rs 10,000 and Rs 50,000 with probabilities 0.6 and 0.4 respectively.

We ask him to choose between the two alternatives. He chooses, say, alternative 1. We now modify the second alternative and present him with the following choice situation:

Alternative 1 : A certain gain of Rs 10,000.

Alternative 2 : A lottery which has two possible outcomes—Rs 10,000 and Rs 50,000 with probabilities .55 and .45 respectively.

He again chooses alternative 1. We further modify alternative 2 and present him with the following choice situation:

Alternative 1 : A certain gain of Rs 10,000.

Alternative 2 : A lottery which has two possible outcomes—Rs 10,000 and Rs 50,000 with probabilities .5 and .5 respectively.

This time he expresses an indifference to both alternatives. From this we infer that his utility for Rs 10,000 is 0.5. (This is $0.5 \times 0 \times 0.5 \times 1.0$.)

It should be noted that we assigned a utility of 0 to the lowest outcome (of the relevant range) and a utility of 1 to the highest outcome (of the relevant range). These values were chosen arbitrarily. We could choose any other set of values, say 1 and 10 or $-12\frac{1}{2}$ and $11\frac{1}{3}$. The point to note is that there is no sanctity attached to any set of values because the utility function is unique up to a linear transformation.

Once the utility curve of the decision making unit is obtained the expected utility of a project is measured as follows:

1. Define the probability distribution of *NPV*.
2. Calculate the expected utility by using Eq. (11B.1).

$$\sum U(NPV_i)\, p_i \qquad (11B.1)$$

where $U(NPV_i)$ = utility of the ith possible *NPV*

p_i = probability of ith possible outcome

A numerical example may be given to illustrate the nature of calculation. Let the probability distribution of the *NPV* for a project be as follows:

NPV (Rs)	*Probability*
− 10,000	0.1
0	0.3
+ 20,000	0.4
+ 30,000	0.2

Let the utility for money for the decision maker be as follows:

Money (Rs)	*Utility*
– 20,000	0
– 10,000	0.10
0	0.35
+ 10,000	0.50
+ 20,000	0.68
+ 30,000	0.85
+ 40,000	0.90
+ 50,000	1.00

Hence the expected utility of the project is:

$$0.10 \times 0.1 + 0.35 \times 0.3 + 0.68 \times 0.4 + 0.85 \times 0.2 = 0.557$$

EVALUATION

The applied utility theory appears superior to other methods of risk adjustment because it offers an approach for incorporating the risk factor consistently. However, there are certain problems in using this approach. First, it may be difficult to obtain the utility function of an individual. Translating the risk attitude of an executive in the form of a utility function realistically requires patience and ingenuity on the part of the analyst and understanding and trust on the part of the decision maker. As a rule, checks for consistency are required after the first plot of the utility function is obtained. Modifications should be made on the basis of additional probing till the decision maker is confident that the utility function represents his attitude towards risk. Second, the utility function of the decision maker may not remain stable over time since it is dependent on the organisation's financial position. (We are presuming here that the decision maker acts on behalf of his organisation.) Third, there is no generally acceptable way of determining the utility function of a group. (Note that many important investment decisions are group decisions.)

In view of the above problems, the utility theory does not seem to be very useful, particularly for investment decisions where the costs and benefits are spread over a fairly long time period and where the time of resolution of uncertainty is usually a very impor-

tant consideration. It is, however, a potential tool for short-term investment decisions. John S. Hammond III, an advocate of the utility theory, says:

> By isolating attitude toward risk from the other aspects of a complex decision problem and eliciting the attitude by simple questions, we force the decision maker to be far more explicit about his attitude than he has ever been.[3]

APPENDIX 11C

CERTAINTY EQUIVALENT METHODS VS. RISK ADJUSTED DISCOUNT RATE METHOD

The expressions of *NPV* according to the certainty equivalent method and the risk adjusted discount rate method are as follows:

Certainty Equivalent Method

$$\sum_{t=1}^{n} \frac{\alpha_t \overline{A}_t}{(1+i)^t} - I$$

Risk Adjusted Discount Rate Method

$$\sum_{t=1}^{n} \frac{\overline{A}_t}{(1+r)^t} - I$$

From the above expressions, it is clear that the following conditions must be satisfied if the risk adjusted discount rate method is to give the same value for each expected return as the certainty equivalent method.

$$\frac{\alpha_t \overline{A}_t}{(1+i)^t} = \frac{\overline{A}_t}{(1+r)^t} \tag{11C.1}$$

for all values of t

Juggling Eqn. (11C.1) a bit, we get

$$\alpha_t = (1+i)^t/(1+r)^t \tag{11C.2}$$

Likewise we find

$$\alpha_t = (1+i)^{t+1}/(1+r)^{t+1} \tag{11C.3}$$

Combining Eqns. (11C.2) and (11C.3) we get

$$\frac{\alpha_{t+1}}{\alpha_t} = \frac{(1+i)}{(1+r)} \tag{11C.4}$$

This means that the coefficient α_t, in general, declines at a constant rate of $1 - (1 + i)/(1 + r)$ per period. (For our present purposes, we may ignore the possibility of α_t increasing over time, which, though conceivable, is very unlikely.) This implies that risk increases at a constant rate.

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3. John S. Hammond III, 'Better Decisions with Preference Theory', *Harvard Business Review*, Nov-Dec, 1967.

It may be argued that given a stream of expected returns, a value of r can be found which would give the same net present value as obtained by employing the certainty equivalent approach. Compared to the certainty equivalent approach, such a rate would over-estimate the present value of returns in some periods and underestimate in others with the differences cancelling out.

However, it should be borne in mind that the net present value, and not r, is the unknown. Thus, it is difficult to see how r can be interpreted as a reasonable standard for discounting purposes unless Eqn. (11C.2) is satisfied. Hence, on a conceptual level, the certainty equivalent approach is superior to the risk-adjusted discount rate approach.

PART IV

Selection: Advanced Techniques

12. Risk Analysis: Firm Risk and Market Risk
13. Special Decision Situations
14. Social Cost Benefit Analysis
15. Multiple Projects and Constraints
16. Valuation of Real Options
17. Judgmental, Behavioural, Strategic and Organisational Considerations

CHAPTER 12

Risk Analysis: Firm Risk and Market Risk

In Chapter 11, we looked at the risk of a project in isolation. The questions we tried to answer were: How should the risk of a project, viewed independently, be measured? Given the risk and return characteristics of a project, should it be accepted or rejected?

While looking at a project in isolation may appear convenient and pragmatic, many consider it as a very narrow approach to project evaluation. The critics of the 'project risk' approach fall into two groups. The first group argues that the risk of a project must be judged in the context of the total risk of the firm. This means that the question to be asked is: What is the incremental contribution of a project to the risk exposure of the firm as a whole? To answer this question, portfolio theory is employed. The second group takes an even broader view of risk and argues that the risk of a project must be judged in the context of the aggregate market portfolio of all assets. The analytical model employed by the votaries of this approach is the capital asset pricing model.

This chapter discusses risk analysis from the firm point of view as well as the market point of view. It is organised into seven sections as follows:

- Portfolio related risk measures
- Mean-variance portfolio construction
- Portfolio theory and capital budgeting
- Capital asset pricing model
- Inputs required for capital asset pricing model
- Empirical evidence on capital asset pricing model
- Capital asset pricing model and capital budgeting

12.1 PORTFOLIO RELATED RISK MEASURES

Although there are various portfolio risk measures, the mean-variance portfolio model is the most widely used. This model assumes that the risk of a portfolio is defined by the variance or standard deviation of the probability distribution of portfolio returns.

The return of a security or investment is generally measured as a holding period return which is defined as:

$$\frac{\text{Cash inflow during the period + [Ending value – Beginning value]}}{\text{Beginning value}}$$

For example, if a capital investment requires an initial outlay of Rs 100,000, generates a cash inflow of Rs 5,000 and has an end-of-the-period value of Rs 110,000, the holding period return is :

$$\text{Holding period return} = \frac{5{,}000 + (110{,}000 - 100{,}000)}{100{,}000} = 15 \text{ percent}$$

Variance, covariance, correlation, and beta are the key measures used in portfolio analysis. They are defined as follows:

$$\sigma_A^2 = \Sigma p_i [R_{A,i} - E(R_A)]^2 \quad (12.1)$$

$$\sigma_B^2 = \Sigma p_i [R_{B,i} - E(R_B)]^2 \quad (12.2)$$

$$\sigma_{A,B} = \Sigma p_i [R_{A,i} - E(R_A)] [R_{B,i} - E(R_B)] \quad (12.3)$$

$$\rho_{A,B} = \frac{\sigma_{A,B}}{\sigma_A \cdot \sigma_B} \quad (12.4)$$

$$\beta_{A,B} = \frac{\sigma_{A,B}}{\sigma_B^2} \quad (12.5)$$

where: σ_A^2, σ_B^2 = variance of returns on investments A and B

p_i = probability of the state of nature i

$R_{A,i}$, $R_{B,i}$ = holding period return on investments A and B if the state of nature i occurs

$E(R_A)$, $E(R_B)$ = expected return on investments A and B

$\sigma_{A,B}$ = covariance of the returns on investments A and B

$\rho_{A,B}$ = coefficient of correlation of the returns on investments A and B

σ_A, σ_B = standard deviations of returns on investments A and B

$\beta_{A,B}$ = beta of returns on A with respect to B

Illustration

The returns on two projects A and B under different states of nature which correspond to different states of the economy are as follows:

	Return	
Economic Growth (Probability)	*A*	*B*
Strong (0.30)	0.233	0.10
Moderate (0.50)	0.20	0.15
Weak (0.20)	0.15	0.225

Based on the above information, we can calculate the following:

$$E(R_A) = 0.30(0.233) + 0.50(0.20) + 0.20(0.15) = 0.20$$

$$E(R_B) = 0.30(0.10) + 0.50(0.15) + 0.20(0.225) = 0.15$$

$$\sigma_A^2 = [\,0.30(0.233 - 0.20)^2 + 0.50(0.20 - 0.20)^2 + 0.20(0.15 - 0.20)^2\,]$$
$$= 0.0008$$

$$\sigma_A = (0.0008)^{1/2} = 0.0283$$

$$\sigma_B^2 = [\,0.30(0.10 - 0.15)^2 + 0.50(0.15 - 0.15)^2 + 0.20(0.225 - 0.15)^2\,]$$
$$= 0.0019$$

$$\sigma_B = (0.0019)^{1/2} = 0.0436$$

$$\sigma_{A,B} = 0.30(0.233 - 0.20)(0.10 - 0.15) + 0.50(0.20 - 0.20)(0.15 - 0.15)$$
$$+ 0.20(0.15 - 0.20)(0.225 - 0.15) = -.0012$$

$$\rho_{A,B} = \frac{\sigma_{A,B}}{\sigma_A \cdot \sigma_B} = \frac{-.0012}{.0283 \times .0436} = -0.973$$

12.2 MEAN-VARIANCE PORTFOLIO CONSTRUCTION

Harry Markowitz[1] developed the principles of portfolio analysis. We will first apply them to a two-asset portfolio and then to an n-asset portfolio.

The Two-Asset Portfolio

The expected return and the standard deviation of return for a two-asset portfolio are:

$$E(R_p) = W_A E(R_A) + W_B E(R_B) \tag{12.6}$$

$$\sigma_p = (W_A^2 \sigma_A^2 + W_B^2 \sigma_B^2 + 2W_A W_B \sigma_{A,B})^{1/2} \tag{12.7}$$

where W_A and W_B are the proportions of the total funds invested in assets A and B ($W_A + W_B = 1$). The other items are as defined earlier.

Since $\sigma_{A,B} = \rho_{A,B} \cdot \sigma_A \cdot \sigma_B$, Eq (12.7) can be rewritten as:

$$\sigma_p = (W_A^2 \sigma_A^2 + W_B^2 \sigma_B^2 + 2W_A W_B \rho_{A,B} \sigma_A \sigma_B)^{1/2} \tag{12.8}$$

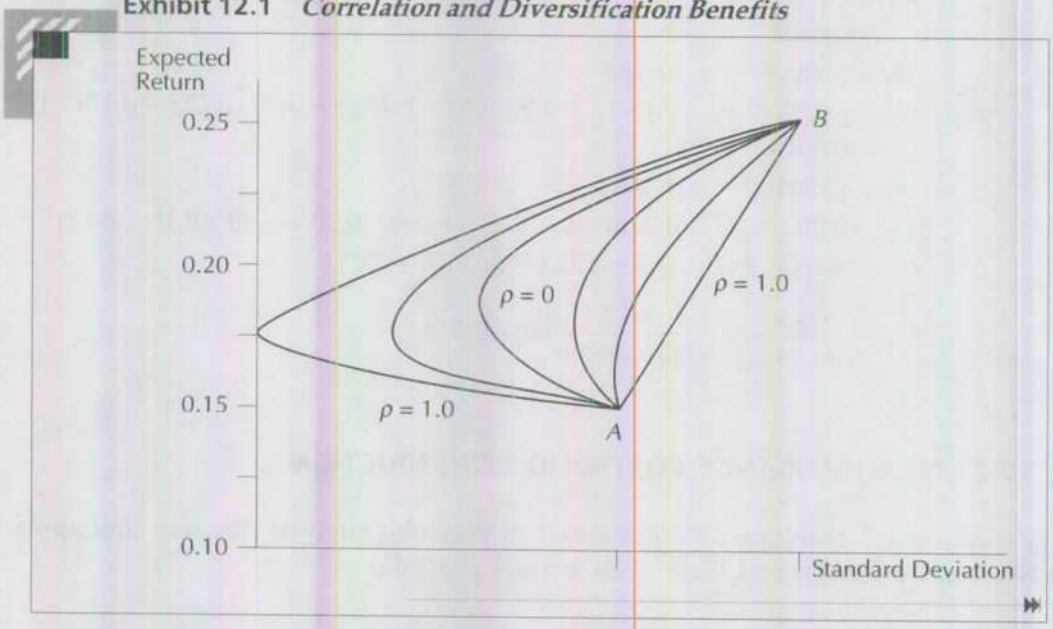
1. Harry M. Markowitz, *Portfolio Selection: Efficient Diversification of Investments*, New York: John Wiley and Sons,1959.

From the above it is clear that the risk-return positions that can be obtained from a combination of two assets depends on the expected returns of the two assets, the standard deviations of the two assets, and the correlation between the returns on the two assets.

Exhibit 12.1 illustrates graphically the various risk-return positions that can be achieved with two projects, A and B, whose expected returns and standard deviations of returns are as follows:

$$E(R_A) = 0.15 \qquad E(R_B) = 0.25$$
$$\sigma_A = 0.20 \qquad \sigma_B = 0.30$$

Exhibit 12.1 ***Correlation and Diversification Benefits***



Depending on the correlation coefficient, the set of lines connecting dots A and B represent the risk-return positions attainable by investments in A and B in various proportions. Note that the lower (or more negative) the coefficient of correlation, the lower is the risk that can be achieved at any given level of expected return. In the extreme case, if the coefficient of correlation is -1.0, the risk can be reduced to zero for a certain combination of A and B.

The *n*-Asset Portfolio

When more than two assets are combined in a portfolio, the expected portfolio return and the standard deviation of portfolio return are:

$$E(R_p) = \sum_{i=1}^{n} W_i E(R_i) \qquad (12.9)$$

$$\sigma_p = \left[\sum_{j=1}^{n} \sum_{i=1}^{n} W_i W_j \rho_{ij} \sigma_i \sigma_j \right]^{1/2} \tag{12.10}$$

where $E(R_p)$ = expected return on the portfolio
$E(R_i)$ = expected return on asset i
W_i, W_j = weights associated with assets i and j
ρ_{ij} = coefficient of correlation between the returns on assets i and j
σ_i, σ_j = standard deviations of the returns on assets i and j

The relationship embodied in Eq. (12.10) is not as complicated as it appears. It is the sum of n^2 terms found in the $n \times n$ matrix shown in Exhibit 12.2.

Exhibit 12.2 ***n × n Matrix***

	1	2	3	...	n
1	$W_1^2 \sigma_1^2$	$W_1 W_2 \rho_{12} \sigma_1 \sigma_2$	$W_1 W_3 \rho_{13} \sigma_1 \sigma_3$	...	$W_1 W_n \rho_{1n} \sigma_1 \sigma_n$
2	$W_2 W_1 \rho_{21} \sigma_2 \sigma_1$	$W_2^2 \sigma_2^2$	$W_2 W_3 \rho_{23} \sigma_2 \sigma_3$	...	$W_2 W_n \rho_{2n} \sigma_2 \sigma_n$
3	$W_3 W_1 \rho_{31} \sigma_3 \sigma_1$	$W_3 W_2 \rho_{32} \sigma_3 \sigma_2$	$W_3^2 \sigma_3^2$	...	
⋮	⋮				⋮
n	$W_n W_1 \rho_{n1} \sigma_n \sigma_1$				$W_n \sigma_n^2$

Example Three assets, designated A, B, and C have expected returns of 0.12, 0.18, and 0.24 respectively. The variances and covariances are as follows:

	A	B	C
A	.02	.01	−.03
B	.01	.06	0
C	−.03	0	.08

What is the expected return and standard deviation of a portfolio consisting of 40 percent of funds in A, 30 percent of funds in B, and 30 percent of funds in C?

$$E(R_p) = 0.40\ (0.12) + 0.30\ (0.18) + 0.3\ (0.24)$$
$$= 0.174$$
$$\sigma_p = [\ (0.40)(0.40)(0.02) + (0.40)(0.30)(0.01)$$
$$+\ (\ 0.40)(0.30)(-\ 0.03) + (0.30)(0.40)(0.01) + (\ 0.30)(0.30)(0.06)$$
$$+\ (0.30)(0.30)(0) + (0.30)(0.40)(-\ 0.03) + (0.30)(0.30)\ (0) + (0.30)(0.30)(0.08)]^{1/2}$$
$$= 0.1049$$

Feasible Region and Efficient Frontier

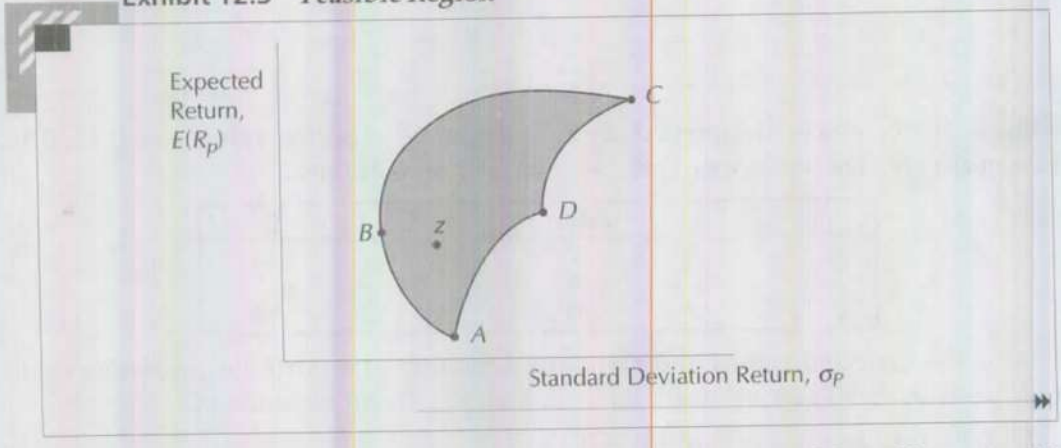
The investments available can be combined into any number of portfolios. Each possible portfolio may be described in terms of its expected rate of return and standard deviation of rate of return and plotted on a two-dimensional graph like the one shown in Exhibit 12.3. The collection of all possible portfolios represents the feasible region which is the shaded region in Exhibit 12.3.

Given the feasible region, which portfolio should the investor choose? The investor should choose the portfolio that maximises his utility function. This choice involves two steps:

(i) Delineation of the set of efficient portfolios.
(ii) Selection of an optimal portfolio from the set of efficient portfolios.

A portfolio is efficient if (and only if) there is no alternative with (i) the same $E(R_P)$ and a lower σ_p or (ii) the same σ_p and a higher $E(R_P)$ or (iii) a higher $E(R_P)$ and a lower σ_p. Thus in Exhibit 12.3, in which the available portfolios are contained in the region *ABCD*, only the portfolios which lie along the boundary *BC* are the portfolios which are efficient. The boundary *BC* may be referred to as the efficient frontier. All other portfolios are inefficient. A portfolio like *Z* is inefficient because a portfolio like *B* (among others) dominates it. The efficient frontier is the same for all investors because the portfolio theory is based on the assumption that the investors have homogeneous expectations.

Exhibit 12.3 ***Feasible Region***



We have merely defined what is meant by a set of efficient portfolios. How can this set be actually obtained from the innumerable portfolio possibilities that lie before the investor? The set of efficient portfolios may be determined with the help of graphical analysis, or calculus analysis, or quadratic programming analysis[2]. The major advantage of

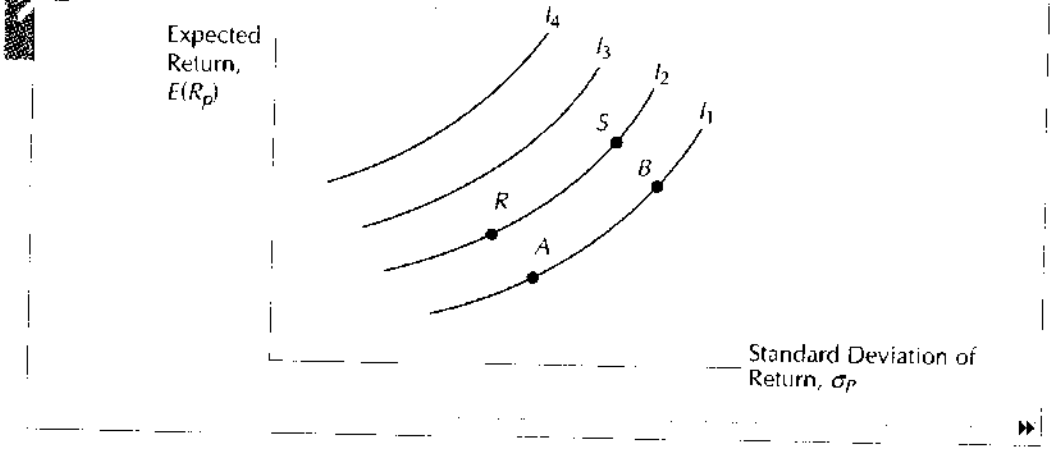
2. Readers may refer to: Jack Clark Francis and Stephen H. Archer, *Portfolio Analysis*, Englewood Cliffs, N.J: Prentice–Hall, Inc.

graphical analysis is that it is easier to grasp. The disadvantage of graphical analysis is that it cannot handle portfolios containing more than three securities[3]. The calculus method can handle portfolios containing any number of securities since mathematical analysis can grapple with the n-dimensional space. However, the calculus method is not capable of handling constraints in the form of inequalities. Quadratic programming analysis is the most versatile of all the three approaches. It can handle any number of securities and it can cope with inequalities as well. For practical purposes, the quadratic programming approach is the most useful approach.

Risk–return Preferences

The set of efficient portfolios delineated, the next step is to define the risk-return preferences of the investor. Exhibit 12.4 shows the risk–return indifference curves for a hypothetical investor. In this exhibit, four risk–return indifference curves I_1, I_2, I_3, and I_4 are shown. All the points lying on a given indifference curve offer the same level of satisfaction. For example, points A and B which lie on the indifference curve I_1, offer the same level of satisfaction; likewise, points R and S, which lie on the indifference curve I_2 offer the same level of satisfaction. The level of satisfaction increases as one moves leftward. The indifference curve I_2 represents a higher level of satisfaction than the indifference curve I_1, the indifference curve I_3 represents a higher level of satisfaction than the indifference curve I_2, and so on. Note that each indifference line is curved upward, implying that ever increasing amounts of expected return are needed to compensate for increasing risk.

Exhibit 12.4 ***Utility Indifference Curves***

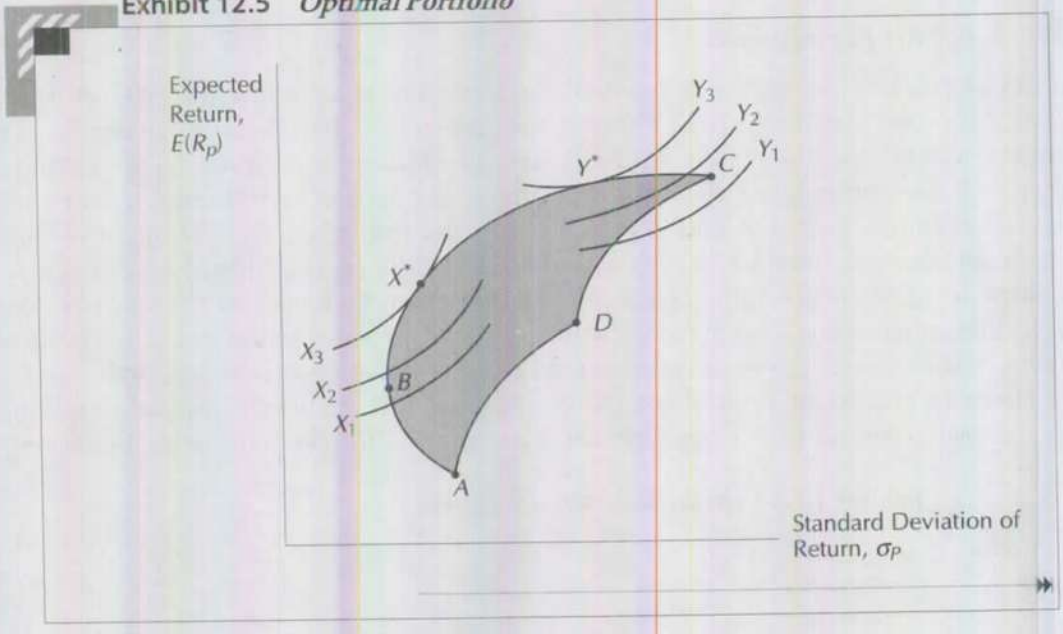


3. At the most, portfolios of four securities may be handled if 3-dimensional graphic analysis is used.

Optimal Portfolio

Given the efficient frontier and the risk-return indifference curves, the optimal portfolio is found at the point of tangency between the efficient frontier and a utility indifference curve. This point represents the highest level of utility the investor can reach. In Exhibit 12.5, two investors X and Y, confronted with the same efficient frontier, BC, but having differing utility indifference curves (X_1, X_2, and X_3 for X and Y_1, Y_2, and Y_3 for Y) are shown as achieving their highest utilities at points X^* and Y^* respectively.

Exhibit 12.5 *Optimal Portfolio*



Optimal Portfolio with Lending and Borrowing at a Riskless Rate

Let us introduce one more possibility. Suppose that the investors can lend and borrow money at a risk-free rate. *Per se*, the addition of one asset to the vast array of opportunities may appear trivial. However, the riskless asset has some special characteristics that influence the optimal portfolio choice for all investors:

- The return on the riskless asset is constant, implying that its variance is zero.
- Given the zero variance of the riskless asset, its returns are uncorrelated with the returns on any risky asset.

To understand the implications of these features, let us look at the equation for the standard deviation of a portfolio of two assets:

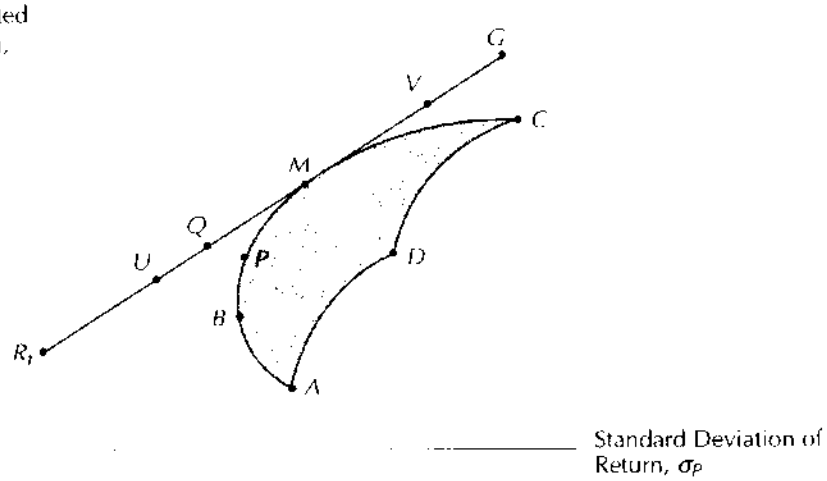
$$\sigma_p = (W_1^2 \sigma_1^2 + W_2^2 \sigma_2^2 + 2W_1 W_2 \rho_{12} \sigma_1 \sigma_2)^{1/2} \qquad (12.11)$$

If one of the assets, say asset 2, is a riskless asset, it means that $\sigma_2 = 0$ and $\rho_{12} = 0$. The standard deviation of the portfolio becomes:

$$\sigma_p = [W_1^2 \sigma_1^2 + 0 + 0]^{1/2} = W_1 \sigma_1$$

The significance of this result can be seen by adding the riskless asset to the choices available to the investors. The effect of this addition is depicted in Exhibit 12.6, which shows what happens when investors can lend and borrow money at the risk-free rate of R_f percent. If any investor lends a portion of his funds at R_f and invests the balance in M (M is the point where the straight line emanating from R_f is tangential to the efficient frontier of risky portfolios defined by BC), he can obtain any combination of risk and return along the line that connects R_f and M. Further, if he borrows some money and invests it along with his own funds, he can reach a point like G, which is beyond M, as shown in Exhibit 12.6. Thus with the opportunity of lending and borrowing at the risk-free rate, the efficient frontier changes. It is no longer BC. Rather, it becomes $R_f MG$ because $R_f MG$, as is clear from Exhibit 12.6, dominates BC. For example, compared to P on BC, Q on $R_f MG$ offers the same expected return with a lower standard deviation; and so on.

Exhibit 12.6 ***Optimal Portfolio with Lending and Borrowing Possibilities***



Since $R_f MG$ dominates BC, every investor would do well to choose some combination of R_f and M. A conservative investor may choose a point like U, whereas an aggressive investor may choose a point like V. While the conservative investor weights R_f more in his portfolio, the aggressive investor weights M more in his portfolio—In fact, in the portfolio represented by point V, the weight assigned to R_f is negative whereas the weight assigned to M is more than 1.

Thus, the task of portfolio selection can be separated into two steps:

- Identification of M, the optimal portfolio of risky securities.
- Choice of a combination of R_f and M depending on one's risk tolerance.

This is the import of the celebrated separation theorem, first enunciated by James Tobin, a Nobel Laureate in Economics.

It may be emphasised here that portfolio M has two important features. First, it represents the point where a straight line drawn through the risk-free rate is tangential to the efficient frontier of risky securities. Second, portfolio M has the highest reward to the variability ratio (RV)

$$RV = \frac{\left[E(R_M) - R_f\right]}{\sigma_M} \tag{12.12}$$

12.3 PORTFOLIO THEORY AND CAPITAL BUDGETING

In applying the portfolio theory to capital budgeting we face some special problems. We will first discuss these problems and then look at some suggestions for applying the portfolio concepts to capital budgeting.

Special Problems

Some special problems are encountered in applying the portfolio theory to capital budgeting. These relate to:

- Indivisibility of assets
- Holding period
- Data requirements

Indivisibility of Assets Unlike securities, which are almost infinitely divisible, capital investments often come in large, indivisible units. They have to be accepted or rejected in toto. Fortunately, the problem of indivisibility can be handled with integer programming.

Holding Period Mean-variance analysis can be used to determine the portfolio of capital investments that has the highest net present value for each level of risk. Unfortunately, it is difficult to interpret such an efficient frontier because asset lives tend to be different. To avoid ambiguity caused by unequal lives, the return should be measured over a common holding period.

One alternative is to define the holding period as the life of the longest asset being considered. In this case we have to identify all investments that will be made between now and the chosen holding period and also impute terminal values to assets which still have a balance economic life at that point. This is indeed a daunting proposition.

To avoid these difficulties, a second alternative is to use a short holding period, say one year. If this alternative is chosen, the value of each asset has to be defined at the end of one year. This too is a difficult proposition because capital assets cannot be sold after a short period without incurring losses.

Data Requirements Mean-variance portfolio analysis is highly data-intensive. For a portfolio of n assets, the number of risk and return inputs required is: $0.5n^2 + 1.5n$. For example, if 100 capital assets are being considered the number of inputs required is: $0.5 \times 100^2 + 1.5 \times 100 = 5{,}150$. The difficulty is further compounded by the fact that managers normally do not think in terms of covariances and correlations.

Simpler Applications

Due to the problems discussed above, a full blown application of the portfolio theory to capital budgeting seems to be an impractical proposition. The basic ideas of portfolio analysis, however, may be applied in somewhat simpler ways:

- When a large project is being considered, it may be viewed as one asset and the existing firm as a second asset. A portfolio consisting of the existing firm and the new asset may be compared to the existing firm in terms of expected return and standard deviation. The two alternatives may be evaluated subjectively or judged in terms of their reward-to-variability ratios.
- The mean-variance portfolio model may be used to allocate funds across major business divisions which may be few in number, say 3 to 5 for most companies. Data requirement of such analysis is quite manageable.
- When a small project is being considered, the beta between the project and the company's existing portfolio may be regarded as the risk measure for incremental decision making.

Developing the Inputs for Portfolio Analysis

Estimates of expected return, variance, and covariance are required to apply the mean-variance portfolio model. For security portfolios, historical values can be used as proxies for future values. This is, however, not feasible for proposed capital investments. What is the way out? One method is to identify various states of nature, assign probabilities to them, and estimate the return of each investment in each state of nature. Based on this information, the required inputs for portfolio analysis, viz., expected returns, variances, and covariances, can be generated.

Example Rahul Corporation is considering two new investments, P and Q, to go with the existing portfolio of the company's assets, designated as A. Three possible states of nature, have been identified: (a) Strong economic growth with a probability of 0.3. (b)

Moderate economic growth with a probability of 0.5. (c) Weak economic growth with a probability of 0.2. The expected returns from *P*, *Q*, and *A* for different states of nature has been estimated as follows:

	Expected Return		
Economic Growth	*P*	*Q*	*A*
Strong (0.30)	0.20	0.07	0.21
Moderate (0.50)	0.15	0.14	0.12
Weak (0.20)	0.08	0.22	0.05

Given the above information, we can compute the expected return, standard deviation, and covariance terms:

$$E(R_P) = 0.30\ (0.20) + 0.50(0.15) + 0.20\ (0.08) = 0.151$$

$$E(R_Q) = 0.30\ (0.07) + 0.50(0.14) + 0.20\ (0.22) = 0.135$$

$$E\ (R_A) = 0.30\ (0.21) + 0.50(0.12) + 0.20\ (0.05) = 0.133$$

$$\sigma_P = [\ 0.30\ (0.20 - 0.151)^2 + 0.50(0.15 - 0.151)^2 + 0.20\ (0.08 - 0.151)^2\ ]^{1/2}$$
$$= 0.041$$

$$\sigma_Q = [\ 0.30\ (0.07 - 0.135)^2 + 0.50\ (0.14 - 0.135\ )^2 + 0.20(0.22 - 0.135)^2\ ]^{1/2}$$
$$= 0.052$$

$$\sigma_A = [\ 0.30\ (0.21 - 0.133)^2 + 0.50\ (0.12 - 0.133)^2 + 0.20\ (0.05 - 0.133)^2\ ]^{1/2}$$
$$= 0.057$$

$$\sigma_{PQ} = 0.30\ (0.20 - 0.151)\ (0.07 - 0.135) + 0.50\ (0.15 - 0.151)(0.14 - 0.135)$$
$$+ 0.20(0.08 - 0.151)(0.22 - 0.135)$$
$$= -0.001 + 0 - .0028 = -.0038$$

$$\sigma_{PA} = 0.30\ (0.20 - 0.151)(0.21 - 0.133) + 0.50\ (0.15 - 0.151)(0.12 - 0.133)$$
$$+ 0.20\ (0.08 - 0.151)(0.05 - 0.133)$$
$$= .0011 + 0 + .0013 = .0024$$

$$\sigma_{QA} = 0.30\ (0.07 - 0.135)(0.21 - 0.133) + 0.50\ (0.14 - 0.135\ )(0.12 - 0.133)$$
$$+ 0.20\ (0.22 - 0.135)(0.05 - 0.133)$$
$$= -.0015 + 0 + .0014 = -.0029$$

12.4 CAPITAL ASSET PRICING MODEL

As we have seen, portfolio theory is a normative theory which prescribes how rational utility-maximising investors should behave. The capital asset pricing model (CAPM, hereafter) was developed to examine what would be the relationship between risk and return in the capital market if investors behaved in conformity with the prescription of the portfolio theory. Thus, the CAPM may be viewed as an extension of the portfolio theory. An exercise in positive economics, CAPM is concerned with two sets of questions:

I (a) What is the appropriate measure of risk for an efficient portfolio?
(b) What is the relationship between risk and return for an efficient portfolio?
II (a) What is the appropriate measure of risk for an individual security or an inefficient portfolio?
(b) What is the relationship between risk and return for an individual security or an inefficient portfolio?

Assumptions

The standard CAPM is based on the following assumptions:

- Individuals are risk-averse.
- Individuals seek to maximise the expected utility of their portfolios over a single period planning horizon.
- Individuals have homogeneous expectations. This means that they have identical subjective estimates of the means, variances, and covariances among returns.
- Individuals can borrow and lend freely at the riskless rate of interest.
- The market is perfect: there are no taxes; there are no transaction costs; securities are completely divisible; the market is competitive.
- The quantity of risky securities in the market is given.

Looking at these assumptions, one may feel that the CAPM is unrealistic. However, the value of a model depends not on the realism of its assumptions but on the validity of its conclusions. Extensive empirical analysis suggests that the conclusions of the capital asset pricing model are reasonably valid.

Capital Market Line

An important assumption of the CAPM is that investors can borrow or lend freely at the risk-free rate of interest. This means that investors would be interested only in that portfolio of risky investments at which the line from the point representing the risk-free investment is tangential to the feasible region of risky portfolios. This is clarified graphically in Exhibit 12.7. In this exhibit the shaded region represents the feasible region of risky investments, point R_f represents the risk-free investment, and point M represents the point at which the straight line from R_f is tangential to the feasible region of risky investments. By a suitable combination of R_f and M investors can reach any point along $R_f M\ G$. Since $R_f M\ G$, with the exception of point M which $R_f M\ G$ has in common with BC, dominates the frontier BC, all investors would hold a portfolio consisting of R_f and M in some combination. Exhibit 12.8 shows, by way of illustration, what investors with differing risk attitudes would do. An investor with risk-return preferences reflected by indifference curves A_1 through A_4 would lend a part of his funds at the risk-free rate of return and invest the balance in the portfolio of assets shown by point M, since this leads him to his preferred position A^*; an investor with indifference curves C_1 through C_4 would borrow some funds

Exhibit 12.7 ***Efficiency Frontier***

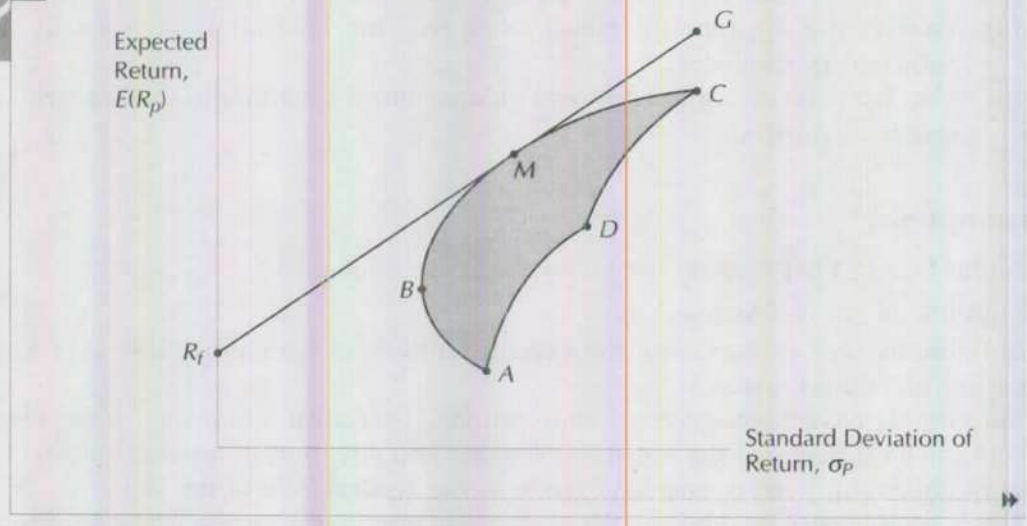
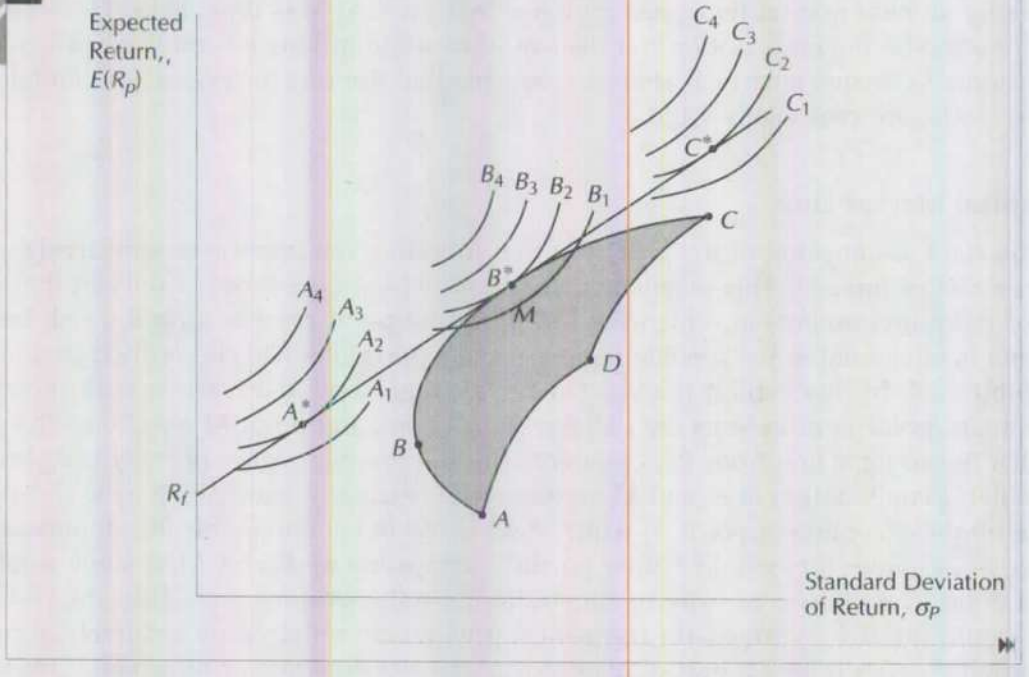


Exhibit 12.8 ***Portfolio Choices of Investors***



at the risk-free rate of interest and put his own funds and borrowed funds in the portfolio M to reach his preferred over-all position C^*; an investor with indifference curves B_1 through B_4 would put all his funds in portfolio M.

Since every investor wishes to hold the risky portfolio, M, this portfolio, in order for the market to be in equilibrium, must represent the totality of risky securities in the market. If some security were not in M, its price would fall making its expected return higher. As a result, it would become more attractive and get included in M. As M represents the totality of risky securities in the market place, the proportion in market value terms of each security in M is equal to the proportion of its value to the total value of risky securities.

The straight line passing through R_f and M is the capital market line. It can be expressed as:

$$E(R_i) = R_f + \lambda\sigma_i \tag{12.13}$$

where $E(R_i)$ = expected return on a portfolio i held by investors

R_f = risk-free rate of interest

λ = slope of the capital market line

σ_i = standard deviation of the return on portfolio i.

The slope of the capital market line may be obtained as follows:

$$\lambda = \frac{E(R_M) - R_f}{\sigma_M} \tag{12.14}$$

The slope of the capital market line, may be regarded as the "price of risk" in the market.

Security Market Line

The capital market line reflects the relationship between risk and return for efficient portfolios, but it does not spell out the relationship between risk and return for inefficient assets, either individual securities or portfolios. The relationship between risk and return for an inefficient portfolio or a single security is expressed by the security market line

$$E(R_i) = R_f + (E(R_M) - R_f)\frac{C_{iM}}{\sigma_M^2} \tag{12.15}$$

where $E(R_i)$ = expected return on security i

R_f = risk-free rate of return

$E(R_M)$ = expected return on market portfolio

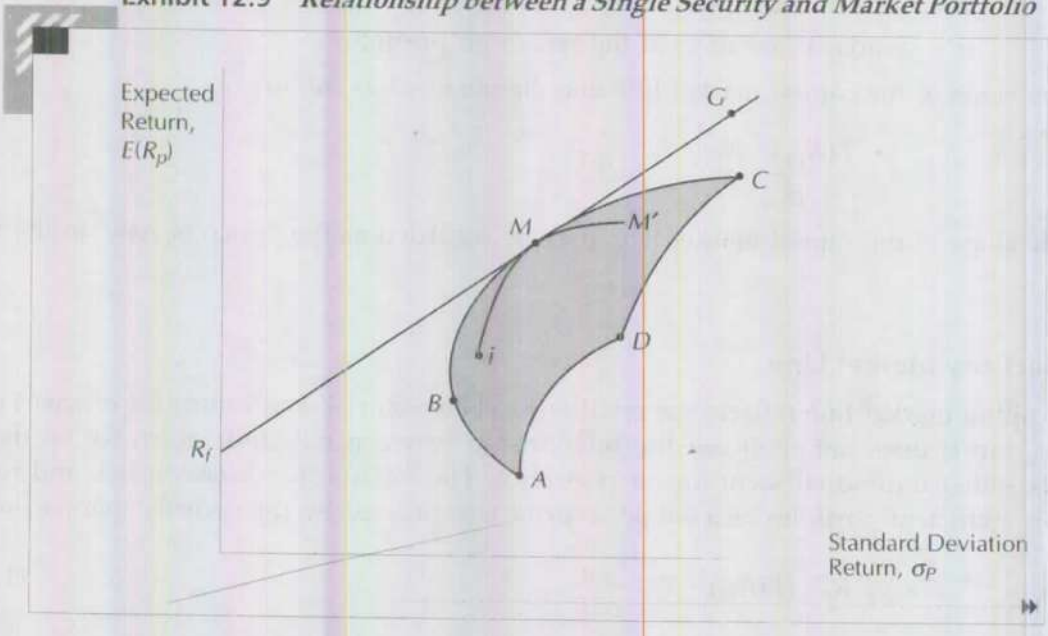
σ_M^2 = variance of return on market portfolio

C_{iM} = covariance of return between security i and the market portfolio

Derivation of the Security Market Line

The expected return and standard deviation values associated with single securities will normally lie below the capital market line, since undiversified holdings are usually inefficient. Such points may be found throughout the feasible region with no consistent relationship between expected return and standard deviation. Exhibit 12.9 shows the typical relationship between a single security (point i) and the market portfolio (M). The proportion of i is denoted by X_i and the proportion of M by X_M. $X_i = 1$ indicates 100 percent investment in i and $X_m = 1$ indicates 100 percent investment in M. Note that $X_M = 1$ implies that some funds are invested in i since i is included in portfolio M. This means that a combination in which i is not found at all must have some negative value of X_i. Point M' represents such a combination.

Exhibit 12.9 ***Relationship between a Single Security and Market Portfolio***



The curve iMM' in Exhibit 12.9 is tangential to the capital market line $R_f MG$ at M. All such curves are tangential to the capital market line in equilibrium. Such curves cannot intersect $R_f MG$ (i.e. fail to be tangential to $R_f MG$) because this would mean that some feasible combination of assets lies to the left of the capital market line, an impossibility

since the capital market line represents the efficient frontier. This fact means that the slope of iMM' at point M is equal to the slope of the capital market line.

The slope of iMM' at point M is equal to:

$$S_M = \frac{E(R_i) - E(R_M)\sigma_M}{C_{iM} - \sigma_M^2} \tag{12.16}^4$$

where S_M = slope of iMM' at point M
$E(R_i)$ = expected return on security i
$E(R_M)$ = expected return on market portfolio
σ_M = standard deviation of the return on market portfolio
C_{iM} = covariance of return between security i and market portfolio

Since the slope of iMM' at M is equal to the slope of the capital market line, we get

$$\frac{E(R_i) - E(R_M)\,\sigma_M}{C_{iM} - \sigma_M^2} = \frac{E(R_M) - R_f}{\sigma_M} \tag{12.17}$$

Simplifying and re-arranging we get:

4. The slope of iMM' is the derivative of $E(R_p)$ with respect to σ_p, $dE(R_p)/d\sigma_p$. Applying the chain rule of differentiation

$$dE(R_p)/d\sigma_p = \frac{dE(R_p)/\sigma x_i}{d\sigma_p/dx_i} \tag{1}$$

Now $$E(R_p) = x_i E(R_i) + (1 - x_i)\,E(R_M) \tag{2}$$

So $$dE(R_p)/dx_i = E(R_i) - E(R_M) \tag{3}$$

Further $$\sigma_p = [\,x_i^2\,\sigma_i^2 + (1 - x_i)^2\,\sigma_M^2 + 2x_i\,(1 - x_i)\,C_{iM}\,]^{1/2} \tag{4}$$

So $$\frac{d\sigma_p}{dx_i} = \frac{x_i\,(\sigma_i^2 + \sigma_M^2 - 2C_{iM}) + C_{iM} - \sigma_M^2}{\sigma_p} \tag{5}$$

Substituting the results of (3) and (5) in (1), we get

$$\frac{dE(R_p)}{d\sigma_p} = \frac{E(R_i) - E(R_M)\,\sigma_p}{x_i\,(\sigma_i^2 + \sigma_M^2 - 2C_{iM}) + C_{iM} - \sigma_M^2} \tag{6}$$

Evaluating $dE(R_p)/d\sigma_p$ at point M where $x_i = 0$, we get

$$\left[\frac{dE(R_p)}{d\sigma_p}\right]_{x_i\,=\,0} = \frac{E(R_i) - E(R_M)\,\sigma_M}{C_{iM} - \sigma_M^2} \tag{7}$$

This is the slope S_M at M, referred to above.

$$E(R_i) = R_f + \left(\frac{E(R_M) - R_f}{\sigma_M^2} \right) C_{iM} \tag{12.18}$$

Since C_{iM} / σ_M^2 in Eq.(12.17) is the slope of a simple regression of R_i over R_M, the above relationship may be put as:

$$E(R_i) = R_f + (E(R_M) - R_f)\, \beta_i \tag{12.19}$$

In words, this relationship, referred to popularly as the *CAPM*, says:

$$\begin{matrix}\text{Expected} \\ \text{return on} \\ \text{security } i\end{matrix} = \begin{bmatrix}\text{Risk-free} \\ \text{rate}\end{bmatrix} + \underbrace{\begin{bmatrix}\text{Expected return on} \\ \text{market portfolio}\end{bmatrix} - \begin{bmatrix}\text{Risk-free} \\ \text{rate}\end{bmatrix}}_{\text{Market risk premium}} [\text{Security beta}]$$

12.5 DEVELOPING THE INPUTS REQUIRED FOR APPLYING CAPM

To apply the CAPM, you need estimates of the following factors that determine the CAPM line:

- Risk-free rate
- Market risk premium
- Beta

Risk-free Rate

The risk-free rate is the return on a security (or a portfolio of securities) that is free from default risk and is uncorrelated with returns from anything else in the economy. Theoretically, the return on a zero-beta portfolio is the best estimate of the risk-free rate. Constructing zero-beta portfolios, however, is costly and complex. Hence they are often unavailable for estimating the risk-free rate.

In practice, two alternatives are commonly used:

- The rate on a short-term government security like the 364-days Treasury bill.
- The rate on a long-term government bond that has a maturity of 15 to 20 years.

It appears that the rate on a long-term bond is a good choice because the duration of a long-term bond is similar to that of the duration of a stock market index. Hence the rate on a long-term bond is consistent with the betas and market risk premiums that are estimated in relation to the stock market index portfolio.

Market Risk Premium

The risk premium used in the CAPM is typically based on historical data. It is calculated as the difference between the average return on stocks and the average risk-free rate. Two

measurement issues have to be addressed in this context: How long should the measurement period be? Should arithmetic mean or geometric mean be used?

The answer to the first question is: Use the longest possible historical period, absent any trends in risk premium over time.

Practitioners seem to disagree over the choice of arithmetic mean versus geometric mean. The arithmetic mean is the average of the annual rates of return over the measurement period whereas the geometric mean is the compounded annual return over the measurement period. The difference between the two may be illustrated with a simple example where we have two years of returns:

Year	*Price*	*Return*
0	100	
1	180	80%
2	135	−25%

The arithmetic mean over the two years is 27.5% [(80 − 25)/2], whereas the geometric mean is only 16.2% ($1.35^{0.5} - 1 = 1.162$). The advocates of arithmetic mean argue that it is more consistent with the mean-variance framework and can better predict the premium in the next period. The votaries of geometric mean argue that it takes compounding into account and can better predict the average premium in the long term. In corporate finance, expected returns are compounded over long time periods. Hence the geometric mean seems to be a better choice for estimating the risk premium.

Determinants of Risk Premium Three factors primarily seem to influence the market risk premium.These are:

Variance in the Underlying Economy If the underlying economy is more volatile, risk premium is likely to be large. For example, the risk premiums for emerging markets, given their high-growth and high-risk economies, are larger than the risk premiums for developed markets.

Political Risk Risk premiums are larger in markets subject to higher political instability. Remember that political instability causes economic uncertainty.

Market Structure If the companies listed on the market are mostly large, stable, and diversified, risk premium is smaller. On the other hand, if the companies listed on the market are generally small and risky, risk premium is larger.

Aswath Damodaran[5] suggests the following risk premiums for various markets:

5. Aswath Damodaran, *Corporate Finance: Theory and Practice*, John Wiley & Sons Inc., New York, 1997, p. 128.

Financial Market Characteristics	*Examples*	*Premium over the Government Bond Rate (%)*
Emerging markets, with political risk	South American markets, China, Russia	7.5—9.5
Emerging markets with limited political risk	Singapore, Malaysia, Thailand, India, some East European markets	7.5
Developed markets with wide stock listings	United States, Japan, U.K., France, Italy	5.5
Developed markets with limited listings and stable economies	Germany, Switzerland	3.5—4.5

Beta

The beta of an investment j is the slope of the following regression relationship:

$$R_{it} = \alpha_i + \beta_i R_{Mt} + e_{it} \qquad (12.20)^6$$

where R_{it} = return on investment i (a project or a security) in period t

R_{Mt} = return on the market portfolio in period t

α_i = intercept of the linear regression relationship between R_{it} and R_{Mt} (α is pronounced as alpha)

β_i = slope of the linear regression relationship between R_{it} and R_{Mt} (β is pronounced as beta)

e_{it} = error term

6. In this regression model, the following properties are usually assigned to the error term e_{it}. It has an expected value of zero and a finite variance:

$$E(e_{it}) = 0$$

$$\text{Var}(e_{it}) = Q^2 \text{ (a finite term)}$$

It is not correlated with the return on the market portfolio:

$$\text{Cov}(e_{it}, R_{Mt}) = 0$$

It is not serially correlated over time:

$$\text{Cov}(e_{it}, e_{i,t+n}) = 0 \text{ for all values of } n$$

In addition to these assumptions, commonly made in regression models, the capital asset pricing model is based on the assumption that the error term for i is not correlated with the error term for any other security j. This means:

$$\text{Cov}(e_{it}, e_{jt}) = 0$$

The variance of R_{it} as per Eq. (12.19) is:

$$\text{Var}\ (R_{it}) = \beta_i^2\ \sigma_M^2 + \text{Var}\ (e_{it}) \qquad (12.21)^7$$

Examining Eq. (12.20), we find that the total risk associated with investment i as measured by its variance is the sum of two components: (i) The risk associated with the responsiveness of the return of the investment to the market index: $\beta_i^2\ \sigma_M^2$ and (ii) The risk associated with the error term: Var (e_{it}). The first component represents the systematic risk and the second, unsystematic risk. Systematic risk stems from economy-wide factors which have a bearing on the fortune of all firms whereas unsystematic risk emanates from firm-specific factors. While systematic risk cannot be diversified away, unsystematic risk can be. Hence, the relevant risk, as per the CAPM, is the systematic risk. It is also referred to as non-diversified risk.

To measure the systematic risk of a project, we have to calculate the slope of the regression Eq. (12.19). The estimate of the slope of the regression model is:

$$\beta_i = \frac{\rho_{iM}\ \sigma_i\ \sigma_M}{\sigma_M^2} \qquad (12.22)$$

where β_i = estimate of the slope in the regression model

ρ_{iM} = coefficient of correlation between the return on investment i and the return on investment M

σ_i = standard deviation of the return on investment i

σ_M = standard deviation of the return on market portfolio

The calculation of beta may be illustrated with an example. The rates of return on stock A and the market portfolio for 15 periods are given below:

Period	*Return on stock A (%)*	*Return on market portfolio (%)*	*Period*	*Return on stock A (%)*	*Return on market portfolio M (%)*
1	10	12	9	−9	1
2	15	14	10	14	12
3	18	13	11	15	−11
4	14	10	12	14	16
5	16	9	13	6	8
6	16	13	14	7	7
7	18	14	15	−8	10
8	4	7			

7. Eq. (12.21) is derived as follows:

$$\begin{aligned}
\text{Var}\ (R_{it}) &= \text{Var}\ (\alpha_i + \beta_i R_{Mt} + e_{it}) = E\left[\alpha_i + \beta_i R_{Mt} + e_{it} - E\ (\alpha_i + \beta_i R_{Mt} + e_{it})\right]^2 \\
&= E\left[\alpha_i + \beta_i R_{Mt} + e_{it} - \alpha_i - \beta_i E(R_{Mt})\right]^2 = E\left[(\beta_i\ (R_{Mt} - E\ (R_{Mt})) + e_{it}\right]^2 \\
&= E\left[\beta_i^2\ (R_{Mt} - E\ (R_{Mt}))^2 + e_{it}^2 + 2\beta_i\ (R_{Mt} - E(R_{Mt}))\ e_{it}\right] \\
&= E\ (\beta_i)^2\ E\ (R_{Mt} - E(R_{Mt}))^2 + E\ (e_{it}^2) + 2E\ (\beta_i)\ E\ (R_{Mt} - E\ (R_{Mt}))\ E(e_{it}) \\
&= \beta_i^2\ \sigma_M^2 + \text{Var}\ (e_{it}) + 0 = \beta_i^2\ \sigma_M^2 + \text{Var}\ (e_{it})
\end{aligned}$$

What is the beta for stock A ? The beta of stock A is equal to:

$$\frac{\text{Cov}\,(R_A, R_M)}{\sigma_M^2}$$

The inputs required for calculating beta are drawn from Exhibit 12.10.

$$\text{Cov}\,(R_A, R_M) = \frac{\sum (R_A - \bar{R}_A)(R_M - \bar{R}_M)}{n-1} = \frac{221}{15} = 15.79$$

$$\sigma_M^2 = \frac{\sum (R_M - \bar{R}_M)^2}{n-1} = \frac{624}{15} = 44.57$$

So, the beta for stock A is $15.79/44.57 = 0.354$.

Note that when covariance and variance are calculated on the basis of a sample of observed returns, the divisor is $n-1$and not n. The reason for subtracting 1 is to correct what is technically called the loss of 1 degree of freedom.

Exhibit 12.10 ***Calculation of Beta***

Period	Return on Stock A, R_A	Return on Market Portfolio, R_M	Deviation of Return on Stock A from its Mean $(R_A - \bar{R}_A)$	Deviation of Return on Market Portfolio from its Mean $(R_M - \bar{R}_M)$	Product of the Deviation, $(R_A - \bar{R}_A)$ $(R_M - \bar{R}_M)$	Square of the Deviation of Return on Market Portfolio from its Mean $(R_M - \bar{R}_M)^2$
1	10	12	0	3	0	9
2	15	14	5	5	25	25
3	18	13	8	4	32	16
4	14	10	4	1	4	1
5	16	9	6	0	0	0
6	16	13	6	4	24	16
7	18	14	8	5	40	25
8	4	7	−6	−2	12	4
9	−9	1	−19	−8	152	64
10	14	12	4	3	12	9
11	15	−11	5	−20	−100	400
12	14	16	4	7	28	49
13	6	8	−4	−1	4	1
14	7	7	−3	−2	6	4
15	−8	10	−18	1	−18	1
	$\Sigma R_A = 150$ $\bar{R}_A = 10$	$\Sigma R_M = 135$ $\bar{R}_M = 9$			$\Sigma(R_A - \bar{R}_A)$ $(R_M - \bar{R}_M) = 221$	$\Sigma(R_M - \bar{R}_M)^2$ $= 624$

Estimation Issues In setting up the regression described above, the analyst has to make decisions with respect to the length of the estimation period, the return interval, and the choice of the market index.

Estimation Period A longer estimation period provides more data but the risk profile of the firm may change over that period. Given this tradeoff, most analysts regard a 5-year period to be reasonable.

Return Interval Returns may be calculated on an annual, monthly, weekly, or daily basis. Using daily returns increases the number of observations, but introduces a bias due to nontrading. Hence analysts prefer weekly or monthly returns to reduce nontrading bias.

Market Index The standard practice is to estimate the beta of a stock in relation to the index of the market to which it belongs. Thus, the betas of Indian stocks are estimated relative to the Nifty index (or any other Indian stock market index) and the betas of US stocks are estimated relative to the S&P 500 index (or any other US market index). While this practice provides an acceptable measure of risk for a parochial investor, it may not be appropriate for an international investor.

Adjusting Historical Beta

The beta calculated above reflects a measure of historical alignment of the price of a stock with that of the market. Hence many regard it as a "measurement" of past relationship that cannot be naively used as an "estimate" of future risk. Why? Two reasons are commonly given:

- The historical alignment may have been significantly influenced by chance factors.
- A company's beta may change over time.

To overcome these limitations, some adjustment may be required. A procedure that is sometimes recommended is to take a weighted average of the historical beta, on the one hand, and 1.0 (the value of market beta) on the other. The weighting scheme should take into account the degree of historical estimation error and the dispersion of individual firms around the average. If the historical estimation error is large, the weight assigned to the historical beta should be small. If the dispersion of individual firms around the average is large, the weight assigned to 1.00 (the market beta) should be small. By balancing these factors, a suitable weighting scheme can be developed. Note that Merill Lynch, in its beta prediction, assigns a weight of 0.66 to historical beta and a weight of 0.34 to market beta (*see* Merill Lynch's booklet *Security Risk Evaluation Service*).

Other Approaches to Beta Estimation

As described above, the standard approach for estimating betas requires information on market prices. Hence this approach cannot be applied easily to assets which are not traded

or to assets which have been traded only for a short period or to assets subject to a lot of manipulative trading that casts doubt over the quality of market price information. To cope with these situations, analysts try to get a handle over beta by looking at fundamental factors, or accounting earnings, or cross-sectional regression relationship for traded companies.

Betas Based on Fundamental Information Can fundamental information be used for predicting betas? Based on the research done by Rosenberg[8] and others, the answer seems to be "yes". Applying complex econometric analysis, Rosenberg and others have devised methods for predicting betas largely on the basis of the fundamental operating and financial characteristics of the company. The key fundamental factors employed by them for predicting betas are given below:

Industry Affiliation Betas vary significantly across industries. These differences are primarily attributable to variations in business risks across industries.

Corporate Growth Corporate growth and beta are correlated. The stronger the growth orientation, the higher the beta is likely to be.

Earnings Variability The greater the variability of earnings over time, the higher the beta is likely to be.

Financial Leverage The greater the financial leverage, the higher the beta is likely to be.
Size The larger the size of a company, the smaller the beta is likely to be.

From the point of view of the financial manager, fundamental betas have several advantages over historical (market-generated) betas: These are:

- Fundamental betas have a stronger intuitive appeal as the rules for predicting them are consistent with our general understanding of what makes a company risky.
- Fundamental betas are ideal for the analysis of non-trading assets like individual projects, strategic business units, and corporate divisions as price behaviour for such assets is not available.
- Fundamental betas, in general, seem to outperform historical betas.
- Fundamental betas can be based on future descriptors, whereas historical betas necessarily require past data (for example, a firm's growth orientation can be estimated using revenue projections).

Betas Based on Accounting Earnings One can estimate the beta of a company (or a division or a project) by using accounting earnings rather than traded prices. This involves regressing the changes in company earnings (on a quarterly or annual basis) against changes in the earnings for the market (the aggregate earnings of all the companies included in a market index which is used as the proxy for the market)

Although this approach is intuitively appealing, it suffers from three possible limitations which are:

8. Barr Rosenberg and James Guy, "Prediction of Systematic Risk from Investment fundamentals, Part I and Part II, *Financial Analysts Journal* (May–June 1976 and July–Aug 1976).

- Accounting earnings are generally smoothed out, relative to the value of the company. This results in betas which have an upward bias (for safe firms) or a downward bias (for risky firms).
- Accounting earnings are influenced by non-operating factors like extraordinary gains or losses and changes in the accounting policy with respect to depreciation, inventory valuation, and so on.
- Compared to stock prices which are observed on a daily basis, accounting earnings are measured at less frequent intervals (yearly or at most quarterly). This means that regression analysis using accounting data will have fewer observations and lesser power.

Betas from Cross-sectional Regressions Yet another approach to estimate beta for unlisted companies or divisions or projects calls for cross-sectional regression analysis. It involves two steps, namely:

Step 1 Estimate a cross-sectional regression relationship for publicly traded firms in which the dependent variable is beta and the independent variables are fundamental firm factors like growth rate, earnings variability, financial leverage, size, and dividend payout ratios, which seem to drive betas.

Step 2 Plug the specific characteristics of the project, division, or unlisted company in the regression relationship to arrive at an estimate of beta.

For example, the following is a regression relating the betas of *NYSE* and *AMEX* stocks in 1994 to four variables: coefficient of variation in operating income, debt-equity ratio, earnings growth, and total assets.

Beta = 0.6507 + 0.27 Coefficient of variation in operating income
+ 0.09 Debt/equity ratio + 0.54 Earnings growth
– 0.00009 Total assets (millions of dollars)

Suppose an unlisted firm has the following characteristics:

Coefficient of variation in operating income	= 1.85
Debt-equity ratio	= 0.90
Earnings growth rate	= 12 percent
Total assets	= $ 150 million

Plugging these values into the regression relation yields the following beta:

Beta = 0.6507 + 0.27 (1.85) + 0.09 (0.90) + 0.54 (0.12) – 0.00009 (150) = 1.2095

12.6 EMPIRICAL EVIDENCE ON CAPITAL ASSET PRICING MODEL

According to the CAPM, the expected return on a security is:

$$E(R_i) = R_f + \beta i\,[\,E\,(R_M) - R_f\,] \qquad (12.23)$$

The ideal way to test the CAPM would be to observe investors' expectations of betas and expected returns on individual securities and the market portfolio and then compare the expected return on each security with its return as predicted by CAPM. Unfortunately, this procedure is not very practical since information on investor expectations is very sketchy.

In practice, researchers have tested the CAPM using *ex post facto* data, rather than *ex ante* data. The commonly followed procedure involves three basic steps which are:

1. Set up the sample data.
2. Estimate the security characteristic lines (*SCL*s).
3. Estimate the security market line (*SML*).

Set up the Sample Data Suppose you are looking at a sample of 75 securities over a period of 60 monthly holding periods (five years). For each of the 60 holding periods, you have to collect the rates of returns on 75 securities, a market portfolio proxy, and a one-month (risk-free) Treasury bill rate. Your data set will thus consist of :

R_{it} : returns on 75 securities over the 60 month period (i =1, 2 ... 75 and t = 1, 2 ... 60)

R_{Mt}: returns on a market portfolio proxy over a sixty month period

R_{ft} : risk-free rates over the sixty month period.

This constitutes a total of $77 \times 60 = 4620$ rates of return

Estimate the Security Characteristic Lines You have to estimate the beta for each security in the sample. The beta for each security is simply the slope of its security characteristic line. There are two ways in which security beta is estimated:

$$R_{it} = a_i + b_i R_{Mt} + e_{it} \tag{12.24}$$

$$R_{it} - R_{ft} = a_i + b_i (R_{Mt} - R_{ft}) + e_{it} \tag{12.25}$$

Note that in Eq.(12.23) the return on security i is regressed on the return on the market portfolio, whereas in Eq. (12.24) the excess return on security i is regressed on the excess return on market portfolio.

Estimate the Security Market Line Once you have the beta estimates of various securities, you can estimate the security market line:

$$\overline{R_i} = \gamma_0 + \gamma_1 b_i + e_i \quad i = 1, \ldots 75 \tag{12.26}$$

Comparing Eqs (12.24) and (12.25) you can infer that if the CAPM holds:

- The relationship should be linear. This means that terms like b_i^2, if substituted for b_i, should not yield better explanatory power.
- γ_0, the intercept, should not be significantly different from the risk-free rate, $\overline{R_f}$.
- γ_1, the slope coefficient, should not be significantly different from $\overline{R_M - R_f}$.
- No other factors, such as company size or total variance, should affect $\overline{R_i}$.

- The model should explain a significant portion of variation in returns among securities.

Numerous empirical studies have been conducted to test the CAPM. Without going into the details of the individual studies. Let us note the following general conclusions that emerge from these studies:

- The relation appears to be linear.
- In general γ_0 is greater than the risk-free rate and γ_1 is less than $\overline{R_M - R_f}$. This means that the actual relationship between risk (as measured by beta) and return is flatter than what the CAPM says.
- In addition to beta, some other factors too, such as standard deviation of returns and company size, have a bearing on return.
- Beta does not explain a very high percentage of the variance in return among securities.

While reviewing the empirical evidence, bear in mind two important problems. First, the studies use historical returns as proxies for expectations. This assumes that the expected returns will be the same as the realised returns. Second, the studies use a market index as a proxy for the market portfolio. Richard Roll[9] has argued persuasively that since the 'true' market portfolio (which in principle must include all assets—financial, real, as well as human—and not just equity stocks), cannot be measured, the CAPM cannot be tested.

Notwithstanding the problems mentioned above, the CAPM is the most widely used risk return model. Its popularity may be attributed to the following factors:

- Some objective estimate of risk premium is better than a completely subjective estimate or no estimate.
- CAPM is a simple and intuitively appealing risk-return model. Its basic message that diversifiable risk does not matter is accepted by nearly every one.
- While there are plausible alternative risk measures, no consensus has emerged on what course to plot if beta is abandoned. As Brealey and Myers say[10]: "So the capital asset pricing model survives not from a lack of competition but from a surfeit."

The situation perhaps may change as additional evidence is gathered in favour of the arbitrage pricing model and operational guidelines for applying that model are developed further. As of now, however, the CAPM appears to be the model of choice in practice.

12.7 CAPITAL ASSET PRICING MODEL AND CAPITAL BUDGETING

You can apply the CAPM to figure out a project's required rate of return. Before we discuss the procedure to do this, it is helpful to understand the link between equity beta and asset beta.

9. Richard Roll, "A Critique of the Asset Pricing Theory's Tests; Part I. On Past and Potential Testability of the Theory," *Journal of Financial Economics* (March 1977), pp.129–176.
10. Richard Brealey and S.C. Myers, *Principles of Corporate Finance*, Sixth Edition, New York: Irwin-McGraw-Hill, 2000.

Equity Beta and Asset Beta

To explore the relationship between equity beta and asset beta, we will initially ignore taxes. Look at Zenith Limited which has the following balance sheet:

Equity : 50	Assets: 100
Debt : 50	

If you buy all the securities of Zenith (its entire equity as well as debt), you will own all its assets. So the beta of your portfolio (β_p) of Zenith's securities is equal to the beta of Zenith's assets (β_A)

$$\beta_P = \beta_A \tag{12.27}$$

Now, the beta of your portfolio is simply the weighted arithmetic average of the betas of its components, viz., equity (E) and debt (D)

$$\beta_P = \beta_E \frac{E}{E+D} + \beta_D \frac{D}{E+D} \tag{12.28}$$

Hence

$$\beta_A = \beta_E \frac{E}{E+D} + \beta_D \frac{D}{E+D} \tag{12.29}$$

Juggling Eq.(12.28) a bit, you get:

$$\beta_E = \beta_A + (\beta_A - \beta_D)\frac{D}{E} \tag{12.30}$$

If the beta of debt, β_D, is assumed to be zero (this means that debt is considered to be risk-free)[11]

$$\beta_E = \beta_A + \beta_A \frac{D}{E} = \beta_A \left(1 + \frac{D}{E}\right) \tag{12.31}$$

So far we have assumed that taxes don't exist. What happens in a world of taxes[12] where interest on debt is a tax-deductible expense? In this case, as Robert Hamada[13] and others have shown

$$\beta_E = \beta_A \left(1 + \frac{D}{E}(1-T)\right) \tag{12.32}$$

This means

$$\beta_A = \frac{\beta_E}{\left(1 + \frac{D}{E}(1-T)\right)} \tag{12.33}[14]$$

Eqns. (12.31) and (12.32) show how equity beta and asset beta are related.

11. This is a reasonable assumption for the debt of financially strong companies.
12. This, indeed, is a more realistic representation of the real world.
13. Robert Hamada, "Portfolio Analysis, Market Equilibrium, and Corporate Finance", *Journal of Finance*, March 1969.
14. In Eq. (12.24), T stands for the tax rate.

Procedure for Calculating a Project's Required Rate of Return

The procedure for calculating a project's required rate of return, as per the CAPM, involves the following steps:

Step 1 *Find a sample of firms engaged in the same line of business* If a firm is considering a project for manufacturing a certain product, identify a sample of firms which are engaged wholly or largely in the manufacture of that product.

Step 2 *Obtain equity betas for the sample firms* To calculate the equity beta of a firm, employ the procedure discussed earlier. Regress the monthly return of the equity stock of the firm on the monthly return of the market portfolio for 50 to 60 months. Where 50 to 60 observations of monthly returns are not available, you may use 50–60 observations of fortnightly returns.

Step 3 *Derive asset betas after adjusting equity betas for financial leverage* For each firm in the sample, the asset beta can be derived from its equity beta using the following relationship:

$$\beta_A = \frac{\beta_E}{\left(1 + \frac{D}{E}(1-T)\right)} \tag{12.34}$$

Step 4 *Find the average of the asset betas* Once the asset betas for the sample firms are obtained, the average can be readily calculated.

Step 5 *Figure out the equity beta for the proposed project* The equity beta for the proposed project can be derived by adjusting the average asset beta (obtained in the previous step) for the financial leverage planned for the project. Remember the formula:

$$\beta_E = \beta_A \left(1 + \frac{D}{E}(1-T)\right) \tag{12.35}$$

Step 6 *Estimate the cost of equity for the proposed project* As per the capital asset pricing model, the cost of equity for the proposed project is

$$r_E = R_f + \left(\overline{R}_M - R_f\right)\beta_E \tag{12.36}$$

Step 7 Calculate the project's required rate of return. The project's required rate of return or its weighted average cost of capital will be:

$$r_A = W_E\, r_E + W_D\, r_D\,(1-T) \tag{12.37}$$

where r_A = weighted average cost of capital
W_E = weight associated with equity $(E/E + D)$
r_E = cost of equity
W_D = weight associated with debt $(D/E + D)$
r_D = pre-tax cost of debt
T = tax rate

Illustration

Diversified Limited is evaluating a granite project for which it proposes to use a debt-equity ratio of 1.5:1. The pre-tax cost of debt is 15 percent and the tax rate is expected to be 30 percent. The risk-free rate is 12 percent and the expected return on the market portfolio is 16 percent. The project's required rate of return may be calculated as follows:

Step 1 *Find a sample of firms engaged in similar business* According to the chief executive of Diversified Limited the following firms are engaged wholly in the same line of business:

1. Ankit Granites Limited
2. Bharath Granites Company
3. Modern Granites Limited

Step 2 *Obtain equity betas for the sample of comparable firms* The equity betas of the three firms, obtained by regressing their equity returns of the market portfolio for the past 60 months, are as follows

Ankit Granites Limited : 1.20

Bharath Granites Company : 1.10

Modern Granites Limited : 1.05

Step 3 *Derive asset betas after adjusting equity betas for financial leverage* The debt-equity ratios for the three firms, namely, Ankit Granites Limited, Bharath Granites Company, and Modern Granites Limited are 2.1, 1.8, and 1.3 respectively. The effective tax rate for all of them is 40 percent. Their asset betas are derived by using the formula:

$$\beta_A = \beta_E / [1 + D / E (1 - T)]$$

Ankit Granites Ltd : $\dfrac{1.20}{[1+2.1(0.6)]} = 0.53$

Bharath Granites Co. : $\dfrac{1.10}{[1+1.6(0.6)]} = 0.56$

Modern Granites Ltd : $\dfrac{1.05}{[1+1.3(0.6)]} = 0.59$

Step 4 *Find the average of asset betas* The average of asset betas of Ankit Granites Limited, Bharath Granites Company, and Modern Granites Limited is:

$(0.53 + 0.56 + 0.69) / 3 = 0.56$

Step 5 *Figure out the equity beta for the proposed project* The equity beta for the proposed project is:

$$\beta_E = \beta_A [1 + D / E (1 - T)]$$
$$= 0.56 [1 + 1.5 (1 - .3)] = 1.148$$

Step 6 *Estimate the cost of equity for the proposed project* As per the capital asset pricing model, the cost of equity for the proposed project is:

$$r_E = R_f + (\bar{R}_M - R_f) \beta_E$$
$$= .12 + (.16 - .12)\ 1.148 = .166$$

Step 7 *Calculate the project's required rate of return* The weighted average cost of capital (the required rate of return) for the granite project of Diversified Limited is:

$$r_A = W_E r_E + W_D r_D (1 - T)$$
$$= [\ (\ (1/2.5)\ 0.166\ ) + (\ (1.5/2.5)\ (0.15)\ (0.7)\ )\ ]$$
$$= .1294 = 12.94 \text{ percent}$$

SUMMARY

- Although there are various portfolio risk measures, the mean-variance portfolio model is the most widely used. This model assumes that the risk of a portfolio is defined by the variance or standard deviation of the probability distribution of portfolio returns.
- The expected return and the standard deviation of return for a two-asset portfolio are:

$$E(R_p) = W_A E (R_A) + W_B E (R_B)$$

$$\sigma_p = (W_A^2\ \sigma_A^2 + W_B^2\ \sigma_B^2 + 2\ W_A W_B\ \rho_{A,B}\ \sigma_A\ \sigma_B)^{1/2}$$

- The expected return and the standard deviation of return for an n-asset portfolio are:

$$E (R_p) = \sum_{i=1}^{n} W_i E (R_i)$$

$$\sigma_p = \left[\sum_{j=1}^{n} \sum_{i=1}^{n} W_i\ W_j\ \rho_{ij}\ \sigma_i \sigma_j \right]$$

- The investments available to an investor may be combined into any number of portfolios.
- The investor should choose the portfolio that maximises his utility function. This involves two steps: (i) delineation of the set of efficient portfolios, and (ii) selection of the optimal portfolio from the set of efficient portfolios.
- A portfolio is efficient if and only if there is no alternative with (i) the same $\bar{R}_p$ and a lower σ_p, or (ii) the same σ_p and a higher $\bar{R}_p$, or (iii) a higher $\bar{R}_p$ and a lower σ_p. The efficient frontier contains all the efficient portfolios.
- All the points lying on a given risk-return indifference curve offer the same level of satisfaction.

- Given the efficient frontier and the risk–return indifference curves, the optimal portfolio is found at the point of tangency between the efficient frontier and a utility indifference curve.
- If the opportunity to lend and borrow at a riskless rate is available, the efficient frontier is redefined. The straight line emanating from the risk-free rate, which is tangential to the efficient frontier of risky portfolios, becomes the new efficient frontier. Given this new efficient frontier, every investor would do well to choose some combination of the risk-free rate and the same risky portfolio (represented by the point at which the straight line emanating from the risk-free rate is tangential to the efficient frontier of risky portfolios).
- Thus, the task of portfolio selection can be separated into two steps (a) Identification of M, the optimal portfolio of risky securities. (b) Choice of a combination of R_f and M depending on one's risk tolerance. This is the import of the celebrated separation theorem, first enunciated by James Tobin, a Nobel Laureate in Economics.
- Some special problems are encountered while applying the portfolio theory to capital budgeting. These relate to: indivisibility of assets, holding period, and data requirements.
- Due to these problems, a full blown application of portfolio theory to capital budgeting seems to be an impractical proposition. The basic ideas of portfolio analysis, however, can be applied in somewhat simpler ways.
- The capital asset pricing model (CAPM), an exercise in positive economics, is concerned with two broad questions:
  (a) What is the relationship between risk and return for efficient portfolios?
  (b) What is the relationship between risk and return for an individual security or an inefficient portfolio?
- The relationship between risk and expected return for efficient portfolios, as given by the *capital market line*, is:

$$\underbrace{E(R_i)}_{\text{Expected Return}} = \underbrace{R_f}_{\text{Risk-free rate}} + \underbrace{\lambda}_{\text{Price per unit of risk}} \underbrace{\sigma_i}_{\text{Risk}}$$

- The relationship between risk and expected return for an inefficient portfolio or a single security is expressed by the *security market line*:

$$\underbrace{E(R_i)}_{\text{Expected Return}} = \underbrace{R_f}_{\text{Risk-free rate}} + \underbrace{\left(E(R_M) - R_f\right)}_{\text{Market risk premium}} \times \underbrace{\frac{C_{iM}}{\sigma_M^2}}_{\text{Risk}}$$

- In theory, the risk-free rate is the return on a security (or a portfolio of securities) that is free from default risk and that is uncorrelated with returns from anything else in the economy. In practice two alternatives are commonly used: (a) The rate on a short-term government security like the 364-days Treasury bill. (b) The rate on a long-term government bond that has a maturity of 15 to 20 years.

- The market risk premium is the difference between the expected risk on the market portfolio and the risk-free rate. Three factors seem to influence the market risk premium, namely: variance of the underlying economy, political risk, and market structure.
- The beta of an investment j is the slope of the following regression relationship:

$$R_{it} = \alpha_i + \beta_i R_{Mt} + e_{it}$$

- The standard approach for estimating betas requires information on market prices. Where market prices are not available or not reliable, analysts try to get a handle over beta by looking at fundamental factors, or accounting earnings, or the cross-sectional regression relationship for traded companies.
- The ideal way to test the CAPM is to use *ex ante* information on investor expectations. Unfortunately this procedure is not very practical because information on investor expectations is very sketchy. In practice, researchers have tested the CAPM using *ex post facto* data rather than *ex ante* data. The commonly followed procedure involves two steps. In the first step the security betas are estimated.

$$R_{it} = a_i + \beta_i R_{Mt} + e_{it}$$

In the second step the relationship between the security beta and return is examined.

$$\bar{R}_i = \gamma_0 + \gamma_1 b_i + e_i$$

- The broad conclusions that emerge from the numerous studies conducted to test the CAPM are: (a) The relationship between risk (as measured by beta) and return appears to be linear. (b) The actual relationship between risk and return is flatter than what the CAPM says. (c) In addition to beta, some other factors too, such as standard deviation of returns and company size, have a bearing on return. (d) Beta does not explain a very high percentage of the variance in return among securities.
- Notwithstanding its limitations, the CAPM is the most widely used risk–return model because it is simple and intuitively appealing and its basic message that diversifiable risk does not matter is accepted by nearly every one.
- The relationship between equity beta and asset beta is as follows:

$$\beta_E = \beta_A \left(1 + \frac{D}{E}\right)$$

- The procedure for calculating a project's required rate of return, as per the CAPM, involves the following steps: (i) Find a sample of firms engaged in the same line of business. (ii) Obtain equity betas for the sample of firms. (iii) Derive asset betas after adjusting equity betas for financial leverage. (iv) Find the average of asset betas. (v) Figure out the equity beta for the proposed project. (vi) Estimate the cost of equity for the proposed project. (vii) Calculate the project's required rate of return.

Questions

1. Define the key risk measures used in portfolio analysis.
2. How is the risk of a two-asset portfolio defined?
3. How is the risk of an n-asset portfolio defined?
4. What is the efficient frontier?
5. How is the optimal portfolio on the efficient frontier determined?
6. What is the optimal portfolio of risky securities if investors can lend or borrow at the risk-free rate?
7. What problems are encountered in applying the portfolio theory to capital budgeting?
8. How can basic ideas of portfolio analysis be applied to capital budgeting in simpler ways?
9. Mention the assumptions underlying the standard capital asset pricing model.
10. What is the relationship between risk and return for efficient portfolios?
11. Discuss the relationship embodied in the security market line.
12. Show how the security market line is derived.
13. What is the risk-free rate? How would you measure it?
14. Suggest an appropriate measure for the market risk premium and justify it.
15. What factors influence market risk premium?
16. What is beta and how is it measured?
17. What adjustment is done to historical betas?
18. What fundamental factors drive beta? How are fundamental betas superior to historical betas?
19. Discuss the limitations of betas based on accounting earnings.
20. How is beta estimated from cross-sectional regressions?
21. Discuss the procedure commonly used in practice to test the CAPM.
22. What is the empirical evidence on the CAPM?
23. Despite its limitations, why is the CAPM widely used?
24. Discuss the relationship between equity beta and asset beta in a taxless world?
25. What is the relationship between equity beta and asset beta when taxes exist?
26. Describe the procedure for calculating a project's required rate of return as per the capital asset pricing model.

Problems

1. A portfolio consists of five securities 1, 2, 3, 4, and 5. The proportions of these securities are: $W_1 = 0.1$, $W_2 = 0.2$, $W_3 = 0.3$, $W_4 = 0.3$, $W_5 = 0.1$. The standard deviations of returns on these securities are: $\sigma_1 = 8$, $\sigma_2 = 9$, $\sigma_3 = 10$, $\sigma_4 = 16$, $\sigma_5 = 12$. The correlation coefficients among returns are: $\rho_{12} = 0.1$, $\rho_{13} = 0.5$, $\rho_{14} = -0.2$, $\rho_{15} = 0.3$, $\rho_{23} = 0.4$, $\rho_{24} = 0.8$, $\rho_{25} = 0.2$, $\rho_{34} = 0.1$, $\rho_{35} = 0.6$, $\rho_{45} = 0.1$
   Calculate the standard deviation of the portfolio return.

2. Assume that a group of securities has the following characteristics: (a) the standard deviation of each security is equal to σ_A; (b) covariance of returns σ_{AB} is equal for each security pair in the group. Calculate the portfolio variance for two portfolios.
   (i) A portfolio containing three securities which are equally weighted.
   (ii) A portfolio containing nine securities which are equally weighted.
3. The one period rates of return on stock *B* and the market portfolio for a 20-year period are given below:

Period	*Return on stock B (%)*	*Return on market portfolio (%)*	*Period*	*Return on stock B (%)*	*Return on market portfolio (%)*
1	15	9	11	− 2	12
2	16	12	12	12	14
3	10	6	13	15	− 6
4	− 15	4	14	12	2
5	− 5	16	15	10	8
6	14	11	16	9	7
7	10	10	17	12	9
8	15	12	18	9	10
9	12	9	19	6	12
10	− 4	8	20	13	10

   What is the beta for stock *B*?
4. An all-equity firm is evaluating the following projects:
   The risk-free rate is 11 percent, and the expected market risk premium is 6 percent. The firm's cost of capital is 16 percent.

Project	*Beta*	*Expected return (%)*
A	0.5	15
B	0.8	16
C	1.2	21
D	1.6	22
E	1.7	23

   (a) Which projects should be accepted?
   (b) If the firm's cost of capital is used as a hurdle rate, which projects will be accepted or rejected incorrectly?
5. Magnum Limited is considering a cement project for which it proposes to employ a debt-equity ratio of 2:1. Its pre-tax cost of debt will be 16 percent and its expected tax rate is 30 percent.
   There are three firms, *A*, *B*, and *C* engaged wholly in cement manufacture. Their tax rate is 30 per cent. Their equity betas and debt-equity ratios are as follows:

	Equity beta	*Debt-equity ratio*
A	1.25	2.25
B	1.15	2.00
C	1.10	2.10

The risk-free rate is 12 percent and the expected return on the market portfolio is 17 percent. What should be the required rate of return on Magnum's cement project?

6. Pariman Company's equity beta is 1.25. Its debt-equity ratio is 1.60 and its tax rate is 40 percent. What is Pariman Company's asset beta?
7. Growmore Fertiliser Company has a debt-to-equity ratio of 1.25 to 1.0. Its cost of debt funds is 12 percent and it has a marginal tax rate of 40 percent. Growmore is considering a proposal to diversify into petrochemicals, a field that is considerably different from its own. Growmore regards Sunrise Petrochemicals as a good proxy company. Sunrise has a debt-equity ratio of 1.5, an equity beta of 1.30, and an effective tax rate of 40 percent.
   (a) If Growmore wishes to manufacture petrochemicals, what systematic risk is involved if it intends employing the same amount of leverage in the new project as it currently employs?
   (b) If the risk-free rate is 12 percent and the expected return on the market portfolio is 18 percent, what is the required rate of return for the petrochemicals project as per the CAPM?

CHAPTER

13

Special Decision Situations

Our discussion so far assumed that: (i) Every project being considered is independent. This means, among other things, that we don't have a situation where two or more projects are mutually exclusive. (ii) A project is being considered for implementation now or never. (iii) The economic life of a project is fixed. (iv) The investment and financing aspects of a project are independent. (v) The cash flows of a project may be estimated on the basis of current prices.

This chapter discusses decision situations where there are mutually exclusive projects, where a project can be deferred by one or more years, where the economic life of a project is not predetermined and fixed, where the investment and financing side of the project are related, and where inflation is explicitly considered in evaluating the project. In addition it looks at evaluation of overseas investment proposals. It is divided into six sections as follows:

- Choice between mutually exclusive projects of unequal life
- Optimal timing decision
- Determination of economic life
- Interrelationship between investment and financing aspects
- Inflation and capital budgeting
- International capital budgeting

13.1 CHOICE BETWEEN MUTUALLY EXCLUSIVE PROJECTS OF UNEQUAL LIFE

Alpha Limited is considering two machines, *A* and *B*. Though designed differently, they serve the same function. Machine *A*, a standard model, costs Rs 75,000 and lasts for 5 years

Its annual operating costs will be Rs 12,000. Machine *B*, an economy model, costs Rs 50,000 but lasts for only 3 years Its annual operating costs will be Rs 20,000. All the figures are expressed in real terms; this means that they represent rupees of constant purchasing power.

How should Alpha Limited choose between the two machines? Since they serve the same function, the choice between them should be based on a comparison of costs. One way of doing this may be to compare the present value of all the costs associated with the two machines. Assuming a discount rate of 12 percent, the present value of all the costs associated with the two machines are:

Machine *A*: $75{,}000 + \frac{12{,}000}{(1.12)} + \frac{12{,}000}{(1.12)^2} + \frac{12{,}000}{(1.12)^3} + \frac{12{,}000}{(1.12)^4} + \frac{12{,}000}{(1.12)^5}$

$= 118{,}260$

Machine *B*: $50{,}000 + \frac{15{,}000}{(1.12)} + \frac{15{,}000}{(1.12)^2} + \frac{15{,}000}{(1.12)^3} = 86{,}030$

The present value of costs associated with machine *B* is lower than that of machine *A*. Based on such a comparison, one may argue that machine *B* is preferable to machine *A*. Such an argument, however, is flawed because it overlooks the fact that machine *B* has a shorter life and has to be replaced earlier.

For a proper comparison of the two alternatives, that have different lives, we have to convert the present value of costs into a uniform annual equivalent (*UAE*) figure—this is also called an equivalent annual cost (*EAC*) figure. The *UAE* is a function of the present value of cost, the life of the asset, and the discount rate. The *UAE* is simply:

$$\frac{PV \text{ Cost}}{PVIF\ A_{r,n}}$$

The *UAE* of the two machines is calculated below:

Machine *A*: $UAE = \frac{118{,}260}{3.605} = 32{,}804$

Machine *B*: $UAE = \frac{86{,}030}{2.402} = 35{,}816$

What does a *UAE* value of Rs 32,804 for machine *A* mean? It simply means that incurring a capital outlay and operating costs which have a present value of Rs 118,260 for a machine that lasts five years is like incurring an annual cost of Rs 32,804 for five years. Likewise a *UAE* value of Rs 35,816 for machine *B* implies that incurring a capital outlay and operating costs which have a present value of Rs 86,030 for a machine that lasts three years is like incurring an annual cost of Rs 35,816 for three years.

The choice between machines *A* and *B* can be made by comparing their *UAE*. Since the *UAE* of machine *A* is lower than the *UAE* of machine *B*, machine *A* is preferable to machine *B*.

13.2 OPTIMAL TIMING

In real life, an investment is rarely a "now or never" proposition. Typically, it can be undertaken now or at some point of time in the future. Given this option, the issue of optimal timing assumes significance.

Under conditions of certainty, the optimal timing may be determined by using the following procedure:

1. Examine alternative dates (t) when the investment can be made.
2. Estimate the net future value as of each alternative date and convert the same to its current value.
3. Choose the timing that has the highest current value.

This procedure may be explained with the help of an example. Futuristic Limited is evaluating different dates for investing in a micro-electronics project. The net future value for various dates is as follows:

Time	*Net future value (Rs in million)*
0	20
1	28
2	33
3	36
4	38

The discount rate applicable for the project is 12 percent. Hence the current value for different timing options is as follows:

Time	*Current value (Rs in million)*
0	$\frac{20}{(1.12)^0} = 20.00$
1	$\frac{28}{(1.12)^1} = 25.00$
2	$\frac{33}{(1.12)^2} = 26.30$
3	$\frac{36}{(1.12)^3} = 22.90$
4	$\frac{38}{(1.12)} = 21.55$

The optimal timing is year 2 as it maximises the current value.

Thus, determining the optimal timing under conditions of certainty is a fairly easy proposition. Under conditions of uncertainty, however, the problem of optimal timing is very complex. If an investment is not undertaken now ($t = 0$) it may become either more or less valuable in the future and there may be no way of figuring that out. Perhaps it may be advantageous to exploit a good opportunity today even though it may become more attractive in the future. Or it may be worthwhile to wait for the resolution of some uncertainty to minimise the possibility of an investment blunder.

13.3 DETERMINATION OF ECONOMIC LIFE

A distinction may be made between the physical life and the economic (or optimal) life of an asset. The physical life of an asset represents the number of years it can be used to produce a certain output by regular maintenance and repair (which, of course, tends to cost more and more as the years roll by). The economic life of an asset refers to the number of years the asset should be used to produce a certain output.

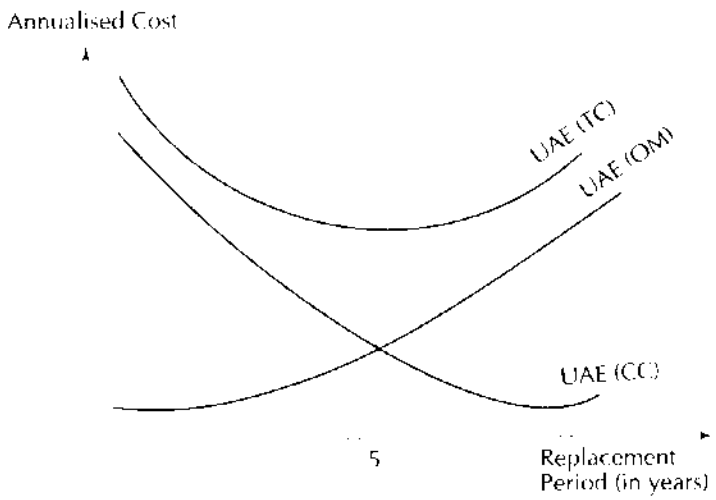
The economic life of an asset is influenced by the behaviour of operating and maintenance costs on the one hand and capital costs on the other. Operating and maintenance costs cover labour, material, and power expenses to operate, maintain, and repair the asset. Capital costs, also referred to as ownership costs, represent the decline in the value of the asset over time—this decline occurs as the asset is used up for producing goods and also as it ages with the passage of time.

The economic life of an asset is conceptually defined as the period after which the asset should be replaced to minimise the sum of operating and maintenance costs and capital costs expressed on an annual basis. Put differently, it is the replacement cycle that minimises the uniform annual equivalent total cost, *UAE* (*TC*), of operating and owning the asset. The *UAE* (*TC*) is simply the sum of the uniform annual equivalent operating and maintenance cost, *UAE* (*OM*), and the uniform annual equivalent capital cost, *UAE* (*CC*). That is,

$$UAE\,(TC) = UAE\,(OM) + UAE\,(CC) \tag{13.1}$$

Exhibit 13.1 shows the behaviour of *UAE* (*TC*), *UAE* (*OM*), and *UAE* (*CC*) as the replacement cycle is extended. *UAE* (*OM*) increases as the replacement period is lengthened because with aging it costs more and more to operate, maintain, and repair the asset to produce a given quantity and quality of output. The *UAE* (*CC*), however declines as the replacement cycle is extended. This happens because, as the asset is used for a longer period, the capital cost per year falls.

Exhibit 13.1 ***Costs over the Life of a Machine***



Since *UAE (OM)* rises and *UAE (CC)* falls with the lengthening of the replacement period, their sum, *UAE (TC)*, will be minimised for some replacement period. As shown in Exhibit 13.1, *UAE (TC)* is minimised when the replacement period is 5 years.

The Problem

We have discussed conceptually how the economic life of an asset is defined. Its measurement in practice involves a series of calculations, which may be illustrated with the help of an example. Modern Plastics Limited is considering a machine to produce plastic products. It requires an initial outlay of Rs 0.6 million and will be depreciated at a rate of 33 $^{1}/_{3}$ percent per annum as per the written down value method for income tax purposes. The expected operating and maintenance costs and salvage (market) value for the next eight years which represents the maximum physical life of the machine are shown in Exhibit 13.2. The cost of capital appropriate for the machine is 12 percent and the tax rate for Modern Plastics Limited is 40 percent. Not sure of what the economic life of the machine is, the firm seeks your help in determining it.

Exhibit 13.2 ***Operating and Maintenance Costs and Salvage Value for the Machine***

Rs ('000)

Year	1	2	3	4	5	6	7	8
Operating and maintenance cost	80.00	100.00	130.00	180.00	240.00	300.00	360.00	450.00
Salvage value at time *t*	400.00	252.00	180.00	100.00	80.00	60.00	50.00	40.00

To determine the economic life of the machine, it is useful to separately consider the operating and maintenance cost and the capital cost. When these are adjusted for taxes and translated into the *UAE* form, the behaviour of *UAE* (*TC*) with respect to the replacement period can be studied and the economic life determined.

Operating and Maintenance Costs

To obtain the *UAE* (*OM*) for various replacement periods, the following calculations may be done:

1. Convert the operating and maintenance costs into post-tax terms.
2. Discount the post-tax operating and maintenance costs to obtain their present values.
3. Cumulate the present values for various replacement periods.
4. Calculate the *UAE* (*OM*) for various replacement periods by applying suitable annuity factors.

Exhibit 13.3 shows the calculation of *UAE* (*OM*) for the various replacement cycles for the machine being considered by Modern Plastics. The first row shows the operating and maintenance costs as taken from Exhibit 13.2; the second row converts the operating and maintenance costs into post-tax terms; the third row gives the present value interest factors, assuming a discount rate of 12 percent; the fourth row translates the post-tax operating and maintenance costs into their present value; the fifth row cumulates the present values for various replacement periods, the sixth row contains the annuity factors (*PVIFA*s) assuming a discount rate of 12 percent; finally the seventh row displays the *UAE* (*OM*) for various replacement periods.

Exhibit 13.3 ***Calculation of UAE (OM) for Various Replacement Periods***

								Rs ('000)
	t=1	*t*=2	*t*=3	*t*=4	*t*=5	*t*=6	*t*=7	*t*=8
Operating and maintenance costs	80.00	100.00	130.00	180.00	240.00	300.00	360.00	450.00
Post-tax operating and maintenance costs	48.00	60.00	78.00	108.00	144.00	180.00	216.00	270.00
PVIF (*r*=12%, *t*)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404
Present value of post-tax operating and maintenance costs	42.86	47.82	55.54	68.69	81.65	91.26	97.63	109.08
Cumulative present value	42.86	90.68	146.22	214.91	296.56	387.82	485.45	594.53
PVIFA (*r*=12%, *t*)	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968
UAE(*OM*)	48.00	53.66	60.87	70.76	82.26	94.34	106.37	119.67

Capital Costs

To derive the *UAE* (*CC*) for various replacement periods, the following components must be taken into account: the initial outlay (*IO*), the depreciation tax shields (*DTS*), and the net salvage value (*SV*). The *UAE* (*CC*) for a given replacement period is equal to:

$$UAE\ (IO) - [UAE\ (DTS) + UAE\ (SV)]$$

The calculations of *UAE* (*IO*), *UAE* (*DTS*), and *UAE* (*SV*) are shown in Exhibits 13.4, 13.5, and 13.6 respectively.

Economic Life

The economic life represents the replacement period which minimises the *UAE* (*TC*). The information required to determine the economic life is summarised in Exhibit 13.7. For each replacement period, column 1 shows *UAE* (*OM*) drawn from Exhibit 13.3. Columns 2, 3, and 4 show *UAE* (*IO*), *UAE* (*DTS*), and *UAE* (*SV*) drawn from Exhibits 13.4, 13.5, and 13.6 respectively. Column 5 shows *UAE* (*CC*), which is *UAE* (*IO*) – [*UAE* (*DTS*) + *UAE* (*SV*)]. Finally, column 6 represents *UAE* (*TC*), which is simply *UAE* (*OM*) plus *UAE* (*CC*). Looking at the column for *UAE* (*TC*) we find that *UAE* (*TC*) is minimised when the replacement period is 5 years. So the economic life is 5 years.

Exhibit 13.4 ***Calculation of UAE (IO) for Various Replacement Periods***

Rs ('000)

	t=1	*t*=2	*t*=3	*t*=4	*t*=5	*t*=6	*t*=7	*t*=8
Investment outlay	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00
PVIFA (*r*=12%, *t*)	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968
UAE (*IO*)	671.89	355.03	249.79	197.56	166.45	145.95	131.46	120.77

Exhibit 13.5 ***Calculation of UAE (DTS) for Various Replacement Periods***

Rs ('000)

	t=1	*t*=2	*t*=3	*t*=4	*t*=5	*t*=6	*t*=7	*t*=8
Depreciation charge	200.00	133.33	88.89	59.26	39.51	26.34	17.56	11.70
Depreciation tax shield	80.00	53.33	35.55	23.70	15.80	10.53	7.02	4.68
PVIF (*r*=12%, *t*)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404
Present value of depreciation tax shield	71.44	42.50	25.31	15.07	8.96	5.34	3.17	1.89
Cumulative present value	71.44	113.94	139.25	154.32	163.28	168.62	171.79	173.68
PVIFA (*r*=12%, *t*)	0.893	1.690	2.402	3.037	3.505	4.111	4.564	4.968
UAE (*DTS*)	80.00	67.42	57.97	50.81	45.29	41.02	37.64	34.96

Exhibit 13.6 ***Calculation of UAE (SV) for Various Replacement Periods***

							Rs ('000)	
	t=1	t=2	t=3	t=4	t=5	t=6	t=7	t=8
Salvage value	400.00	252.00	180.00	100.00	80.00	60.00	50.00	40.00
PVIF (r=12%, t)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404
Present value of salvage value	357.20	200.84	128.16	63.60	45.36	30.42	22.60	16.16
PVIFA (r=12%, t)	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968
UAE(SV)	400.00	118.84	53.36	20.94	12.58	7.40	4.95	3.25

Exhibit 13.7 ***Summary of Information Required to Determine the Economic Life***

Replacement Period	UAE(OM)	UAE(IO)	UAE(DTS)	UAE(SV)	UAE(CC)	UAE(TC)
1 year	48.00	671.89	88.00	400.00	183.89	231.89
2	53.66	355.03	67.42	118.84	168.77	222.43
3	60.68	249.79	57.97	53.36	138.46	199.14
4	70.76	197.56	50.81	20.94	125.81	196.57
5	82.26	166.44	45.29	12.58	108.57	190.83
6	94.34	145.95	41.02	7.40	97.53	191.87
7	106.37	131.46	37.64	4.95	88.87	195.24
8	119.67	120.77	34.96	3.25	82.56	202.23

13.4 INTERRELATIONSHIP BETWEEN INVESTMENT AND FINANCING ASPECTS

The most commonly followed procedure for capital budgeting involves four steps namely:

1. Forecast the post-tax cash flows of the project.
2. Assess the riskiness of the project.
3. Estimate the post-tax weighted average cost of capital (WACC).
4. Calculate the net present value.

Note that the WACC calculated in Step 3 reflects the tax shield associated with debt. Thus the above procedure incorporates the value contributed by the financing decision.

Recall that two basic conditions should be satisfied for using WACC for evaluating new investments which are:

- The risk of new investments is the same as the average risk of existing investments. In other words, the adoption of new investments will not change the risk complexion of the firm.
- The capital structure of the firm will not be affected by the new investments. Put differently, the firm will continue to pursue the same financing policy.

Thus, strictly speaking, WACC is the right discount rate for a project that is a carbon copy of the firm's existing business.

Adjusted Present Value

A project may have financing effects that differ from those of the existing investments of the firm[1]. It may have a different debt capacity or be entitled to certain subsidies or have some special financial features. In such cases the recommended method is to calculate the adjusted *NPV* (or *APV* for short). *APV* is calculated by first estimating the base-case *NPV* and then adjusting it to reflect the financing impact of the project.

APV = Base-case *NPV* + Present value of the financing side effects of the project.

The base-case *NPV* is the *NPV* of the project under the following assumptions:

- The project is financed entirely by equity.
- There is no financing effect like issue cost or subsidy.

The present value of financing side effects is equal to:

- Present value of positive financing side effects like tax shield on debt and availability of subsidies.
- Present value of negative financing side effects like issue costs.

Illustration

The *APV* calculation may be illustrated with an example. Parimala Company is considering a project requiring Rs 5 million of investment. It is expected to generate a net cash flow of Rs 1 million per year for 8 years . The opportunity cost of capital is 15 percent—this reflects the return required by the equity investors, assuming that the project is entirely financed by equity. The cost of issuing equity is 5 percent. The project enables the firm to raise Rs 2.4 million of debt finance. The debt finance will carry 14 percent interest and will be repaid in equal annual instalments over an 8 year period—the first instalment will be paid at the end of the first year. The tax rate applicable to the firm is 40 percent.

Given the above information about the project, let us calculate its base-case *NPV*. This is equal to:

$$-5{,}000{,}000 + \sum_{t=1}^{8} \frac{1{,}000{,}000}{(1.15)^2} = -\text{Rs } 512{,}700$$

The base-case *NPV* has to be adjusted for two factors: (i) issue cost, and (ii) tax-shield associated with debt.

1. For the time being we assume that it does not differ from the existing investments of the firm in terms of risk.

Out of the total financing requirement of the project Rs 2,600,000 will come from the equity sources and Rs 2,400,000 will come in the form of debt finance. As the net equity finance required by the project is Rs 2,600,000 and the issue costs would absorb 5 percent of the gross proceeds of the issue, the firm will have to issue Rs 2,736,842 (Rs 2,600,000/0.95) of equity stock in order to realise a net amount of Rs 2,600,000. The difference of Rs 136,842 is the cost of underwriting, brokerage, printing, and other issue related expenses. The *APV* after adjustment for issue cost is:

$$APV = \text{Base-case } NPV - \text{Issue cost}$$
$$= -\text{Rs } 512{,}700 - \text{Rs } 136{,}842$$
$$= -\text{Rs } 649{,}542$$

Now we consider the adjustment for the tax shield associated with the debt finance. The present value of tax shield associated with Rs 2,400,000 of debt finance is calculated in Exhibit 13.8. From this exhibit we find that the debt finance associated with the project brings a stream of tax shields which has a present value of Rs 403,385. If we make adjustment for this also, we get:

$$APV = \text{Base-case } NPV - \text{Issue cost} + \text{Present value of tax shield}$$
$$= -\text{Rs } 512{,}700 - \text{Rs } 136{,}842 + \text{Rs } 403{,}385$$
$$= -\text{Rs } 246{,}157$$

Exhibit 13.8 ***Calculation of the Present Value of Tax Shield***

Year	Debt Outstanding at the Beginning	Interest	Tax Shield	Present Value (at 14% discount rate)
1	2,400,000	336,000	134,400	117,869
2	2,100,000	294,000	117,600	90,552
3	1,800,000	252,000	100,800	68,040
4	1,500,000	210,000	84,000	49,728
5	1,200,000	168,000	67,200	34,877
6	900,000	126,000	50,400	22,982
7	600,000	84,000	33,600	13,440
8	300,000	42,000	16,800	5,897
			Total	Rs 403,385

The calculation in Exhibit 13.8 assumes that the firm can fully capture the interest tax shield which can be considered as safe cash inflows and can be discounted at the interest rate on debt.

The actual present value of tax shield, however, would almost surely be less than Rs 403,385 for the following reasons:

- Few firms can be certain that they will have enough profits in the future to avail of the interest tax shield fully.
- Apart from the tax that the firm pays on its income, investors (bondholders and shareholders) have to pay personal tax on their debt returns and equity returns as well. At the personal level, debt returns are generally taxed at a higher rate than stock returns.

Opportunity Cost of Capital

Recall that the base-case *NPV* is calculated using the opportunity cost of capital. How is it defined? The opportunity cost of capital, r, is the expected rate of return required by the investors if the firm (or project) has no debt. In our illustration, r was assumed to be 15 percent. How can you estimate r ? Since you can't get it from any published source, you have to infer it. Under the Modigliani-Miller capital structure theory[2],

$$r = r_D \frac{D}{V} + r_E \frac{E}{V} \tag{13.2}$$

where r = opportunity cost of capital

r_D = expected return on the debt

r_E = expected return on the equity of the firm

D/V = market value weight of debt

E/V = market value weight of equity

How does r, the opportunity cost of capital, compare with *WACC*, the after-tax weighted average cost of capital. Recall that

$$WACC = r_D (1-T_c) \frac{D}{V} + r_E \frac{E}{V} \tag{13.3}$$

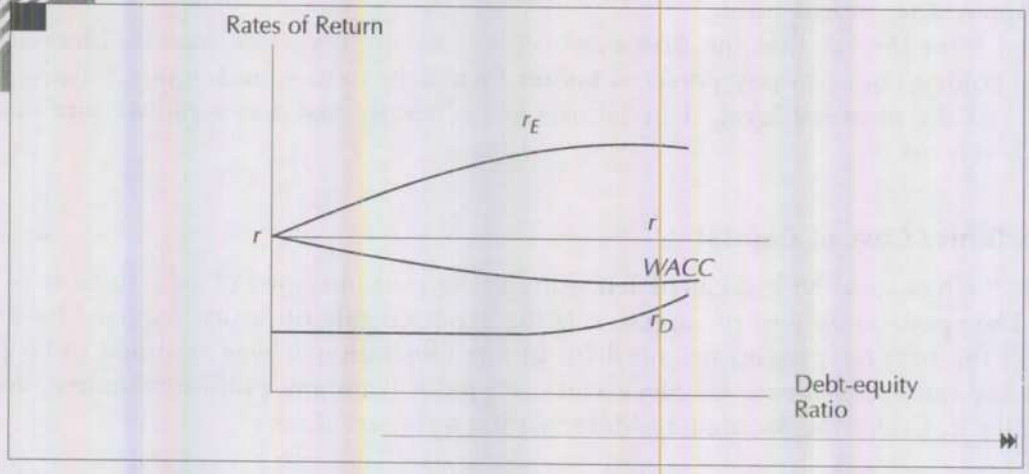
Note that when a firm employs debt, *WACC* is less than r because in *WACC*'s calculation the cost of debt is calculated after tax. Exhibit 13.9 shows the typical behaviour of r_E, r_D, r and *WACC*.

Merits of *APV*

The principle underlying *APV* is to divide and conquer. *APV* does not reflect the side effects of financing in a single calculation. Instead, it captures them in a series of calculations. This makes it more illuminating. You not only know what the *APV* is but also where it is coming from. This is helpful in reformulating the project.

2. In a seminal contribution made in 1958 Franco Modigliani and Merton H. Miller, who later became Nobel Laureates in Economics, argued that in a taxless world the opportunity cost of the capital is independent of the capital structure.

Exhibit 13.9 ***Behaviour of r and WACC***



Suppose the *APV* of a project is calculated as follows:

Base-case *NPV*	:	Rs 1,000,000
PV of issue cost	:	–Rs 7,000,000
PV of tax shield	:	Rs 4,000,000
PV of subsidy	:	Rs 1,000,000
APV	:	–Rs 1,000,000

To salvage the project you may explore ways to reduce issue costs or stake a claim for a higher subsidy with suitable justification.

APV makes more sense for projects that have a capital structure that is different from the rest of the firm or which have a capital structure that changes significantly over time or which enjoy special concessions, incentives, and subsidies. For example, *APV* is eminently suitable for leveraged buyouts (LBOs) or infrastructure projects.

LBOs An LBO is a takeover financed almost entirely with debt. However, the debt employed for an LBO is not meant to be permanent. It is intended to be repaid over time. Obviously you can't use WACC (which presupposes a stable capital structure) to evaluate an LBO.

Infrastructure Projects Infrastructure projects have important financing side effects. They have a high debt ratio which is gradually brought down. Further, debt may be available at concessional rates. Finally, subsidies, incentives, and concessions are often given to such projects.

Adjusted Cost of Capital

Though conceptually sound, *APV* is not very popular because (i) it requires some sophistication to assess the financing side effects, and (ii) it involves a series of adjustments which may be cumbersome.

That is why *WACC*, which is the cost of capital adjusted for financing effects, is more commonly used in practice. Recall that *WACC* is:

$$r_D (1-T_c) \frac{D}{V} + r_E \frac{E}{V} \tag{13.4}$$

There are some other formulae also of adjusted cost of capital. Two of them are:

Modigliani and Miller formula: $r^* = r (1 - TL)$ (13.5)

Miles and Ezzell formula[3]: $r^* = r - L\, r_D\, T \dfrac{1+r}{1+r_D}$ (13.6)

where r^* = adjusted cost of capital

r = opportunity cost of capital assuming 100 percent equity financing

T = tax rate applicable to the firm

L = marginal contribution of the project to the firm's debt capacity

r_D = cost of debt

Example 1 A firm is considering a project for setting up a captive power plant for which the following information has been gathered.

Investment outlay	:	Rs 50 million
Annual post-tax savings	:	Rs 5 million
Life of the project	:	Perpetual
Debt capacity of the project	:	Rs 25 million
Interest rate of debt	:	10 percent
Nature of debt	:	Perpetual
Tax rate of the firm	:	40 percent
Opportunity cost of capital	:	12 percent

The adjusted cost of capital as per Modigliani–Miller formula is:

$$r^* = r (1-TL) = 0.12 (1- 0.4 \times 0.5) = 0.096 \text{ or } 9.6\%$$

The adjusted cost of capital as per Miles and Ezzell formula is:

3. J. Miles and R. Ezzell, "The Weighted Average Cost of Capital, Prefect Capital Markets, and Project Life: A Clarification," *Journal of Financial and Quantitative Analysis* (September 1980), pp. 719–730.

$$r^* = r - L\, r_D\, T\, \frac{1+r}{1+r_D} = 0.12 - 0.5 \times 0.10 \times 0.4 \times \frac{1.12}{1.10} = 0.100 \text{ or } 10.0\%$$

Example 2 A real estate company is considering the acquisition of a piece of land that it plans to resell after a year. The following information is available:

Investment	:	Rs 10 million
Net cash flow expected from resale after one year	:	Rs 11.5 million
Debt capacity	:	Rs 5 million
Interest rate on debt	:	12 percent
Tax rate of the firm	:	35 percent
Opportunity cost of capital	:	15 percent

The adjusted cost of capital as per Modigliani—Miller formula is:

$$r^* = r\,(1-TL) = 0.15\,(1 - 0.35 \times 0.5\,) = 0.12375 \text{ or } 12.375\%$$

The adjusted cost of capital as per Miles and Ezzell formula is:

$$r^* = r - L\, r_D\, T\, \frac{1+r}{1+r_D} = 0.15 - 0.5 \times 0.12 \times 0.35 \times \frac{1.15}{1.12} = 0.1284 \text{ or } 12.84\%$$

The Modigliani–Miller formula is valid when a project generates constant perpetual cash flow and supports permanent debt (these conditions were satisfied by the power project above). The Miles and Ezzell formula requires that the project maintains a constant debt proportion but it does not presuppose any particular cash flow pattern or project life.

13.5 INFLATION AND CAPITAL BUDGETING

Inflation has been a persistent feature of the Indian economy. Hence, it should be properly considered in capital investment appraisal. Since the cost of capital, the discount rate, is typically expressed in nominal terms, all the cash flows should also be expressed in nominal terms. This means that (a) projected revenues and costs must reflect the inflation rates expected in future and (b) salvage values, too, must be expressed in future nominal amounts.

In practice, however, adjustment for inflation is rarely, if ever, made. The use of current price structure is deemed satisfactory and the reasoning offered runs as follows:

> "Inflation is expected to raise the revenues and costs of the project in a similar fashion. Hence, net revenues after adjustment for inflation would be equal to net revenues in current terms."

The above argument, however, overlooks the following considerations which cause distortion:

- The depreciation charge is based on historical costs and hence the tax benefits arising from it does not keep pace with inflation.
- The cost of capital used for investment appraisal typically contains a premium for anticipated inflation.

13.6 INTERNATIONAL CAPITAL BUDGETING

India Pharma Limited, an India-based multinational company, is evaluating an overseas investment proposal. India Pharma's exports of pharmaceutical products have increased to such an extent that it is considering a project to build a plant in the US. The project will entail an initial outlay of US$100 million and is expected to generate the following cash flows over its four year life.

Year	*Cash flow (in million)*
1	US $ 30
2	US $ 40
3	US $ 50
4	US $ 60

The current spot exchange rate is Rs 45 per US dollar, the risk-free rate in India is 11 percent and the risk-free rate in the US is 6 percent—these are rates observed in the financial markets.

India Pharma's required rupee return on a project of this kind is 15 percent. Should India Pharma undertake this project? The answer, of course, depends on the *NPV* of the project. How is the *NPV* of such a project calculated?

There are two basic ways of doing this:

Home Currency Approach

- Convert all the dollar cash flows into rupees (use forecasted exchange rates).
- Calculate the NPV in rupees (using the rupee discount rate).

Foreign Currency Approach

- Calculate the NPV in dollars (use the dollar discount rate).
- Convert the dollar NPV into rupees (use the spot exchange rate).

Home Currency Approach

To apply the home currency approach we have to come up with the forecasted exchange rates. According to the International Fisher Effect, the expected spot exchange rate at time t is:

$$S^e_t = S_o\left[\frac{1+r_h}{1+r_f}\right]^t \tag{13.7}$$

where S^e_t = expected spot exchange rate at time t

S_o = current spot exchange rate

r_h = nominal risk-free rate in home currency

r_f = nominal risk-free interest rate in foreign currency

In our example, S_o = Rs 45, r_h = 11 percent, r_f = 6 percent. Hence the forecasted spot exchange rates are as follows

Year	*Forecasted spot exchange rate*
1	Rs 45 $(1.11/1.06)^1$ = Rs 47.12
2	Rs 45 $(1.11/1.06)^2$ = Rs 49.35
3	Rs 45$(1.11/1.06)^3$ = Rs 51.67
4	Rs 45 $(1.11/1.06)^4$ = Rs 54.11

Using these forecasted spot exchange rates along with the current spot rate of Rs 45, we can convert the dollar cash flows into rupees as shown below:

Year	*(1)* *Cash flow in dollar (million)*	*(2)* *Expected exchange rate*	*(3)* *Cash flow in rupees (million)* *(1) × (2)*
0	–100	Rs 45.00	– Rs 4500
1	30	47.12	1413.6
2	40	49.35	1974.0
3	50	51.67	2583.5
4	60	54.11	3246.6

Given a rupee discount rate of 15 percent, the *NPV* in rupees is:

$$NPV = -4500 + \frac{1413.6}{(1.15)} + \frac{1974.0}{(1.15)^2} + \frac{2583.5}{(1.15)^3} + \frac{3246.6}{(1.15)^4}$$

= Rs 1776.8 million

Foreign Currency Approach

To apply the foreign currency approach we have to come up with a risk-adjusted dollar discount rate corresponding to the risk-adjusted rupee discount rate of 15 percent. To do this we have to first find the risk-premium implicit in 15 percent:

(1 + Risk-free rupee rate) (1 + Risk premium) = (1 + Risk-adjusted rupee rate)

(1 + 0.11) (1 + Risk premium)= (1+ 0.15)

Hence

$$(1 + \text{Risk premium}) = \frac{(1.15)}{(1.11)} = 1.036$$

Applying the above risk premium to the risk-free dollar rate of 6 percent, we find that the risk-adjusted dollar rate is:

$$(1 + \text{Risk-adjusted dollar rate}) = (1.06)\,(1.036) = 1.0982$$

Given the dollar cash flows, the NPV in dollars works out to :

$$NPV = -100 + \frac{30}{(1.0982)} + \frac{40}{(1.0982)^2} + \frac{50}{(1.0982)^3} + \frac{60}{(1.0982)^4}$$

$$= \$\ 39.484 \text{ million}$$

Since the spot exchange rate is Rs 45 per dollar, the rupee *NPV* of the project is:

$$NPV = 39.484 \times \text{Rs } 45 = \text{Rs } 1776.8 \text{ million}$$

Expectedly, this is the same as the rupee *NPV* we obtained earlier using the home currency approach.

Unremitted Cash Flows

In our previous example, we assumed that the post-tax cash flows from the foreign investments could be freely remitted to the parent firm. In reality, there may be substantial differences between the cash flows generated by a foreign project and the amount that can be remitted to the parent firm because many governments put restrictions on remittances. Funds that cannot be currently remitted are referred to as blocked funds.

Risk-Premium on Foreign Investment

In our discussion so far we assumed that the risk-premium on the foreign investment will be the same as the risk-premium on a similar domestic investment.

Foreign investments generally involve higher risk which arises from factors like change in currency value, discriminatory treatment of a foreign company, and threat of expropriation. Risk stemming from fluctuations in exchange rate looms constantly on the horizon of foreign investment. In addition, a foreign investment is subject to discriminatory treatment and selective control in various forms, motivated mainly by political considerations. Finally, the threat of expropriation without adequate compensation may exist, particularly in countries where radical nationalistic sentiments are strong.

In view of the higher risk associated with a foreign investment, a firm contemplating foreign investment would naturally expect a higher rate of return. Put differently, the discount rate applicable to a foreign investment tends to be higher than the discount rate applicable to a domestic investment.

A higher-than-normal required rate of return by multinational corporations is often viewed unfavourably by the critics of multinational companies. They hurl accusations of 'profiteering' even when the multinational company may simply be following the sound financial practice of asking for a rate of return commensurate with the risks characterising the project.

Can there be situations where the demand for higher returns by a multinational company be unreasonable? Yes, when the multinational company invests in several different economies and enjoys the benefit of risk reduction arising from portfolio diversification. In such a case, it may be possible to reduce the overall risk of the firm's portfolio of investments even while accepting a project which individually is highly risky. Of course, this depends on the existence of low or negative correlations between the project under consideration and the other projects within the firm's portfolio of investments.

SUMMARY

- For a proper comparison of two mutually exclusive alternatives, that have different lives, we have to convert the present value of costs into a uniform annual equivalent (*UAE*) figure.
  The *UAE* is simply:

$$PV\,(\text{Cost})/PVIFA_{r,n}$$

- In real life, an investment can typically be undertaken now or at some point of time in the future. The timing that has the highest current value represents the optimal timing.
- The economic life of an asset is conceptually defined as the period after which the asset should be replaced to minimise the sum of operating and maintenance costs and capital costs expressed on an annual basis.
- Strictly speaking, *WACC* is the right discount rate for a project that is a carbon copy of the firm's existing business.
- A project may have financing effects that differ from those of the existing investments of the firm. It may have a different debt capacity or be entitled to certain subsidies or have some special financial features. In such cases the recommended method is to calculate the adjusted *NPV* (or *APV* for short).
- *APV* is calculated by first estimating the base-case *NPV* and then adjusting it to reflect the financing impact of the project.
  APV = Base-case *NPV* + Present value of the financing side effects of the project
- The base-case *NPV* is the *NPV* of the project under the following assumptions: (a) The project is financed entirely by equity. (b) There is no financing effect like issue cost of subsidy.
- The present value of financing side effects is equal to: Present value of positive financing side effects like tax subsidies – Present value of negative financing side effects like issue costs.

- Though conceptually sound, *APV* is not very popular because (i) it requires some sophistication to assess the financing side effects, and (ii) it involves a series of adjustments which may be cumbersome. That is why *WACC*, which is the cost of capital adjusted for financing effects, is more commonly used in practice.
- *WACC* is equal to:

$$r_D (1 - T_c) \frac{D}{V} + r_E \frac{E}{V}$$

- There are some other formulae also for calculating the adjusted cost of capital. Two of them are:
  Modigliani and Miller formula : $r^* = r (1 - TL)$
  Miles and Ezzell formula : $r^* = r - L\, r_D\, T \dfrac{1 + r}{1 + r_D}$
- The adjustment for inflation should be done properly in practice.
- There are two ways of evaluating an international capital budgeting proposal: the home currency approach and the foreign currency approach. Correctly applied both the approaches yield the same result.

Questions

1. Explain how you would compare mutually exclusive projects of unequal life.
2. Discuss the procedure for determining optimal timing under conditions of certainty.
3. Distinguish between the physical life and the economic (or optimal) life of an asset. How would you determine the latter?
4. What is *APV* ? How is it calculated?
5. Show graphically the typical behaviour of r_E, r_D, r, and *WACC*.
6. What are the merits of *APV* ?
7. What is adjusted cost of capital? Give various formulae for adjusted cost of capital.
8. Discuss the bias when the depreciation charge is based on historical cost.
9. Discuss the bias due to ignoring the inflation factor in project cash flows.
10. Explain the ways of evaluating an international investment proposal.

Problems

1. Plastic emulsion painting for a building costs Rs 300,000 and has a life of 7 years. Distemper painting costs Rs 180,000 and has a life of 3 years. How does the *UAE* of plastic emulsion painting compare with that of distemper painting? Assume a discount rate of 10 percent.
2. The initial outlay on an internal transportation system would be Rs 1,500,000. The operating costs are expected to be as follows:

Year	*Operating Costs Rs*
1	300,000
2	360,000
3	400,000
4	450,000
5	500,000

The estimated salvage value at the end of five years is Rs 300,000. What is the *UAE* if the cost of capital is 13 percent?

3. The standard overhaul of an equipment costs Rs 0.5 million and is required every 6 years. A less costly overhaul can be done for Rs 0.2 million and is required every 2 years. Which one would you recommend if the cost of capital is 14 percent? Why?
4. Shimla Municipality is considering two different snowplows. The Gunning plow has an economic life of 12 years, whereas the Coulter plow has an economic life of 9 years The Gunning plow costs Rs 2.5 million and is expected to have a salvage value of Rs 0.8 million at the end of 12 years The Coulter plow costs Rs 1.5 million and is expected to have a salvage value of Rs 0.5 million after 9 years. The operating and maintenance costs for the Gunning plow are expected to be Rs 0.25 million per year and the same costs for the Coulter plow are expected to be Rs 0.32 million per year. The plows have identical capacity. Whichever plow is chosen, Shimla Municipality would continue to replace it with essentially the same machine indefinitely. If the discount rate is 12 percent, which plow should be selected? Ignore taxes.
5. Udyog Limited is evaluating different dates for investing in a drug project. The net future value for various dates are as follows:

Time	*Net future value (Rs in million)*
0	10
1	15
2	19
3	23
4	26

The discount rate applicable to the project is 12 percent. Determine the optimal timing of the project.

6. Zenith Company sews garments for retail stores. The firm is evaluating a new sewing machine costing Rs 80,000. The machine has a physical life of five years. The depreciation rate applicable to it is 25 percent as per the written down value method. The estimated operating and maintenance costs and salvage values are as follows:

Year	*Operating and maintenance costs*	*Salvage value*
	Rs	Rs
1	20,000	60,000
2	25,000	45,000
3	35,000	32,000
4	50,000	22,000
5	70,000	15,000

Zenith's cost of capital is 12 percent and its tax rate is 40 percent. What is the economic life of the sewing machine which minimises the uniform annual equivalent cost of buying and operating the machine?

7. Sushant Well Drillers is evaluating a new well-drilling machine costing Rs 4 million. Estimates of operating and maintenance costs and salvage values are as follows:

Year	*Operating and maintenance costs (Rs in million)*	*Salvage value (Rs in million)*
1	0.8	2.8
2	1.0	2.0
3	1.3	1.4
4	1.9	1.0
5	2.8	0.8

Sushant has a cost of capital of 12 percent and a tax rate of 30 percent. For tax purposes, Sushant is allowed to depreciate the machine at a rate of 25 percent as per the written down value method.

Determine the economic life for the well-drilling machine that minimises the uniform annual equivalent cost of buying and operating the machine.

8. The contribution of a project which involves an outlay of 100 to the firm's debt capacity is 60. The project's opportunity cost of capital is 16 percent and the tax rate for the firm is 50 percent. The borrowing rate is 15 percent.
   (a) What is the adjusted cost of capital as per Modigliani and Miller formula?
   (b) What is the adjusted cost of capital as per Miles and Ezzell formula?
9. Nimesh Electricals Limited is evaluating a capital project requiring an outlay of Rs 12 million. It is expected to generate a net cash inflow of Rs 3 million for 6 years. The opportunity cost of capital is 20 percent. Nimesh Electricals can raise a term loan of Rs 8 million for the project. It will carry an interest rate of 18 percent and will be repayable in 8 equal annual instalments, the first instalment falling due at the end of the second year.

   The balance amount required for the project can be raised by issuing external equity. The issue cost is expected to be 12 percent. The tax rate for the company is 30 percent.
   (a) What is the base case *NPV*?
   (b) What is the adjusted *NPV* if the adjustment is made only for the issue cost of external equity?
   (c) What is the present value of the tax shield on debt finance?

10. Nikhil Electronics Limited is evaluating a capital project requiring an outlay of Rs 8 million. It is expected to generate a net cash inflow of Rs 2 million for 6 years. The opportunity cost of capital is 18 percent. Nikhil Electronics Limited can raise a term loan of Rs 5 million for the project. The term loan will carry an interest rate of 15 percent and would be repayable in 5 equal instalments, the first instalment falling due at the end of the second year. The balance amount required for the project can be raised by issuing external equity. The issue cost is expected to be 10 percent. The tax rate for the company is 40 percent.
    (a) What is the base-case *NPV*?
    (b) What is the adjusted *NPV* if the adjustment is made only for the issue cost of external equity?
    (c) What is the present value of the tax shield on debt finance?
11. The contribution of a project which involves an outlay of 100 to a firm's debt capacity is 50. The project's opportunity cost of capital is 19 percent and the tax rate for the firm is 50 percent. The borrowing rate is 16 percent.
    (a) What is the adjusted cost of capital as per the Modigliani and Miller formula?
    (b) What is the adjusted cost of capital as per the Miles and Ezzell formula?
12. Videsh Ventures, a Mumbai-based company, is considering a project to be set up in the US. The project will entail an initial outlay of $200 million and is expected to generate the following cash flow over its five year life:

Year	1	2	3	4	5
Cash flow (in million)	$50	$70	$90	$105	$80

The current spot exchange rate is Rs 46 per US dollar, the risk-free rate in India is 11 percent and the risk-free rate in the US is 6 percent.
Videsh Venture's required rupee return on a project of this kind is 18 percent.
Calculate the *NPV* of the project using the home currency approach.

CHAPTER 14

Social Cost Benefit Analysis

Social Cost Benefit Analysis (hereafter referred to as SCBA), called economic analysis, is a methodology developed for evaluating investment projects from the point of view of the society (or economy) as a whole. Used primarily for evaluating public investments (though it can be applied to both private and public investments), SCBA has received a lot of emphasis in the decades of 1960s and 1970s in view of the growing importance of public investments in many countries, particularly in developing countries, where governments are playing a significant role in the economic development. SCBA is also relevant, to a certain extent, to private investments as these have now to be approved by various governmental and quasi-governmental agencies which bring to bear larger national considerations in their decisions.

In the context of planned economies, SCBA aids in evaluating individual projects within the planning framework which spells out national economic objectives and broad allocation of resources to various sectors. In other words, SCBA is concerned with tactical decision making within the framework of broad strategic choices defined by planning at the macro level. The perspectives and parameters provided by the macro level plans serve as the basis of SCBA which is a tool for analysing and appraising individual projects.

This chapter discusses various aspects of SCBA. It is divided into ten sections as follows:

- Rationale for SCBA
- UNIDO approach
- Net benefit in terms of economic (efficiency) prices
- Savings impact and its value
- Income distribution impact
- Adjustment for merit and demerit goods
- Little-Mirrlees approach

- Shadow prices
- SCBA by financial institutions
- Public sector investment decisions in India

14.1 RATIONALE FOR SCBA

In SCBA the focus is on the social costs and benefits of the project. These often tend to differ from the monetary costs and benefits of the project. The principal sources of discrepancy are:

- Market imperfections
- Externalities
- Taxes and subsidies
- Concern for savings
- Concern for redistribution
- Merit wants

Market Imperfections

Market prices, which form the basis for computing the monetary costs and benefits from the point of view of the project sponsor, reflect social values only under conditions of perfect competition, which are rarely, if ever, realised by developing countries. When imperfections exist, market prices do not reflect social values.

The common market imperfections found in developing countries are: (i) rationing, (ii) prescription of minimum wage rates, and (iii) foreign exchange regulation. Rationing of a commodity means control over its price and distribution. The price paid by a consumer under rationing is often significantly less than the price that would prevail in a competitive market. When minimum wage rates are prescribed, the wages paid to labour are usually more than what the wages would be in a competitive labour market free from such wage legislations. The official rate of foreign exchange in most of the developing countries, which exercise close regulation over foreign exchange, is typically less than the rate that would prevail in the absence of foreign regulation. This is why foreign exchange usually commands a premium in unofficial transactions.

Externalities

A project may have beneficial external effects. For example, it may create certain infrastructural facilities like roads which benefit the neighbouring areas. Such benefits are considered in SCBA, though they are ignored in assessing the monetary benefits to the project sponsors because they do not receive any monetary compensation from those who enjoy this external benefit created by the project. Likewise, a project may have a harmful

external effect like environmental pollution. In SCBA, the cost of such environmental pollution is relevant, though the project sponsors may not incur any monetary costs. It may be emphasised that externalities are relevant in SCBA because in such analysis all costs and benefits, irrespective to whom they accrue and whether they are paid for or not, are relevant.

Taxes and Subsidies

From the private point of view, taxes are definite monetary costs and subsidies are definite monetary gains. From the social point of view, however, taxes and subsidies are generally regarded as transfer payments and hence considered irrelevant.

Concern for Savings

Unconcerned about how its benefits are divided between consumption and savings, a private firm does not put differential valuation on savings and consumption. From a social point of view, however, the division of benefits between consumption and savings (which leads to investment) is relevant, particularly in the capital-scarce developing countries. A rupee of benefits saved is deemed more valuable than a rupee of benefits consumed. The concern of the society for savings and investment is duly reflected in SCBA wherein a higher valuation is placed on savings and a lower valuation is put on consumption.

Concern for Redistribution

A private firm does not bother how its benefits are distributed across various groups in the society. The society, however, is concerned about the distribution of benefits across different groups. A rupee of benefit going to an economically poor section is considered more valuable than a rupee of benefit going to an affluent section.

Merit Wants

Goals and preferences not expressed in the market place, but believed by policy makers to be in the larger interest, may be referred to as merit wants. For example, the government may prefer to promote an adult education programme or a balanced nutrition programme for school-going children even though these are not sought by consumers in the market place. While merit wants are not relevant from the private point of view, they are important from the social point of view.

14.2 UNIDO APPROACH

Towards the end of the sixties and in the early seventies two principal approaches for SCBA emerged: the UNIDO approach and the Little–Mirrlees approach. This section discusses the UNIDO approach; the following discusses the Little–Mirrlees approach.

The UNIDO approach was first articulated in the *Guidelines for Project Evaluation*[1] which provides a comprehensive framework for SCBA in developing countries. The rigour and length of this work created a demand for a succinct and operational guide for project evaluation in practice. To fulfill this need, UNIDO came out with another publication, *Guide to Practical Project Appraisal*[2] in 1978. Our discussion of the UNIDO approach is based largely on the latter publication though at places we will draw on the former publication (generally referred to as *Guidelines*) too.

The UNIDO method of project appraisal involves five stages:

1. Calculation of the financial profitability of the project measured at market prices.
2. Obtaining the net benefit of the project measured in terms of economic (efficiency) prices.
3. Adjustment for the impact of the project on savings and investment.
4. Adjustment for the impact of the project on income distribution.
5. Adjustment for the impact of the project on merit goods and demerit goods whose social values differ from their economic values.

Each stage of appraisal measures the desirability of the project from a different angle.

The measurement of financial profitability of the project in the first stage is similar to the financial evaluation discussed at great length in the previous chapters of this book. So, skipping the first stage, we will discuss the remaining stages here.

14.3 NET BENEFIT IN TERMS OF ECONOMIC (EFFICIENCY) PRICES

Stage two of the UNIDO approach is concerned with the determination of the net benefit of the project in terms of economic (efficiency) prices, also referred to as shadow prices.

Market prices represent shadow prices only under conditions of perfect markets which are almost invariably not fulfilled in developing countries. Hence, there is a need for developing shadow prices and measuring net economic benefit in terms of these prices.

Shadow Pricing: Basic Issues

Before we deal with shadow pricing of specific resources, certain basic concepts and issues must be discussed: choice of numéraire, concept of tradability, source of shadow prices, treatment of taxes, and consumer willingness to pay.

Choice of Numéraire One of the important aspects of shadow pricing is the determination of the numéraire, the unit of account in which the value of inputs or outputs is expressed.

1. UNIDO, *Guidelines for Project Evaluation*, United Nations, 1972.
2. UNIDO, *Guide to Practical Project Appraisal*, United Nations, 1978.

To define the numéraire, the following questions have to be answered: What unit of currency, domestic or foreign, should be used to express benefits and costs? Should costs and benefits be measured in current values or constant values? With reference to which point present or future—should costs and benefits be evaluated? What use—consumption or investment—will be made of the income from the project? Should the income of the project be measured in terms of consumption or investment? With reference to which group should the income of the project be measured?

The specification of the UNIDO numéraire in terms of the above questions is: "net present consumption in the hands of people at the base level of consumption in the private sector in terms of constant price in domestic accounting rupees."

Concept of Tradability A key issue in shadow pricing is whether a good is tradable or not. For a good that is tradable, the international price is a measure of its opportunity cost to the country. Why? For a tradable good, it is possible to substitute import for domestic production and vice versa; similarly it is possible to substitute export for domestic consumption and vice versa. Hence the international price, also referred to as the border price, represents the 'real' value of the good in terms of economic efficiency.

Sources of Shadow Prices The UNIDO approach suggests three sources of shadow pricing, depending on the impact of the project on national economy. A project, as it uses and produces resources, may for any given input or output (i) increase or decrease the total consumption in the economy, (ii) decrease or increase production in the economy, (iii) decrease imports or increase imports, or (iv) increase exports or decrease exports.

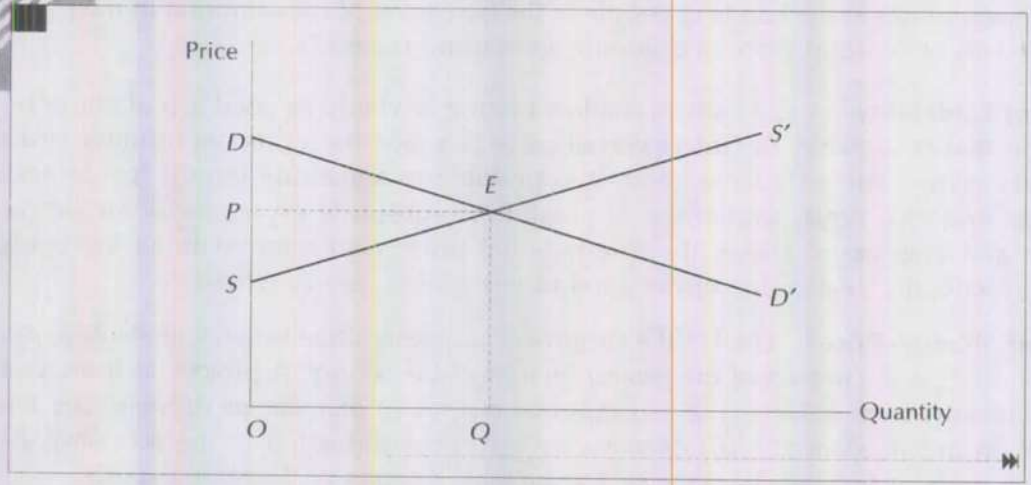
If the impact of the project is on consumption in the economy the basis of shadow pricing is consumer willingness to pay. If the impact of the project is on production in the economy, the basis of shadow pricing is the cost of production. If the impact of the project is on international trade—increase in exports, decrease in imports, increase in imports, or decrease in exports—the basis of shadow pricing is the foreign exchange value.

Taxes When shadow prices are being calculated, taxes usually pose difficulties. The general guidelines in the UNIDO approach with respect to taxes are as follows: (i) When a project results in diversion of non-traded inputs which are in fixed supply from other producers or addition to non-traded consumer goods, taxes should be included. (ii) When a project augments domestic production by other producers, taxes should be excluded. (iii) For fully traded goods, taxes should be ignored.

Consumer Willingness to Pay As noted above, if the impact of the project is on consumption in the economy, the basis of shadow pricing is consumer willingness to pay. How is this measured? The measurement of consumer willingness to pay may be explained with the help of Exhibit 14.1. In the graph shown in this exhibit, DD' represents the demand schedule, SS' the supply schedule, E the equilibrium point, OQ the quantity bought, and

OP the price per unit. Looking at the demand schedule we find that the consumer who buys the first unit is willing to pay *OD* for that unit and the consumer who buys the last unit is willing to pay *OP* for that unit. The consumer willingness to pay for various units is indicated by the schedule *DE*. So the total willingness to pay by consumers who buy the product is measured by the area *ODEQ*. The price paid by them, however, is only *OPEQ*. The difference between *ODEQ* and *OPEQ*, namely *DEP*, is referred to as the consumer surplus.

Exhibit 14.1 ***Consumer Willingness to Pay***



Shadow Pricing of Specific Resources

Tradable Inputs and Outputs A good is fully traded when an increase in its consumption results in a corresponding increase in import or decrease in export or when an increase in its production results in a corresponding increase in export or decrease in import. For fully traded goods, the shadow price is the border price, translated in domestic currency at the market exchange rate.

The above definition of a fully traded good implies that domestic changes in demand or supply affect just the level of imports or exports. This means for an imported good, the following conditions should be met: (i) If there is an import quota, it is not restrictive. (ii) The import supply is perfectly elastic over the relevant range of import volume. (iii) There is no surplus capacity in the domestic industry; all additional supply must be imported. If there is surplus domestic capacity it cannot be utilised for want of necessary inputs. (iv) If the additional demand exists inland, the imported goods, even after taking into account the cost of transport from the port of entry to the point of inland demand, cost less than the marginal cost of local production. (v) The imported input costs less than the domestic marginal cost of purchase.

When the above conditions are satisfied, additional demand will be met fully by external trade. Hence the input is considered fully traded. Similar conditions must be satisfied

for importable outputs, exportable inputs, and exportable outputs, if they are to be considered fully traded. In practice, it is reasonable to regard tradable inputs and outputs as fully traded, even if the above-mentioned conditions are not fully satisfied.

A good is not traded if it is tradable but conditions (i) through (iv) above are not fulfilled. For non-traded goods the border price does not reflect its economic value. What then is the value of non-traded goods? The value of a non-traded good should be measured in terms of of what domestic consumers are willing to pay, if the output of the project adds to its domestic supplies or if the requirement of the project causes reductions of its consumption by others. The value of a non-traded good should be measured in terms of its marginal cost of production if the requirement of the project induces additional production or if the output of the project causes reduction of production by other units.

Non-tradable Inputs and Outputs A good is non-tradable when the following conditions are satisfied: (i) its import price (CIF price) is greater than its domestic cost of production, and (ii) its export price (FOB price) is less than its domestic cost of production.

The valuation of non-tradables is done as per the principles of shadow pricing discussed earlier. On the output side, if the impact of the project is to increase the consumption of the product in the economy, the measure of value is the marginal consumers' willingness to pay; if the impact of the project is to substitute other production of the same non-tradable in the economy, the measure of value is the saving in cost of production. On the input side, if the impact of the project is to reduce the availability of the input to other users, their willingness to pay for that input represents social value; if the project's input requirement is met by additional production of it, the production cost of it is the measure of social value.

Externalities An externality, also referred to as an external effect, is a special class of good which has the following characteristics: (i) It is not deliberately created by the project sponsor but is an incidental outcome of legitimate economic activity. (ii) It is beyond the control of the persons who are affected by it, for better or for worse. (iii) It is not traded in the market place.

An external effect may be beneficial or harmful. Examples of *beneficial external effects* are:

- An oil company drilling in its own fields may generate useful information about oil potential in the neighbouring fields.
- The approach roads built by a company may improve the transport system in that area.
- The training programme of a firm may upgrade the skills of its workers thereby enhancing their earning power in subsequent employments.

Examples of *harmful external effects* are:

- A factory may cause environmental pollution by emitting large volumes of smoke and dirt. People living in the neighbourhood may be exposed to health hazards and put to inconvenience.

- The location of an airport in a certain area may raise noise level considerably in the neighbourhood.
- A highway may cut a farmer's holding in two, separating his grazing land and his cowsheds, thereby adversely affecting his physical output.

Since SCBA seeks to consider all costs and benefits, to whomsoever they may accrue, external effects need to be taken into account. The valuation of external effects is rather difficult because they are often intangible in nature and there is no market price which can be used as a starting point. Their value is estimated by indirect means. For example:

- The benefit of information provided by the oil field to neighbouring oil fields may be equated with what the neighbouring oil fields would have spent to obtain such information.
- The value of better transport provided by the approach roads may be estimated in terms of increased activities and benefits derived therefrom.
- The benefit from the training programme may be estimated in terms of the increased earning power of workers.
- The cost of pollution may be estimated in terms of the loss of earnings as a result of damage to health caused by it and the cost of time spent for coping with the unhygienic surroundings.
- The cost of noise may be inferred from the differences in rent between the noise-affected area and that of some other area which is comparable except for the level of noise.
- The harmful external effect of the highway may be measured by the consumer willingness to pay for the output of the farmer which has been reduced due to the highway.

The above examples serve to emphasise the difficulties in measuring external effects. In view of this, some economists have suggested that these effects be ignored. In order to justify their suggestion, they argue that since a project is likely to have both beneficial and harmful external effects, one may not err much in assuming that the net effect would be zero. This argument, seemingly a rationalisation for one's ignorance, lacks validity. External effects must be taken into account wherever it is possible to do so. Even if these effects cannot be measured in monetary terms, some qualitative evaluation must be attempted.

Labour Inputs The principles of shadow pricing for goods may be applied to labour as well, though labour is considered to be a service. When a project hires labour, it could have three possible impacts on the rest of the economy: (i) it may take labour away from other employments; (ii) it may induce the production of new workers; (iii) and it may involve import of workers.

When a project takes labour away from other employments, the shadow price of labour is equal to what other users of labour are willing to pay for this labour. In a relatively free market this will be equal to the marginal product of such labour.

The social cost associated with inducing 'additional' production of workers consists of the following: (i) the marginal product of the worker in the previous employment if the worker is previously unemployed, this would naturally be zero; (ii) the value assigned by the worker on the leisure that he may have to forego as a result of employment in the project—the value of this leisure is reflected in his reservation wage[3]; (iii) the additional consumption of food when a worker is fully employed as opposed to when he is idle or only partly employed; (iv) the cost of transport and rehabilitation when a worker is moved from one location to another; (v) the increased consumption by the worker and its negative impact on savings and investment in the society when the worker is paid market wage rate by the project; and (v) the cost of training a worker to improve his skills.

The social cost associated with the import of foreign workers is the wage they command. In their case, however, a premium should be added on account of the foreign exchange remitted abroad by these workers from their savings.

Capital Inputs When a capital investment is made in a project two things happen: (i) Financial resources are converted into physical assets. (ii) Financial resources are withdrawn from the national pool of savings and hence alternative projects are foregone. Thus, shadow pricing of capital investment involves two questions:

- What is the value of physical assets?
- What is the opportunity cost of capital (which reflects the benefit foregone by sacrificing alternative project/s)?

The value (shadow price) of physical assets is calculated the way the value of other resources is calculated. If it is a fully traded good, it shadow price is equal to its border price. If it is non-traded good its price is measured in terms of cost of production (if the project induces additional domestic production of the asset) or consumer willingness to pay (if the project takes the asset from other users).

The opportunity cost of capital depends on how the capital required for the project is generated. To the extent that it comes from additional savings, its opportunity cost is measured by the consumption rate of interest (which reflects the price the saver must be paid to sacrifice present consumption); to the extent that it comes from the denial of capital to alternative projects, it opportunity cost is the rate of return that would be earned from those alternative projects. This is also called the investment rate of interest. In practice, the consumption rate of interest may be used as the discount rate because in stage three of the UNIDO analysis all inputs and outputs are converted into their consumption equivalents.

There are, however, problems in determining the consumption rate of interest empirically. So the UNIDO approach recommends a 'bottom up' procedure. As per this

3. The reservation wage of a person depends on the following: (i) the income he already enjoys through transfer payments, (ii) his idea of what job is acceptable to him, and (iii) his preference for work and leisure.

procedure, the project analyst calculates the internal rate of return of a project and presents the project to the planners (or politicians) who are the decision makers. If the project is accepted, the analyst may assume that the planners judge the consumption rate of interest to be more than the interest rate of return. On the basis of a repetitive application of this process, the range for estimated consumption rate of interest can be sufficiently narrowed for practical use, provided, of course, the planners on the top are consistent.

Foreign Exchange The UNIDO method uses domestic currency as the numéraire. So the foreign exchange input of the project must be identified and adjusted by an appropriate premium. This means that valuation of inputs and outputs that was measured in border rupees has to be adjusted upward to reflect the shadow price of foreign exchange.

How is the shadow price of foreign exchange established? The *Guidelines* method determines the shadow price of foreign exchange on the basis of marginal social value as revealed by the consumer willingness to pay for the goods that are allowed to be imported at the margin. The shadow price of a unit of foreign exchange is equal to:

$$\sum_{i=1}^{n} F_i Q_i P_i \qquad (14.1)$$

where F_i = fraction of foreign exchange, at the margin, spent on importing commodity i

Q_i = quantity of commodity i that can be bought with one unit foreign exchange (This will be equal to 1 divided by the CIF value of the goods in question).

P_i = domestic market clearing price of commodity i

Example Commodities 1, 2, 3, and 4 are imported at the margin. The proportion of foreign exchange spent on them, the quantities that can be bought per unit of foreign exchange, and the domestic market clearing prices are as follows:

$$F_1 = 0.3, \quad F_2 = 0.4, \quad F_3 = 0.2, \quad F_4 = 0.1$$
$$Q_1 = 0.6, \quad Q_2 = 1.5, \quad Q_3 = 0.25, \quad Q_4 = 3.0$$
$$P_1 = 16, \quad P_2 = 8, \quad P_3 = 40, \quad P_4 = 5$$

The value of a unit of foreign exchange is:

(.3) (0.6) (16) + (0.4) (1.5) (8) + (0.2) (0.25) (40) + (.1) (3.0) (5) = Rs 13.180.

The calculation of the shadow price of foreign exchange in terms of consumer willingness to pay is based on the assumption that the foreign exchange requirement of a project is met from the sacrifice of others. The use of foreign exchange by a project, however, may also induce the production of foreign exchange through additional exports or import substitution. In such a case, the shadow price of foreign exchange would be based on the cost of producing foreign exchange, not consumer willingness to pay for foreign exchange. One of the best known approaches to determine the cost of producing foreign exchange is the domestic resource cost method proposed by Michael Bruno. Though this approach is oriented to estimate what is the cost of producing foreign exchange by a single project, its principles can be applied to estimate the cost of producing foreign exchange at the macro level.

Programming Approach Another approach for determining the value of foreign exchange is the programming approach. According to this approach, the shadow price of foreign exchange is obtained by solving the dual problem of an economy-wide optimising mathematical programming model. In the primal model, one of the constraints represents limited foreign exchange availability. (More than one constraint relating to foreign exchange may be introduced if it is necessary to distinguish various foreign currencies.) Hence the shadow price represents the contribution that unit of foreign exchange at the margin would make to the objective function.

Conceptually sound, the usefulness of this approach in practice depends on whether the model reflects economic realities and whether the required data are available. Since these conditions are not readily satisfied, caution should be exercised in employing this approach.

Bridge Project

To illustrate the calculation of net economic benefit, two examples are given. The first example is that of a bridge project. The second example is that of a river valley project.

Presently, a ferry service, operated privately, is being used to cross a river. The ferry operator charges Rs 3 per person. It costs him Rs 2 per person. 50,000 persons use the ferry service. (This means that the number of persons crossing the river by ferry service throughout the year is 50,000.)

The government is considering construction of a bridge over the river. It is estimated that after the bridge is constructed 2,50,000 persons will cross the river on the bridge. The bridge is expected to cost Rs 3 million initially and its annual maintenance cost would be Rs 10,000. It has an indefinitely long life. Once the bridge is constructed the ferry operator is expected to close down the ferry service and sell the ferry boats for Rs 100,000.

Required: Define the social costs and benefits of constructing the bridge, assuming that the monetary figures given in the problem represent economic values.

Solution: The social costs and benefits of bridge construction may be defined as follows:

Costs

These consist of the following:

1. Construction cost: Rs 3,000,000 (This is a one-shot cost).
2. Maintenance cost: Rs 10,000 (This is an annual cost).

Benefits

These consist of the following:

1. Value of ferries released: Rs 100,000 (This is one-shot benefit).
2. Savings in the cost of ferry operation: Rs 100,000 (This is an annual benefit).

3. Increase in consumer satisfaction: This is equal to willingness to pay of 200,000 additional persons who are expected to use the bridge. Since the first additional person is willing to pay almost Rs 3 (the charge of the ferry operator) and the last person is willing to pay almost nothing (there is no toll for using the bridge) the average willingness to pay of additional users, assuming that the demand schedule is linear, is Rs 1.50. So the willingness to pay of 200,000 additional persons is 200,000 × Rs 1.50 = Rs 300,000. (This is shown in Exhibit 14.2 by the triangle.)

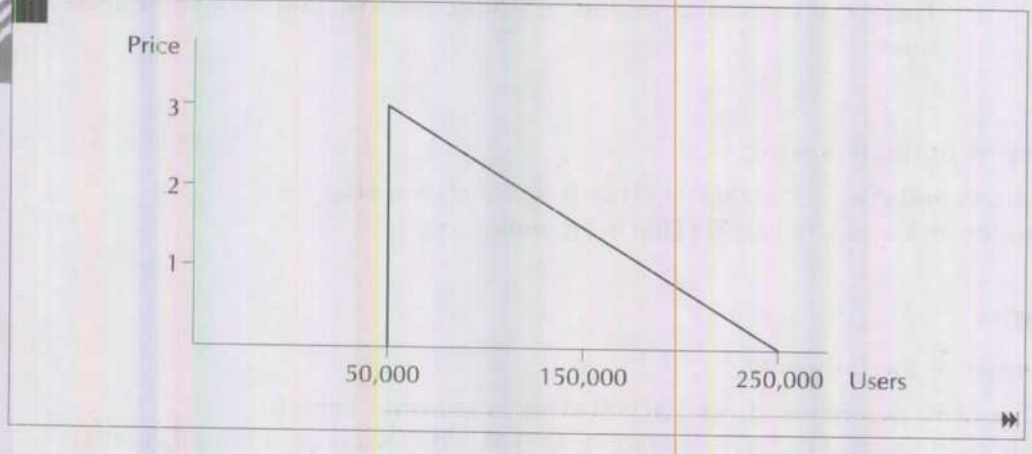
River Valley Project

The government is considering a multi-purpose river valley project which would involve construction of a dam, a reservoir, a power house, and several irrigation canals. The project would supply water for irrigation, generate electricity, and provide a measure of protection against floods. The following information has been gathered by the project control board.

The project will require the following during the construction stage:

1. Indigenous power equipment costing Rs 200 million.
2. Imported power equipment costing $10 million.
3. 20,000 tonnes of steel produced indigenously and made available to the project at Rs 6000 a tonne.
4. 350,000 tonnes of cement produced indigenously and made available to the project at Rs 800 a tonne.
5. Other construction materials (sand, bricks, etc.) costing Rs 100 million.
6. 25 million mandays of unskilled labour for which the project control board has decided to pay a daily wage rate of Rs 10.
7. Skilled labour costing Rs 100 million.

Exhibit 14.2 ***Consumer Willingness to Pay***



Once commissioned, the operating and maintenance cost of the project would be Rs 35 million per year.

The annual benefits expected from the project would be as follows:

1. 300,000 acres of land will be irrigated.
2. 120 million units of electricity will be generated for domestic use.
3. Flood damages to the extent of Rs 10 million will be saved annually.

The following additional information is available:

1. Power equipment produced indigenously is a tradable item whose FOB value is $ 15 million.
2. A gift of $ 10 million, available from a foreign agency, can be used for acquiring imported equipment. This gift, however, is not project-tied. Hence, if it is not assigned to the project, it can be used for some other purpose.
3. The shadow price per dollar is Rs 12, though the official price is Rs 10.
4. Steel is a tradable item whose FOB value is $ 400 per tonne.
5. Cement is not a tradable item. One-half of the cement required for the project will come from additional domestic production which has a cost of Rs 700 per tonne; one-half of the cement required for the project will come from diversion from other consumers who are willing to pay, on average, Rs 1,200 per tonne.
6. Other construction materials are non-tradable items. The requirement of the project will be met by way of additional production. The cost of this production will be Rs 80 million.
7. The shadow price of unskilled labour is Rs 5 per day.
8. The compensation paid to skilled labour reflects what others are willing to pay for their services.
9. The operating and maintenance cost of Rs 35 million reflects economic value as well.
10. The water levy by the project control board would be Rs 100 per acre. However, the value of additional output per acre, attributable to the water supplied by the project, will be Rs 400 a year.
11. The electricity tariff charged by the project control board would be 30 paise per unit. The consumer willingness to pay, however, would be, on an average, 50 per cent more than the tariff charged.
12. The project control board is not able to collect anything for the protection provided against floods.

Required: Define the costs and benefits from the private (project control board's) and the economic point of view.

Solution: The costs and benefits from the private and economic (social) angles are shown in Exhibit 14.3.

Exhibit 14.3 ***Costs and Benefits from the Private and Economic Angles***

	Nature	Private angle (Rs in million)	Economic angle (Rs in million)	Explanation for economic values
Costs				
1. Indigenous power equipment	One shot	200	180	This is a tradable item whose FOB value is $ 15 million. This is converted into rupees by applying the shadow price of foreign exchange.
2. Imported power equipment	One shot	–	120	The foreign exchange is converted into rupees by applying the shadow price of foreign exchange.
3. Steel	One shot	120	96	This is a tradable item whose FOB value is $ 8 million. This is converted into rupees by applying the shadow price of foreign exchange.
4. Cement	One shot	280	332.5	This is a non-tradable item. 175,000 tonnes of cement required by the project is produced additionally in the country for which the cost of production is Rs 122.5 million. 1,75,000 tonnes of cement required for the project is diverted from other users who are willing to pay Rs 210 million.
5. Other construction material	One shot	100	80	This is a non-tradable item. The requirement of the project is met by additional domestic production costing Rs 80 million.
6. Unskilled labour	One shot	250	125	25 million mandays are multiplied by Rs 5, the shadow wage rate.
7. Skilled labour	One shot	100	100	The compensation paid to skilled labour reflects what others are willing to pay for it.
8. Operating and maintenance cost	Annual	35	35	The annual operating and maintenance cost reflects economic value as well.
Benefits				
1. Irrigation	Annual	30	120	The value of additional agricultural output attributable to the water supplied by the project is Rs 120 million.
2. Electricity	Annual	36	54	The consumer willingness to pay for the electricity provided by the project is, on average, 50 per cent higher than the electricity tariff charged.
3. Flood relief	Annual	–	10	The value of savings due to flood relief benefit from the project is Rs 10 million annually.

14.4 MEASUREMENT OF THE IMPACT ON DISTRIBUTION

Stage three and four of the UNIDO method are concerned with measuring the value of a project in terms of its contribution to savings and income redistribution. To facilitate such assessments, we must first measure the income gained or lost by individual groups within the society.

Groups

For income distribution analysis, the society may be divided into various groups. The UNIDO approach seeks to identify income gains and losses by the following:

- Project
- Other private business
- Government
- Workers
- Consumers
- External sector

There can, however be, other equally valid groupings.

Measure of Gain or Loss

The gain or loss to an individual group within the society as a result of the project is equal to the difference between the shadow price and the market price of each input or output in the case of physical resources or the difference between the price paid and the value received in the case of financial transactions.

Example 1 Farmers in a certain area use 1 million units of electricity generated by a hydroelectric project. The benefit derived by them, measured in terms of the willingness to pay, is equal to Rs 0.4 million. The tariff paid by them to the electricity board is Rs 0.25 million. So, the impact of the project on the farmers is a gain of Rs 0.15 million.

Example 2 A mining project requires 1,000 labourers. These labourers are prepared to offer themselves for work at a daily wage rate of Rs 4. (This represents their supply price.) The wage rate paid to the labourers, however, is Rs 10 per day. So the redistribution benefit enjoyed by the group of 1,000 labourers is Rs 6,000 (1,000 × (10 – 4)) per day.

14.5 SAVINGS IMPACT AND ITS VALUE

Most of the developing countries face scarcity of capital. Hence, the governments of these countries are concerned about the impact of a project on savings and its value thereof. Stage

three of the UNIDO method, concerned with this, seeks to answer the following questions:

- Given the income distribution impact of the project what would be its effects on savings?
- What is the value of such savings to the society?

Impact on Savings

The savings impact of a project is equal to:

$$\sum \Delta Y_i MPS_i \tag{14.2}$$

where ΔY_i = change in income of group i as a result of the project.

MPS_i = marginal propensity to save of group i

Example As a result of a project the income gained/lost by four groups is: Group 1 = Rs 100,000 Group 2 = Rs 600,000, Group 3 = – Rs 200,000, and Group 4 = – Rs 400,000. The marginal propensity to save of these four groups is as follows:

$MPS_1 = 0.05$, $MPS_2 = 0.10$, $MPS_3 = 0.20$, and $MPS_4 = 0.40$.

The impact on savings of the project is:

$100{,}000 \times 0.05 + 500{,}000 \times 0.10 - 200{,}000 \times 0.20 - 400{,}000 \times 0.40 =$ – Rs 1,45,000.

Value of Savings

The value of a rupee of savings is the present value of the additional consumption stream produced when that rupee of savings is invested at the margin. The additional stream of consumption generated by a rupee of investment depends on the marginal productivity of capital and the rate of reinvestment from additional income. If the marginal productivity of capital is r and the rate of reinvestment from additional income a, the additional stream of consumption generated by a rupee of investment can be worked out as shown in Exhibit 14.4.

Exhibit 14.4 ***Derivation of Additional Consumption Stream from a Rupee of Investment Now***

Year	0	1	2	3	... n ...
Investment (cumulative)	1	$1 + ar$	$(1 + ar)^2$		$(1 + ar)^n$
Income		r	$r(1 + ar)$	$r(1 + ar)^2$	$r(1 + ar)^{n-1}$
Additional investment		ar	$ar(1 + ar)$	$ar(1 + ar)^2$	$ar(1 + ar)^{n-1}$
Consumption		$r(1 - a)$	$r(1 - a)$	$r(1 - a)$	$r(1 - a)(1 + ar)^{n-1}$
			$(1 + ar)$	$(1 + ar)^2$	

From this exhibit we find that the consumption stream starts with $r(1-a)$ and grows annually at the rate of ar forever. Its present value when discounted at the social discount rate k is:

$$I = \frac{r(1-a)}{(1+k)} + \frac{r(1-a)(1+ar)}{(1+k)^2} + \ldots + \frac{r(1-a)(1+ar)^{n-1}}{(1+k)^n} + \cdots$$

$$= \frac{\frac{r(1-a)}{(1+k)}}{1-\frac{(1+ar)}{(1+k)}} = \frac{r(1-a)}{(k-ar)} \qquad (14.3)$$

where I = social value of a rupee of savings (investment)

r = marginal productivity of capital

a = reinvestment rate on additional income arising from investment

k = social discount rate.

The social value of savings (also called the shadow price of investment) for certain values of r, a, and k is given in Exhibit 14.5. The formula for the social value of savings is valid when the following conditions are satisfied: (i) The marginal productivity of capital and the reinvestment rate on additional income (marginal propensity to save) are constant over time. (ii) Savings rate in the society will not become optimal in the foreseeable future. While these conditions may seem somewhat restrictive, in practice, for want of better information, it is convenient to accept them.

14.6 INCOME DISTRIBUTION IMPACT

Many governments regard redistribution of income in favour of economically weaker sections or economically backward regions as a socially desirable objective. Due to practical difficulties in pursuing the objective of redistribution entirely through the tax, subsidy, and transfer measures of the government, investment projects are also considered as investments for income redistribution and their contribution toward this goal is considered in their evaluation. This call for suitably weighing the net gain or loss by each group, measured earlier, to reflect the relative value of income for different groups and summing them.

How should the relative weights be determined? The *Guidelines* suggested that the weights, which essentially reflect political judgements, may be determined by an iterative process involving interaction between the analyst and the planners. To illustrate, consider a project:

Exhibit 14.5 ***Shadow Price of Investment***

		$k = 0.08$	$k = 0.10$	$k = 0.12$
$r = 0.10$	$a = 0.20$	1.33	1.00	0.80
	$a = 0.30$	1.40	1.00	0.77
	$a = 0.40$	1.50	1.00	0.75
	$a = 0.50$	1.67	1.00	0.71
$r = 0.12$	$a = 0.20$	1.72	1.26	1.00
	$a = 0.30$	1.91	1.31	1.00
	$a = 0.40$	2.25	1.38	1.00
	$a = 0.50$	3.00	1.50	1.00
$r = 0.15$	$a = 0.20$	2.40	1.71	1.33
	$a = 0.30$	3.00	1.91	1.40
	$a = 0.40$	4.50	2.25	1.50
	$a = 0.50$	15.00	3.00	1.67

Net present value of the project – Rs 2 million

Income gain to low income group as a result of the project Rs 5 million

Suppose the project is accepted by the planners. The implies that the planners place a premium of at least 40 percent on income going to the poor. If the planners reject this project but accept some other project which requires a premium of at least 30 percent on the income going to the poor, the project analyst may infer that the premium placed by planners on income going to the poor lies between 30 percent and 40 percent.

This procedure works well if only two groups are involved (in the previous example it was assumed that the two groups were the poor and the others). Where more than two groups are involved the procedure breaks down because several unknown weights are involved. In such a situation, the analyst would not be able to figure out, given the preference of the planners, the relative weights assigned by them on income to the various groups. To tackle this problem, a single factor has to be found which determines the income distribution weights so that the 'bottom-up' approach becomes workable. This single factor, as economists suggest, is the elasticity of marginal utility of income.[4] This is defined as the rate at which the marginal utility of income falls with increases in the level of income. For example, if the marginal utility of income declines by 5 percent with a 5 percent increase in income, the elasticity of marginal utility of income is 5 percent/5 percent = 1[5]. Likewise, if the marginal utility of income declines by 10 percent with a 5 percent increase in income, the elasticity of marginal utility of income is 10 percent/5 percent = 2. If the elasticity of marginal utility is equal to 1.0, a 1 percent increase in the income of a person earning Rs 1,000 a year is socially as valuable as a 1 percent increase in the income of a

4. The marginal utility of income is the value derived from one more unit of income. This obviously depends on the present level of income.
5. It may be noted that by convention the negative sign is omitted.

person earning Rs 10,000 a year, or Rs 100,000 a year, or for that matter any amount a year. This means that from the social point of view the following gains are equally valuable:

A gain of Rs 10 to a person earning Rs 1,000 a year.

A gain of Rs 100 to a person earning Rs 10,000 a year.

A gain of Rs 1,000 to a person earning Rs 100,000 a year.

This implies that if the weight at Rs 1,000 is put at 1, the weight at Rs 10,000 is 1/10, and the weight at Rs 100,000 is 1/100.

In general, the weight attached to an income is given by the formula:

$$w_i = \left(\frac{b}{c_i}\right)^n \tag{14.4}$$

where w_i = weight attached to income at c_i level

b = base level of income that has a weight of 1

n = elasticity of the marginal utility of income.

Exhibit 14.6 shows the relative weights for different levels of income for values of n varying between 0 and 1, given a base level of income of Rs 1,000 which has a weight of 1.

Exhibit 14.6 ***Relative Weights for Different Levels of Income for Values of n Varying Between 0 and 1***

	Value of n				
Level of income	*0.2*	*0.4*	*0.6*	*0.8*	*1.0*
500	1.15	1.32	1.52	1.74	2.00
1,000	1.00	1.00	1.00	1.00	1.00
5,000	0.72	0.53	0.38	0.28	0.20
10,000	0.63	0.40	0.25	0.16	0.10
20,000	0.55	0.30	0.17	0.09	0.05
30,000	0.51	0.26	0.13	0.07	0.03
50,000	0.46	0.21	0.10	0.04	0.02
100,000	0.40	0.16	0.06	0.03	0.01

14.7 ADJUSTMENT FOR MERIT AND DEMERIT GOODS

In some cases, the analysis has to be extended beyond stage four to reflect the difference between the economic value and social value of resources. This difference exists in the case of merit goods and demerit goods. A merit good is one for which the social value exceeds the economic value. For example, a country may place a higher social value than economic value on production of oil because it reduces dependence on foreign supplies. The concept of merit goods can be extended to include a socially desirable outcome like creation of

employment. In the absence of the project, the government perhaps would be willing to pay unemployment compensation or provide mere make-work jobs.

In the case of demerit good, the social value of the good is less than its economic value. For example, a country may regard alcoholic products as having a social value less than the economic value.

The procedure for adjusting for the difference between social value and economic value is as follows: (i) Estimate the economic value. (ii) Calculate the adjustment factor as the difference between the ratio of social value to economic value and unity. (iii) Multiply the economic value by the adjustment factor to obtain the adjustment. (iv) Add the adjustment to the net present value of the project as calculated in stage four.

To illustrate, consider a project for which the following information is available: (i) The present economic value of the output of the project is Rs 25 million. (ii) The output of the project has a social value which exceeds its economic value by 20 percent. Given this information, the adjustment factor would be 0.2 (120 percent/100 percent – 1). Multiplying the present economic value by 0.2, we get an adjustment of Rs 5 million. This, then, is added to the present economic value of Rs 25 million.

Where the socially valuable output of the project does not appear as an output in the economic analysis—as is the case where the project generates employment—the procedure is somewhat different. In such a case the output is treated like an externality and its valuation in social terms is the adjustment.

While the adjustment for the difference between the social value and economic value is seemingly a step in the right direction, it is amenable to abuse. Once the analyst begins to make adjustment for social reasons, projects which are undesirable economically may be made to appear attractive after such adjustment. Since the dividing line between 'political' and 'social' is rather nebulous, it becomes somewhat easy to push politically expedient projects, irrespective of their economic merit by investing them with social desirability. While there is no way to prevent such a manipulation, the stage-by-stage UNIDO approach mitigates its occurrence by throwing it in sharp relief.

14.8 LITTLE–MIRRLEES APPROACH

I.M.D. Little and J.A. Mirrlees have developed an approach (hereafter referred to as the L–M approach) to social cost benefit analysis expounded by them in the following works: *Manual of Industrial Project Analysis in Developing Countries, Vol. II and Project Appraisal and Planning for Developing Countries.*

There is considerable similarity between the UNIDO approach and the L–M approach. Both the approaches call for:

1. Calculating accounting (shadow) prices particularly for foreign exchange savings and unskilled labour.
2. Considering the factor of equity.
3. Use of DCF analysis.

Despite considerable similarities there are certain differences between the two approaches:

1. The UNIDO approach measures costs and benefits in terms of domestic rupees whereas the L–M approach measures costs and benefits in terms of international prices, also referred to as border prices.
2. The UNIDO approach measures costs and benefits in terms of consumption whereas the L–M approach measures costs and benefits in terms of uncommitted social income.
3. The stage-by-stage analysis recommended by the UNIDO approach focuses on efficiency, savings, and redistribution considerations in different stages. The L-M approach, however, tends to view these considerations together.

14.9 SHADOW PRICES

The outputs and inputs of a project are classified into the following categories: (i) traded goods and services, (ii) non-traded goods and services, and (iii) labour.

Shadow Price of Traded Goods

The shadow price of a traded good is simply its border price. If a good is exported, its shadow price is its FOB price and if a good is imported its shadow price is its CIF price. If foreign demand is not perfectly elastic, the marginal export revenue is substituted for the FOB price; similarly, if foreign supply is not perfectly elastic, the marginal import cost is substituted for the CIF price. The logic for using border prices for traded goods is fairly straight-forward: border prices represent the correct social opportunity costs or benefits of using or producing a traded good.

Accounting Price[6] of Non-Traded Goods

Some goods and services like land, building, transportation, and electricity are not amenable to foreign trade. Hence, there is no border price observable for them. Accounting prices for non-traded items are defined in terms of marginal social cost and marginal social benefit.

The marginal social cost of a good is the value in terms of accounting prices of the resources required to produce an extra unit of the good. For example, the marginal social cost

6. The terms accounting price and shadow price are used inter-changeably.

of a bus trip is roughly equal to the cost of material inputs (fuel, oil, wear and tear of the bus, etc.) evaluated at border prices plus the social wage of the driver and the conductor.

The marginal social benefit is the value of an extra unit of the good from the social point of view. When a good is not taxed and is consumed by only one income group, its marginal social benefit is equal to its market price multiplied by a factor which represents the value assigned to an increase in the income of that group vis-à-vis an equal increase in uncommitted social income.

To determine the accounting price of a non-traded input, one should estimate the proportion in which the demand for that input will be met from increased production and decreased consumption elsewhere in the economy. If the proportion of increase in production to decrease in consumption is, say, 2:1, the accounting price of the non-traded input will be:

$$\frac{2}{3} \text{ Marginal social cost} + \frac{1}{3} \text{ Marginal social benefit}$$

Use of Conversion Factors

Ideally, the accounting price of a non-traded item is defined in terms of marginal social cost and marginal social benefit. In practice, the calculation of marginal social cost and marginal social benefit is often a difficult task. As a practical expedient, L–M suggest that the monetary cost of a non-traded item be broken down into tradable, labour, and residual components. The tradable and residual components may be converted into social cost by applying suitable social conversion factors; the labour component's social cost can be obtained by using social wage rate (which is discussed below).

Shadow Wage Rate

The shadow wage rate is an important but difficult-to-determine element in social cost benefit analysis. It is a function of several factors: (i) the marginal productivity of labour, (ii) the cost associated with urbanisation (cost of transport, urban overheads, etc.), and (iii) the cost of having an additional amount committed to consumption when the consumption of the worker increases as a result of the higher income he enjoys in urban employment.

L–M suggest the following formula for calculating the shadow wage rate:

$$SWR = c' - 1/s\ (c - m) \tag{14.5}$$

where SWR = shadow wage rate

c' = additional resources devoted to consumption

$1/s$ = value of a unit of committed resource

c = consumption of the wage earner

m = marginal product of the wage earner.

To understand clearly the components of *SWR*, Eq. (14.5) may be rewritten as follows:

$$SWR = m + (c' - c) + \left(1 - \frac{1}{s}\right)(c - m) \tag{14.6}$$

The first term, m, is the marginal product of labour; the second term, $(c' - c)$, represents the cost of urbanisation (it is the cost associated with providing the consumption level of c though it does not form part of it); the third term, $(1 - 1/s)\ (c - m)$, represents the cost of having an additional amount $(c - m)$ committed to consumption (it may be noted that 1 is the value of a unit of uncommitted resource and $1/s$ is the value of a unit of committed resource).

Accounting Rate of Return[7]

The accounting rate of return (interest) is the rate used for discounting social profits. In determining the accounting rate of return the following considerations should be borne in mind:

- The future social profit for all the projects must be discounted in the same way.
- The accounting rate(s) of interest should be such that all mutually compatible projects with positive present social value can be undertaken.
- The accounting rate of interest should maintain some kind of balance between investment and investible resources: too low an accounting rate of interest would lead to over-investment with inflationary effects and too high an accounting rate of interest would leave savings under-utilised and result in excessive unemployment.
- The rate of return currently being earned is a good guide to the accounting rate of interest when the following conditions are reasonably satisfied: (i) indirect taxes are fairly uniform with little discrimination between imported and exported commodities, and (ii) the social wage rate is close to the actual wage rate.
- The initial estimate of the accounting rate of interest should, in principle, be such that it would allow only a few of the best projects in the past.
- Experience is the best guide to the choice of accounting rate of interest: if the investment requirement of acceptable projects exceeds the availability of investible funds, increase the accounting rate of interest; if the investment requirement of acceptable projects is less than the availability of investible funds, decrease the accounting rate of interest. The adjustment in the accounting rate of interest, however, should be gradual over time.

14.10 SCBA BY FINANCIAL INSTITUTIONS

The all-India term-lending financial institutions—IDBI, IFCI, and ICICI—appraise project proposals primarily from the financial point of view. However, they also scrutinise projects

7. Note that the accounting rate of return to the social discount rate. It is very different in meaning from the accounting rate of return discussed in Chapter 1.

from the larger social point of view. ICICI was perhaps the first financial institution to introduce a system of economic analysis as distinct from financial profitability analysis. IFCI adopted a system of economic appraisal in 1979. Finally, IDBI also introduced a system for economic appraisal of projects financed by them. Though there are some minor variations, the three institutions follow essentially a similar approach which is a simplified version of the L–M approach. We shall describe the appraisal procedure followed by IDBI.

IDBI, in its economic appraisal of industrial projects, considers three aspects:

- Economic rate of return
- Effective rate of protection
- Domestic resource cost

Economic Rate of Return

The method followed by IDBI to calculate the economic rate of return may be described as a 'Partial Little-Mirrlees' method because while international prices are used for valuation of tradable inputs and outputs, L–M method is not followed in its entirety. The significant elements of IDBI's method are described below:

1. International prices are regarded as the relevant economic prices and, hence, it is necessary to substitute market prices with international prices for all non-labour inputs and outputs.
2. For tradable items, where international prices are directly available, CIF prices are used for inputs and FOB prices are used for outputs.
3. For tradable items where international prices are not directly available and for non-tradable items (like electricity, transportation, etc.), social conversion factors are used to convert actual rupee cost into social cost. In some cases (like land), a social conversion factor is applied directly to the actual rupee cost. In other cases (like transport), the actual rupee cost is broken down into three components—tradable component, labour component, and residual component—and these components are valued in social terms. Generally, the social cost of the tradable component is obtained by multiplying it by a factor of 1/1.5; the social cost of labour component is obtained by multiplying it by a factor of 0.5 (shadow price of labour is considered to be 50 percent of the actual); the social cost of the residual component is obtained by multiplying it by a factor of 0.5. Exhibit 14.7 shows the social conversion factor/ break-up into tradable, labour, and residual components for various items.

Exhibit 14.7 ***Social Conversion Factor (SCF) or Proportions of Three Components, Tradable (T), Labour (L), and Residual (R)***

Item	*SCF or Proportions*
Land	$SCF = 1/1.5$
Buildings and construction	Proportions: $T = 0.5$, $L = 0.25$, $R = 0.25$
Indigeneous equipment	$SCF = 0.70$
Transportation	Proportions: $T = 0.65$, $L = 0.25$, $R = 0.10$
Engineering and know-how fees	$SCF = 1.50$
Bank charges	$SCF = 0.02$
Preoperative expenses	$SCF = 1.00$
Labour	$SCF = 0.50$
Salaries	$SCF = 0.80$
Repairs and maintenance	$SCF = 1/1.5$
Water, fuel, etc.	Proportions: $T = 0.50$, $L = 0.25$, $R = 0.25$
Electricity	Proportions: $T = 0.71$, $L = 0.13$, $R = 0.16$
Domestic stores	$SCF = 0.80$
Other overheads	$SCF = 1/1.5$

Illustration

A new project for manufacturing a product which is currently being imported in the country is being appraised. The project would have a life of 15 years and it will lead to import substitution. The capital outlay on the project would be as follows:

	(Rs in million)
Land	0.2
Buildings	10.0
Imported equipment (CIF value: Rs 6 million)	7.0
Indigenous equipment (CIF value of similar equipment: Rs 40 million)	50.0
Transport	1.0
Engineering and know-how fees	5.0
Preoperative expenses	4.8
Bank charges	2.0
	80.0

The working capital requirement of the project, consisting only of imported raw materials, will be Rs 16 million (CIF value: Rs 12 million).

The estimated annual profitability of the project is as follows:

Revenues	(Rs in million)
Sales revenue (10,000 tonnes at Rs 10,000 per tonne; CIF price is Rs 7,500 per tonne)	100
Expenses	
Imported raw materials (CIF value: Rs 8 million)	10
Indigenous raw materials and stores	40
Labour	5

Salaries		3
Repairs and maintenance		1
Water, fuel, etc.		5
Electricity		5
Rate	3	
Duty	2	
Depreciation	–	4
Other overheads	7	
Profit		
Taxable profit		20

For the sake of simplicity we may assume that capital costs are incurred at the beginning (i.e., at the end of year 0) and full production begins from year 1 itself.

Given the above information, let us convert the financial costs and benefits into social costs and benefits. We first begin with social costs associated with the initial outlay on the project which consists of capital outlay and working capital. These are shown in Exhibit 14.8. Based on this exhibit, the social cost of initial outlay is worked out as follows:

	(Rs in million)
Tradable value *ab initio*	70.473
Social cost of tradable component = 5.65/1.5	3.767
Social cost of labour component = 2.75 ´ 0.5	1.375
Social cost of residual component = 2.60 ´ 0.5	1.300
Total social cost of initial outlay	76.915

Exhibit 14.8 ***Social Costs Associated with the Initial Outlay***

				(Rs in million)		
Item	*Financial cost*	*Basis of conversion*	*Tradable value ab initio*	*T*	*L*	*R*
Land	0.2	*SCF* = 1/1.5	0.133			
Buildings	10.0	*T* = 0.50, *L* = 0.25, *R* = 0.25		5.00	2.50	2.50
Imported equipment	7.0	*CIF* value	6.00			
Indigeneous equipment	50.0	*CIF* value of similar equipment	40.0			
Transport	1.0	*T* = 0.65, *L* = 0.25, *R* = 0.10		0.65	0.25	0.10
Engineering and know-how fees	5.0	*SCF* = 1.50	7.5			
Preoperative expenses	4.80	*SCF* = 1.0	4.80			
Bank charges	2.00	*SCF* = 0.02	0.04			
Working capital requirement	16.0	*CIF* value	12.00			
Total	196.0		70.473	5.65	2.75	2.60

Exhibit 14.9 shows the conversion of operating costs into social costs. Based on this exhibit, the annual social cost of operation is worked out as follows:

	(Rs in million)
Tradable value *ab initio*	= 50.234
Social cost of tradable component = 4.63/1.5	= 3.087
Social cost of labour component = 1.64 ´ 0.5	= 0.281
Social cost of residual component = 1.73 ´ 0.5	= 0.865
Annual social cost of operations	= 55.007

The annual value of output at CIF prices is Rs 70 million. Hence, the social net benefit per year would be:

70 – 55.007 = Rs 14.993 million.

In addition to this annual net benefit for 15 years, there will be the recovery of working capital worth Rs 12 million at the end of the 15th year. Other recoveries may be ignored.

Putting the above figures together, we find that the stream of costs and benefits associated with the project would be:

Year/s	*Net social benefit (Rs in million)*
0	– 76.015
1–14	14.993
15	26.993

The economic rate of return for the project, which is the internal rate of return of the stream of social costs and benefits, is the value of r in the equation:

$$76.915 = \sum_{t=1}^{14} \frac{14.993}{(1+r)^t} + \frac{26.993}{(1+r)^{15}}$$

Solving this equation we find that the economic rate of return is about 19 percent.

Exhibit 14.9 ***Conversion of Financial Costs into Social Costs***

Item	*Financial cost*	*Basis of conversion*	*Tradable value ab initio*	*T*	*L*	*R*
				(Rs in million)		
Imported raw material	10.00	*CIF* value	8.00			
Indigenous raw material and stores	40.00	*SCF* = 0.80	32.00			
Labour	5.00	*SCF* = 0.50	2.50			
Salaries	3.00	*SCF* = 0.8	2.40			
Repairs and maintenance	1.00	*SCF* = 1/1.5	0.667			
Water, fuel, etc.	5.00	*T* = 0.50, *L* = 0.25, *R* = 0.25		2.50	1.25	1.25
Electricity (Rate portion)	3.00	*T* = 0.71, *L* = 0.13, *R* = 0.16		2.13	0.39	0.48
Other overheads	7.00	*SCF* = 1/1.5	4.667			
Total	74.00		50.234	4.63	1.64	1.73

Effective Rate of Protection

Tariffs, import restrictions, and subsidies are used to encourage domestic industries and protect them against international competition. The extent to which a project is sheltered is measured by the Effective Rate of Protection (*ERP*). It is calculated as follows:

$$\frac{\text{Value added at domestic prices} - \text{Value added at world prices}}{\text{Value added at world prices}}$$

This ratio is multiplied by 100 to express the *ERP* in percentage terms.

The data required for calculating the *ERP* may be arranged as follows:

	At domestic prices	At world prices
A. Selling price		
B. Input cost		
Traded		
Non-traded		
C. Value added		

The domestic selling price is net of taxes and excise duties but inclusive of a reasonable selling commission. The selling price at world price is the CIF price for imports and FOB for exports.

The input cost consists of the cost of the following inputs:

- Raw materials and stores
- Power, fuel, and water
- Repairs and maintenance
- Part of administrative overheads and expenses
- Selling expenses

The distinction between traded inputs (which are valued both at domestic and world prices) and non-traded inputs (which are valued at domestic price only) is made as follows:

1. *Raw Materials and Stores* In general these are taken as traded items and their value at domestic and world prices (CIF prices) are estimated. However, raw materials which have a low value-to-volume ratio and involve disproportionately high transport cost (like silica and pulp) and which are not imported are regarded as non-traded items.
2. *Power, Fuel, and Water* These are normally treated as 'non-traded' items. However, where fuel is in the form of oil and/or coal and fuel costs are significant, it should be regarded as a traded item and valued at both domestic and world prices.
3. *Repairs and Maintenance* This is a non-traded item. However, when this entails substantial consumption of spares and chemicals (not included in raw materials) it is regarded as a traded item and valued at both domestic and world prices.
4. *Selling Expenses* This is regarded as a non-traded item.
5. *Part of Administrative Overheads and Expenses* Administrative costs may be divided

into two parts: labour costs and other expenses (like rent, insurance charges, telephone tariff, etc.). Since labour costs are part of value added, other expenses only are considered as input costs. These are regarded as non-traded items.

The difference between the selling price and input costs is the value added. This represents payment to labour and capital.

Illustration

The calculation of *ERP* may be illustrated with the help of an example. The domestic prices and world prices of the inputs and outputs of a project in a normal year are given in Exhibit 14.10.

The *ERP* in this case is:

$$\frac{\text{Value added at domestic prices} - \text{Value added at world prices}}{\text{Value added at world prices}}$$

$$= \frac{60 - 30}{30} = 1 \text{ (or } 100\%)$$

Exhibit 14.10 ***Domestic and World Prices***

		(Rs in million)	
		Domestic prices	*World prices*
	Inputs		
• Tradable Inputs			
Raw materials		300	250
Consumable stores		50	30
	Total	350	280
	Inputs		
• Non-tradable Inputs			
Power, fuel, and water		20	
Repairs and maintenance		15	
Administrative and other overheads		30	
Selling expenses		25	
	Total	90	90
• Total Input Costs		440	370
	Output		
• Sales Realisation		500	400
• Value Added		60	30

It may be emphasised that when the value added at domestic prices is the same as the value added at world prices, the *ERP* is zero. In such a case, it implies that the project does not enjoy any protection from international competition. When the value added at domestic prices is higher than the value added at world prices, as is often the case, the *ERP* takes a positive value. Clearly, the higher the value of *ERP*, the higher the implied protection enjoyed by the project. It is generally agreed that the extent of protection given to a project should not exceed 30 percent.

Domestic Resources Cost

Domestic resources cost (*DRC*) reflects the domestic cost incurred per unit of foreign exchange saved or earned. Financial institutions use the following formula to calculate *DRC*:

$$DRC = \frac{A + B + C}{P - (Q + R + S + T)} \times \text{Exchange rate}$$

where A = annual charge on domestic capital calculated at the rate of 10 percent.

B = annual depreciation on domestic capital assets (other than land) calculated at the rate of 8 percent.

P = sales realisation at international prices.

Q = annual charge on imported capital assets at the rate of 10 percent.

R = annual depreciation on imported capital assets at the rate of 8 percent.

S = annual cost of imported inputs.

T = annual cost of domestically procured, but tradable inputs.

A word about the various elements in the above formula is in order.

Domestic Capital This consists of the following: (i) Cost of domestically procured plant, machinery, and miscellaneous fixed assets, excluding excise duty and sales tax. (ii) Preliminary and preoperative expenses excluding interest during construction. (iii) Clearing and local transportation cost of imported machinery. (iv) Working capital investment other than investment in imported and tradable raw material inventory.

Imported Capital This consists of the following: (i) Cost of imported plant, machinery, and miscellaneous fixed assets, excluding import duties. (ii) Working capital investment in imported and tradable raw material inventory, net of all taxes and duties.

Cost of Domestically Procured Operating Inputs Domestically procured operating inputs may be divided into two parts: (a) Traded/tradable inputs. There are items that can be traded in the international market. They are valued at international prices. (ii) Non-traded inputs. These are items that cannot be traded in the international market. They are valued at their domestic cost after excluding transfer payments like taxes, duties, and subsidies.

Sales Realisation at International Prices The output of the project is valued at international prices, also called as border prices. The border price means *CIF* (cost, insurance, and freight) price for an imported/importable/import substitute good and *FOB* (free on board) price for an exported/exportable good.

Cost of Imported Operating Inputs Imported operating inputs are valued at the actual price paid for them. Import duty is not considered. Local transportation cost is treated as a domestic cost.

Note that taxes, duties, and subsidies are excluded from the valuation of all items found in the *DRC* formula because they are mere transfer payments to or from the government and hence do not represent a cost or gain to the economy as a whole.

Illustration

The capital employed in a project is estimated as follows:

Rs in million

Item	*Total Cost (excluding taxes, duties, and subsidies)*	*For DRC Calculation*	
		Domestic Capital	*Imported Capital*
(1)	(2)	(3)	(4)
1. Land	15	15	
2. Buildings	10	10	
3. Plant and machinery			
(i) Imported	100	–	100
(ii) Indigenous	40	40	
4. Transportation and erection	5	5	
5. Miscellaneous fixed assets	30	20	10
6. Preliminary and pre-operative expenses (excluding interest during construction)	35	35	
7. Contingencies	15	5	10
8. Working capital requirement	55	45	10
9. Total capital employed	305	175	130
10. Charge on capital @ 10%		17.5	13.0
11. Depreciation on capital @ 18% (excluding land and working capital requirement)		14.0	10.4

The project is expected to achieve the normal level of production in the third year of operation when its output valued at border prices is estimated at Rs 275 million.

The cost of traded/tradable inputs and non-traded inputs are expected as follows:

Item	*Total Cost (excluding taxes, duties, and subsidies)*	*For DRC Calculation*		
		Non-tradable component	*Tradable component at border prices*	*Imported component*
(1)	(2)	(3)	(4)	(5)
1. Raw materials and consumables	150	20	100	15
2. Utilities (power fuel, water, etc.)	25	20	5	–
3. Repairs and maintenance	10	10	–	–
4. Wages and salaries	20	20	–	–
5. Rent and insurance	3	3	–	–
6. Administrative expenses	5	5	–	–
7. Selling expenses	7	7	–	–
Total operating cost	220	85	105	15

The present exchange rate is Rs 50 per dollar.

Given the above information, the *DRC* of the project is calculated below:

$$DRC = \frac{17.5 + 14.0 + 85.0}{275.0 - (13.0 + 10.4 + 15.0 + 105.0)} \times \text{Rs } 50.0$$

$$= \text{Rs } 44.3$$

Thus the domestic resource cost per US dollar saved is Rs 44.3, which is lower than the present exchange rate. Hence it is desirable to manufacture the product in the country rather than import it.

14.11 PUBLIC SECTOR INVESTMENT DECISIONS IN INDIA

The public sector has been assigned a pre-eminent role in the Indian economy.

There will be an expanding role for the public sector in several fields. Not only will it be a producer of important and strategic goods of basic nature, but it will also be used as a stabilising force for maintaining essential supplies for the consumer.

The public sector today commands a predominant position in many basic industries: coal, crude oil and refining, steel, power, fertilisers, locomotives, basic drugs, machine tools, and so on.

It is somewhat surprising that even though substantial investments were made in the public sector since independence, the mechanisms of appraisal and selection were rather primitive till the middle sixties. For a long time the important proposals were appraised by the Expenditure Finance Committee that used procedures which were rather slip-shod. This is obvious from an examination of the memos of the Expenditure Finance Committee that clearly made a short shrift of economic considerations.

Initiatives to Improve the Quality of Investment Decisions

The need for preparing feasibility studies was perhaps first highlighted by the committee on 'utilisation of external assistance' which observed that "the delay in foreign aid utilisation is due to the dearth of well conceived projects ready for immediate implementation". Triggered by this awareness and a felt need to improve the quality of project planning and strengthen the public investment decision making process in India, the following steps were taken:

- In 1965, the Government of India set up a separate Bureau of Public Enterprises (BPE, hereafter), with the objective of "integrating and strengthening the arrangement for economic coordination and evaluation of technical, economic, and financial aspects of projects and the working of public enterprises in India." The BPE is an autonomous organisation under the Ministry of Finance and is required to supervise and regulate all aspects of public sector projects.

- In 1965, the Planning Commission prepared and circulated a *Manual of Feasibility Studies for Public Sector Projects*. This manual outlines in detail the procedure required to be adopted for project formulation.
- In 1972, the Government of India set up a special division in the Planning Commission called the Project Appraisal Division (PAD, hereafter) to appraise the central sector projects from the national viewpoint and to make observations regarding the economic viability of investment projects whose capital cost exceeds a certain limit. The PAD has been entrusted with the work of developing a research methodology and other steps required to evolve systematic project planning in India. The PAD has prepared and circulated the *Guidelines for the Preparation of Feasibility Reports for Industrial Projects*.
- In 1972, the Government of India set up a high-powered Public Investment Board (PIB, hereafter) with a view to evolve a scientific procedure for taking investment decisions. the functions assigned to the PIB are: (a) examination of the board contours of investment proposals in the project formulation stage based on which a decision to prepare the feasibility report would be taken; (b) taking investment decisions on proposals for public investment to produce goods and services; and (c) consideration of proposals for revision of cost estimates which exceed those approved at the time of investment decisions.

Since the appraisal of the PAD and the recommendations of the PIB have an important bearing on public sector investments in India, we will examine their role in some detail. Before doing that, let us first look at the key steps in the public investment decision making process in India.

Key Steps in the Public Investment Decision Making Process in India

Very broadly the principal steps in the public investment decision making process in India are as follows:

1. The Planning Commission formulates the five-year plan indicating the broad strategy of planning, the role of each sector, the physical targets to be achieved by each sector, and the financial outlays to be made available for the development of each sector.
2. The administrative ministries develop sectoral plans. It is in these plans that the projects of the public sector enterprises are identified. The identification of a project provides the green signal for the preparation of its feasibility report.
3. The concerned public sector enterprise prepares the feasibility report and forwards it to its administrative ministry.
4. The administrative ministry carries out a preliminary scrutiny of the feasibility report and sends copies of the same to the various appraising agencies, namely, the Planning Commission, the Department of Economic Affairs and the Plan Finance Division of the Finance Ministry, and the Bureau of Public Enterprises for their comments.

5. The PAD of the Planning Commission carries out a detailed appraisal. The objective of its appraisal is not only to suggest whether to accept or reject the project but also to suggest how it may be re-formulated to enhance its technical, financial, commercial, and economic viability.
6. The Investment Planning Committee of the Planning Commission discusses the appraisal note of the PAD and recommends to the PIB the view of the Planning Commission on whether the project should be accepted, rejected, deferred, reformulated, or redesigned.
7. The PIB considers the (a) appraisal note of the PAD along with the view of the Planning Commission, (b) the comments of the BPE, (c) the comments of the plan finance division of the ministry of finance, and (d) the note of the administrative ministry. If the PIB clears the project, it sends it to the cabinet for its approval.
8. The cabinet generally accepts the recommendation of the PIB and approves its implementation.

Project Appraisal Division

The Project Appraisal Division (PAD) of the Planning Commission was set up in 1972 and entrusted with the following functions:

(a) to suggest standard formats for submission of projects and procedures for their techno-economic evaluation;
(b) to conduct actual techno-economic evaluation of selected major projects and programmes submitted to the Planning Commission;
(c) to assist the state governments and central ministries in giving effect to standardised formats and procedures for project evaluation; and
(d) to undertake and support research leading to progressive refinement of methodology and procedure for project evaluation.

The appraisal notes of the PAD generally cover the following:

(a) project description and background of the investment proposal, (b) plan and project, (c) justification for the project, (d) demand and market analysis, (e) choice of technology and proposed capacity, (f) gestation period, project life, capacity utilisation, production build-up, product-mix, infrastructural requirements and availability, (g) capital costs and norms, (h) operating costs and norms, (i) possibilities of cost minimisation, (j) possible alternatives and the least cost option, (k) financial analysis by DCF method and sensitivity analysis, and (l) social profitability analysis and sensitivity analysis.

In the economic appraisal (also referred to as social profitability analysis) of industrial projects[8], the methodology followed by the PAD is a modified version of the Little-Mirrlees approach. The key elements of the methodology adopted by the PAD are as follows:

8. The projects forwarded to the PAD are divided into three broad categories: (i) industrial projects, (ii) infrastructural projects, and (iii) social projects. Our discussion focuses on the economic appraisal of industrial projects.

1. All tradable inputs are valued at border prices.
2. Transfer cost items (taxes, duties, etc.) are ignored.
3. All non-tradable items, especially power and transport, are evaluated in terms of marginal cost.
4. Foreign exchange involved in the inputs and outputs are valued at specified premia.
5. Social wage rates (or shadow wage rates) are applied to the unskilled and semi-skilled labour.[9]
6. The numéraire is defined as savings in domestic rupees rather than foreign exchange (as recommended by the Little–Mirrlees approach).

Public Investment Board

The Public Investment Board (PIB) is a committee of secretaries which appraises and recommends all central public sector projects[10] involving an outlay exceeding a certain amount[11]. Besides the Secretary, Expenditure, Ministry of Finance, who serves as its chairman, the PIB has the following members: Secretary, Economic Affairs, Ministry of Finance, Secretary, Planning Commission, Secretary, Industrial Development, Secretary to the Prime Minister, and Secretary to the administrative ministry concerned with the investment proposal. The Director General of the BPE and the Adviser, PAD are permanent invitees to the PIB.

The PIB is assisted by various agencies. The Plan Finance Division of the Ministry of Finance, which functions as the secretariat of the PIB, scrutinises the proposals particularly with reference to budgetary and plan provisions. The BPE examines construction costs, technical aspects, and financial aspects. The PAD of the Planning Commission provides assistance in economic appraisal and examines critical assumptions underlying the project. The Integrated Financial Adviser in the sponsoring ministry furnishes the feasibility study and provides whatever additional information is called for by the PIB.

The guidelines followed by the PIB in appraising investment proposals are as follows:

(a) The contribution of the project to the economic and social objectives and adherence to the concerned policies of the government.

9. Reflecting the employment and income generation aspect of the project, the social wage rate varies from state to state and from urban to rural location. In general, it ranges between 40 percent and 70 percent of the monetary wage rate.
10. Other than the projects of departmental undertakings like the Railways and Ordnance Factories which have their own procedures for project evaluation and sanction.
11. For projects involving smaller outlays, decision making powers have been decentralised as follows: (a) Public sector undertakings have complete autonomy for projects up to specified ceilings depending on their gross blocks. (b) Administrative ministries have complete or partial autonomy within certain ceilings. (c) Expenditure Finance Committee is empowered to decide for certain types of projects within specified cost ceilings.

(b) The advisability of undertaking the project in the public sector or the joint sector or leaving it to the private sector.
(c) Availability of plan funds and desirability of diversion of plan funds to the new project from those already on hand.
(d) The plan capacity and the timing of investment in the light of supply and demand balance including export possibilities of the product/service.
(e) The economic benefits of the project as distinct from financial returns.
(f) Crucial assumptions in the feasibility report that are likely to affect the performance of the commissioned project in relation to the claims made thereon in the feasibility report.
(g) Major technological and constructional aspects which may have a bearing on the investment decision.

Lacunae

The institution of the PIB (and its technical arm, the PAD) represents an important advance in the process of public investment decision making in India. It has (a) promoted a more scientific appraisal of investment projects, (b) provided a forum for bringing to bear an integrated approach to project appraisal and selection, (c) expedited the process of decision making, and (d) strengthened the hands of the government to resist pressures based on non-economic considerations to a certain extent.

Despite these improvements, public investment decision making in India, as the critics argue, suffers from the following deficiencies:

- Lack of detailed disaggregative sectoral planning.
- Pre-emptive advance commitments.
- Practice of submitting projects of the same sector/undertaking in a piecemeal manner.
- Insufficient generation and analysis of options.
- Preparation of feasibility reports without adequate studies/investigations
- Avoidable overlap in the appraisal of several agencies.
- Tardy clearance procedures.
- Sacrifice of economic considerations at the altar of political expediency.
- Emphasis on procedures rather than substance.

SUMMARY

- Social Cost Benefit Analysis (SCBA) is a methodology for evaluating projects from the social point of view. In the context of planned economies, SCBA aids in evaluating individual projects within the planning framework.
- In SCBA the focus is on social costs and benefits of a project. These often tend to differ from the costs incurred in monetary terms and benefits earned in monetary terms by the project. The principal reasons for discrepancy are: (i) market imperfections,

(ii) externalities, (iii) taxes, (iv) concern for savings, (v) concern for redistribution, and (vi) merit and demerit goods.

- Towards the end of the sixties and early seventies two principal approaches for SCBA emerged: UNIDO approach and Little–Mirrlees approach.
- The UNIDO method of project appraisal involves five stages: (i) calculation of the financial profitability of the project measured at market prices; (ii) obtaining the net benefit of the project measured in terms of economic (efficiency) prices; (iii) adjustment for the impact of the project on savings and investment; (iv) adjustment for the impact of the project on income redistribution; and (v) adjustment for the impact of the project on merit and demerit goods.
- The measurement of financial profitability of the project in stage one is similar to the financial evaluation discussed at great length in the previous chapters of this book.
- Stage two is concerned with the determination of the net benefit of the project in terms of economic (efficiency) prices also referred to as shadow prices.
- A key issue in shadow pricing is whether a good is tradable or not. For a traded good, the shadow price is the border price, translated in domestic currency at market exchange rate. The shadow price of a non-traded good is measured in terms of consumer willingness to pay or cost of production depending on the impact of the project on the rest of the economy.
- Since SCBA seeks to consider all costs and benefits, to whomsoever they may accrue, external effects also need to be taken into account. The valuation of external effects is rather difficult because they are often intangible in nature and there is no market price which can be used as a starting point.
- The principles of shadow pricing for goods may be applied to labour as well, though labour is considered to be a service. When a project takes labour away from other employments, the shadow price of labour is equal to what other users of labour are willing to pay. The shadow price associated with inducing 'additional' production of workers consists of the marginal product of labour in previous employment plus certain other costs.
- The opportunity cost of capital depends on how the capital required for the project is generated. To the extent that it comes from additional savings, its opportunity cost is measured by the consumption rate of interest; to the extent that it comes from the denial of capital to alternative projects, its opportunity cost is the rate of turn that would be earned from those alternative projects. In practice, the consumption rate of interest may be used as the discount rate because in stage three of the UNIDO method all inputs and outputs are converted into their consumption equivalents.
- The UNIDO method uses domestic currency as the numéraire. So the foreign exchange impact of the project must be identified and valued. The UNIDO method determines the shadow price of foreign exchange on the basis of marginal social value as revealed by the consumer willingness to pay for the goods that are allowed to be imported at the margin.

- Stage three of the UNIDO method seeks to answer the following questions: Given the income distribution impact of the project what would be its effect on savings? What is the value of such savings to the society? The savings impact of a project is equal to:

$$\sum \Delta Y_i MPS_i$$

The shadow price (value) of a rupee of savings, given certain simplifying assumptions, is equal to:

$$\frac{r(1-a)}{k-ar}$$

- Stage four of the UNIDO method is concerned with measuring the impact of the project on income redistribution. This calls for suitably weighting the net gain or loss to various groups in the society and summing them.
- The Little–Mirrlees (L–M) approach to SCBA has considerable similarity with the UNIDO approach. However, there are certain important differences as well.
- As per the L–M approach, the outputs and inputs of a project are classified into the following categories: (i) traded goods and services, (ii) non-traded goods and services, and (iii) labour.
- The shadow price of a traded good is simply its border price. If a good is exported its shadow price is its FOB price and if a good is imported its shadow price is its CIF price. The shadow prices for non-traded items are defined in terms of marginal social cost and marginal social benefit.
- The L–M approach suggests the following formula for calculating the shadow wage rate (*SWR*):

$$SWR = c' - \frac{1}{s}(c - m)$$

- While the all-India term-lending institutions—IDBI, IFCI, and ICICI—approach project proposals primarily from the financial point of view, they also evaluate them from the larger social point of view.
- Though there are some minor variations, the three institutions follow essentially a similar approach which is a simplified version of the L–M approach.
- IDBI, the apex term-lending financial institution, considers three aspects in its economic appraisal of industrial projects: economic rate of return, effective rate of protection, and domestic resource cost.
- The economic rate of return is simply the internal rate of return of the stream of social costs and benefits.
- The effective rate of protection is calculated as follows:

$$\frac{\text{Value added at domestic prices} - \text{Value added at world prices}}{\text{Value added at world prices}} \times 100$$

- Till the middle of the sixties the mechanism for appraisal and selection of public sector projects was rather primitive. To improve the quality of project planning and strengthen

the public investment decision making process several steps were taken: creation of the Bureau of Public Enterprises; establishment of the Project Appraisal Division (PAD) in the Planning Commission; and institution of the Public Investment Board (PIB).

- In the economic appraisal (also referred to as social profitability analysis) of industrial projects, the PAD follows a modified version of the Little–Mirrlees approach.
- The PIB is a committee of secretaries which appraises and recommends all central public sector projects involving an outlay exceeding a certain amount. (For projects involving smaller outlays the decision making powers have been decentralised.)
- The institution of the PIB (and its technical arm, the PAD) represents an important advance in the process of public investment decision making in India. It has promoted a more systematic approach to public sector investment decision making. Yet, there are serious lacunae which have marred the quality of public investment decisions in India.

Questions

1. Discuss the principal sources of discrepancy between social costs and benefits on the one hand and monetary costs and benefits on the other.
2. What are the five stages of appraisal in the UNIDO method as described in the *Guide to Practical Project Appraisal*?
3. What questions are raised in defining the numéraire? How is the UNIDO numéraire specified?
4. Explain what is the consumer willingness to pay?
5. As per the UNIDO method, how are the following valued?
   (a) tradable inputs and outputs
   (b) non-tradable inputs and outputs
   (c) labour
   (d) foreign exchange
   (e) savings
6. What are the similarities and differences between the UNIDO approach and the Little–Mirrlees approach?
7. How are the following defined or determined in the Little–Mirrlees approach:
   (a) shadow price of traded goods
   (b) accounting price of non-traded goods
   (c) shadow wage rate
   (d) accounting rate of return
8. What are the key elements of the method used by IDBI to calculate the economic rate of return?
9. What is the 'effective rate of protection' and the 'domestic resource cost'? How are the two related?

10. Discuss the initiatives taken to improve the quality of public investment decision making in India.
11. What are the principal steps involved in the public investment decision making process in India?
12. Discuss the role of the PAD and the PIB.
13. What are the key elements of the methodology adopted by the PAD for economic appraisal?
14. What deficiencies characterise public investment decision making in India?

Problems

1. A government is considering building a tunnel across a sea channel which can currently only be crossed by ship. The following information is available.
   (i) The tunnel will consist of a two-track railway and cars and passengers will be carried by train. It will cut crossing time by two hours for cars and passengers.
   (ii) The relevant categories of traffic are:
   (a) cars (and their passengers)
   (b) passengers not in cars
   (c) freight
   (iii) The authorities who would operate the tunnel have decided to charge a toll which would maximise revenue. The toll that they have decided to charge is Rs 160 per car which compares favourably with the charge by ship which is Rs 200.
   (iv) Because of the quicker and cheaper journeys available, it is forecast that the following traffic per year for the foreseeable future will be diverted from the existing method of travel:
   75,000 cars (with an average of two passengers)
   50,000 passengers not in cars
   350,000 tonnes of freight
   In addition 50,000 extra car journeys (with two passengers each) will be made.
   (v) The average value of passenger time is Rs 6 per hour.
   (vi) The diverted traffic will reduce the cost of operation of the existing ship by Rs 40 million a year, while at the forecast levels of traffic, the maintenance and operating cost of the tunnel will be Rs 3 million. Its capital cost will be Rs 400 million. The life of the tunnel will be 50 years.
   (vii) Assuming that the monetary figures given above reflect social value, calculate the *IRR* of the stream of social costs and benefits.
2. A government is considering whether it should close down the branch line passenger services from station *A* to station *B*. No goods are currently carried by rail.
   The chief accountant of the government estimates the annual cost of train movement, track maintenance, signalling, and other expenses to be Rs 1,520,000, including Rs 120,000 toward depreciation and interest charges.

If the line were closed at any time, the diesel train operating on it could be sold to another country for Rs 240,000. Nothing else has any re-sale value. The line is used for 1,000 single journeys each day (250 days per year). The single fare is Rs 4.00. So the line is losing money, a deficit met by taxation.

If the line is closed, it is estimated that of the former journeys, 800 will be made by bus (at the same fare), and 200 will not be made. The bus fare is the same as the rail fare and the extra bus fares exactly offset the bus operations' extra cost. Bus journey takes an average of 40 minutes longer than the rail journey. The average value of passengers' time is Rs 2 per hour. Enumerate the social costs and benefits associated with the proposal.

3. The economic planning department of a state is considering a proposal to build an 80-mile road from a capital to a village which has hitherto only been accessible by river boat. The road will cost Rs 24 million and the annual maintenance charges will be approximately Rs 1 million. The social discount rate is 10 percent. Analysis suggests that the following effects are likely to result from the completion of the road:
   (i) A saving of Rs 0.5 million per year on the cost of shipping agricultural produce from the village and its surrounding area.
   (ii) The opening up to development of an additional 50,000 acres of land. Development will cost Rs 3,000 per acre and produce, after 5 years, crops worth Rs 1,000 per acre per year. The land will be settled by small holders, who will move from other employments where their earnings average Rs 1,500 per year. An estimated 8,000 small holdings will be provided. Land cleaning and drainage cost will be borne by the government, and each settlor will receive a grant of Rs 5,000 to assist him in meeting relocation costs. Prior to the time the main crop becomes established, other crops yielding Rs 200 per acre per year can be grown.
   (iii) The land after development will be worth Rs 380 million whereas its present value as timber land is just Rs 100 million.
   (iv) Tax revenue from the area will be increased by Rs 1 million per year.
   (v) Value of timber output will be increased by Rs 20 million in the first year, while the land is being cleared, but will be reduced by Rs 4 million per year after the clearing.
   (vi) The income of boat operators on the river will be reduced by Rs 0.5 million per year. Boats costing Rs 3 million and scheduled for replacement in five years will not be replaced, and the labour displaced will be absorbed elsewhere at equivalent wages.

   Which of the effects listed above should be taken into account in the social cost benefit analysis? Should the road be built? Assume that the road's life is 30 years.
4. A project for manufacturing a product which is currently being imported in the country is being appraised. The project would have a life of 20 years and it will lead to import substitution. The capital outlay on the project is expected to be as follows:

	(Rs in million)
Land	0.30
Buildings	12.00
Imported equipment	15.00

(CIF value: Rs 9 million)	
Indigenous equipment	80.00
(CIF value of similar equipment: Rs 60 million)	
Transport	2.00
Engineering and know-how fees	6.00
Pre-operative expenses	6.00
Bank charges	3.70

The working capital requirement of the project, consisting only of domestic raw materials, will be Rs 25 million.

The estimated annual profitability of the project is as follows:

Revenue	(Rs in million)
Sales revenues	150
(CIF value of the output is Rs 110 million)	
Expenses	
Raw materials and stores (indigenous)	85
Labour	7
Salaries	5
Repairs and maintenance	1.2
Water, fuel, etc.	6
Electricity	7
Rate 5	
Duty 2	
Depreciation	4.8
Other overheads	10
Profit	
Taxable profit	24

For the sake of simplicity we may assume that capital costs are incurred at the beginning (i.e., at the end of year 0) and full production begins from year 1 itself. Using the social conversion factors employed by IDBI, calculate the economic rate of return for the project. After 20 years only working capital will be recovered.

CHAPTER



15

Multiple Projects and Constraints

When investment projects are considered individually, any of the discounted cash flow criteria—net present value, internal rate of return, or benefit cost ratio—may be applied for obtaining a correct "accept or reject" signal. In an existing organisation, however, capital investment projects often cannot be considered individually or in isolation. This is because the pre-conditions for viewing projects individually—project independence, lack of capital rationing, and project divisibility—are rarely, if ever, fulfilled. Under the constraints obtaining in the real world, the so-called rational criteria *per se* may not necessarily signal the correct decision.

This chapter explains the nature of constraints which render "selection of projects in isolation" meaningless, discusses the problems with the method of ranking, and shows how the techniques of mathematical programming may be employed to select the capital budget in the face of constraints. It is organised into six sections as follows:

- Constraints.
- Method of ranking.
- Mathematical programming approach.
- Linear programming model.
- Integer linear programming model.
- Goal programming model.

15.1 CONSTRAINTS

Project Dependence

Projects *A* and *B* are economically independent if the acceptance or rejection of one does not change the cash flow stream or does not affect the acceptance or rejection of the other. For example, an investment in a power press and an investment in a computer installation are economically independent. On the other hand, Projects *A* and *B* are economically dependent if the acceptance or rejection of one changes the cash flow stream of the other or affects the acceptance or rejection of the other.

What kinds of economic dependency are found among projects? The most conspicuous kind of economic dependency occurs when projects are mutually exclusive. If two or more projects are mutually exclusive, acceptance of any one project out of the set of mutually exclusive projects automatically precludes the acceptance of all other projects in the set. From an economic point of view, mutually exclusive projects are substitutes for each other. For example, the alternative possible uses of a building represent a set of mutually exclusive projects. Clearly if the building is put to one use, it cannot be put to any other use.

A second kind of economic dependency exists when projects, even though not mutually exclusive, negatively influence each other's cash flows if they are accepted together. Bierman and Smidt have given an excellent illustration of this kind of economic dependency: a project for building a toll bridge and a project for operating a toll ferry. These two projects are such that when they are undertaken together, the revenues of one will be negatively influenced by the other.

A third kind of economic dependency, which may be referred to as positive economic dependency, occurs when there is complementarity between projects. If undertaking a project influences favourably the cash flows of another project, the two projects are complementary projects. Complementarity may be of two types: asymmetric complementarity and symmetric complementarity. In asymmetric complementarity, the favourable effect extends only in one direction. For example, project *A* favourably influences the cash flows of project *B* whereas project *B*, in turn, has no influence on the cash flows of project *A*. In symmetric complementarity the favourable effect extends in both directions: project *A* has a favourable influence on the cash flows of project *B* and, likewise, project *B* has a favourable influence on the cash flows of project *A*.

Capital Rationing

Capital rationing exists when funds available for investment are inadequate to undertake all projects which are otherwise acceptable. (It may be recalled that a project is acceptable if the net present value is greater than zero or the internal rate of return is greater than the cost of capital or the benefit–cost ratio is greater than one.)

What are the sources of capital rationing? Capital rationing may arise because of an internal limitation or an external constraint. Internal capital rationing is caused by a decision taken by the management to set a limit to its capital expenditure outlays; or, it may be caused by a choice of hurdle rate higher than the cost of capital of the firm. Internal capital rationing, in either case, results in rejection of some investment projects which otherwise are acceptable.

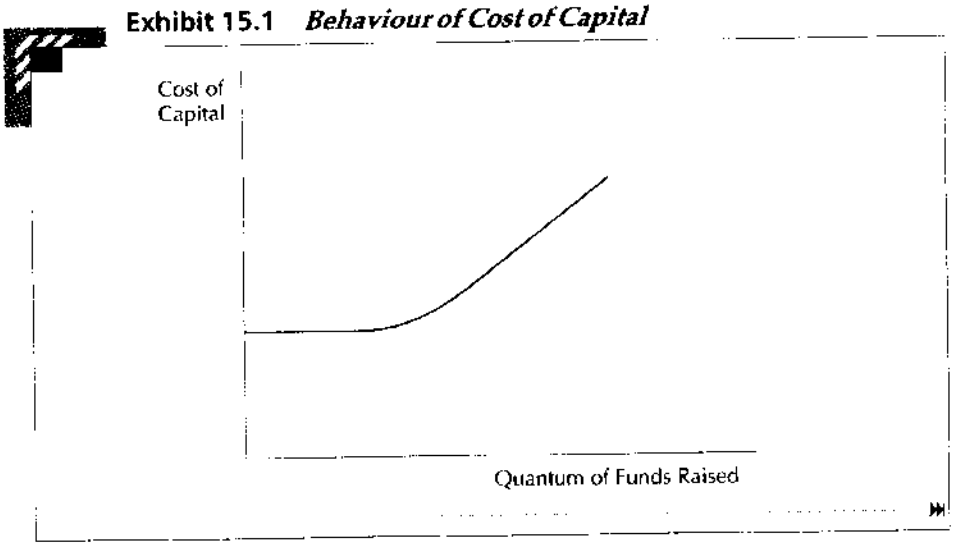
External capital rationing arises out of the inability of the firm to raise sufficient amounts of funds at a given cost of capital. In a perfect market, a firm can obtain all its funds requirement at a given cost of capital. In the real world, however, the firm can raise only a limited amount of funds at a given cost of capital. Beyond a certain point, the cost of capital tends to increase as shown in Exhibit 15.1.

What is the implication of a capital supply curve of the kind shown in Exhibit 15.1? The implication of a rising capital supply curve is that some projects which would be acceptable if the cost of capital were constant will have to be postponed or abandoned.

Project Indivisibility

Capital projects are considered indivisible, i.e. a capital project has to be accepted or rejected in toto—a project cannot be accepted partially.

Exhibit 15.1 ***Behaviour of Cost of Capital***



Given the indivisibility of capital projects and the existence of capital rationing, the need arises for comparing projects. To illustrate this point, consider an example. A firm is evaluating three projects *A*, *B*, and *C* which involve an outlay of Rs 0.5 million, Rs 0.4 million, and Rs 0.3 million respectively. The net present value of these projects are Rs 0.2 million, Rs 0.15 million, Rs 0.1 million respectively. The funds available to the firm for

investment are Rs 0.7 million. In this situation, acceptance of project *A* (project with the highest net present value) which yields a net present value of Rs 0.2 million results in the rejection of projects *B* and *C* which together would yield a combined net present value of Rs 0.25 million. Hence, because of the indivisibility of projects, there is a need for the comparison of projects before the acceptance/rejection decisions are taken.

15.2 METHOD OF RANKING

Because of economic dependency, capital rationing, or project indivisibility, a need arises for comparing projects in order to accept some and reject others. What approaches are available for determining which projects to accept and which projects to reject? Basically, two approaches are available: (i) the method of ranking, and (ii) the method of mathematical programming. This section discusses the method of ranking; the following section discusses the method of mathematical programming.

Fairly simple, the method of ranking consists of two steps: (i) Rank all projects in a decreasing order according to their individual *NPV*'s, *IRR*'s, or *BCR*'s. (ii) Accept projects in that order until the capital budget is exhausted.

The method of ranking, originally proposed by Joel Dean[1] is seriously impaired by two problems: (i) conflict in ranking as per discounted cash flow criteria, and (ii) project indivisibility.

Conflict in Ranking

In a given set of projects, preference ranking tends to differ from one criterion to another. For example, *NPV* and *IRR* criteria may yield different preference rankings. Likewise, there may be a discrepancy between the preference rankings of *NPV* and *BCR* (benefit cost ratio) criteria. When preference rankings differ, the set of projects selected as per one criterion tends to differ from the set of projects selected as per some other criterion. This may be illustrated by an example.

Consider a set of five projects, *A*, *B*, *C*, *D*, and *E*, for which the investment outlay, expected annual cash flow, and project life are as shown below:

Project	*Investment outlay*	*Expected annual cash flow*	*Project life*
	(Rs)	(Rs)	(Years)
A	10,000	4,000	12
B	25,000	10,000	4
C	30,000	6,000	20
D	38,000	12,000	16
E	35,000	12,000	9

1. Joel Dean, *Capital Budgeting*, New York, Columbia University Press, 1951.

The *NPV*, *IRR*, and *BCR* for the five projects and the ranking along these dimensions are shown in Exhibit 15.2.

Exhibit 15.2 ***NPV, IRR, and BCR for the Five Projects***

Project	NPV (Rs)	NPV Ranking	IRR (Per cent)	IRR Ranking	BCR	BCR Ranking
A	14,776	4	39	1	2.48	1
B	5,370	5	22	4	1.21	5
C	14,814	3	19	5	1.49	4
D	45,688	1	30	2	2.20	2
E	28,936	2	29	3	1.83	3

It is clear that in the above case the three criteria rank the projects differently. If there is no capital rationing, all the projects would be accepted under all the three criteria though internal ranking may differ across criteria. However, if the funds available are limited, the set of projects accepted would depend on the criterion adopted.

What causes ranking conflicts? Ranking conflicts are traceable to differing assumptions made about the rate of return at which intermediate cash flows are re-invested.

Project Indivisibility

A problem in choosing the capital budget on the basis of individual ranking arises because of indivisibility of capital expenditure projects. To illustrate, consider the following set of projects (ranked according to their *NPV*) being evaluated by a firm which has a capital budget constraint of Rs 2,500,000.

Project	*Outlay*	*NPV*
	Rs	Rs
A	1,500,000	400,000
B	1,000,000	350,000
C	800,000	300,000
D	700,000	300,000
E	600,000	250,000

If the selection is based on individual *NPV* ranking, projects *A* and *B* would be included in the capital budget—these projects exhaust the capital budget. A cursory examination, however, would suggest that it is more desirable to select projects *B*, *C*, and *D*. These three projects can be accommodated within the capital budget of Rs 2,500,000, and have a combined *NPV* of Rs 850,000 which is greater than the combined *NPV* of projects *A* and *B*.

Feasible Combinations Approach

The above example suggests that the following procedure may be used for selecting the set of investments under capital rationing.[3]

3. This procedure can also take care of project interdependence.

1. Define all combinations of projects which are feasible, given the capital budget restriction and project interdependencies.
2. Choose the feasible combination that has the highest *NPV*.

To illustrate this procedure, consider the following projects that are being evaluated by a firm which has a capital budget constraint of Rs 3,000,000.

Project	*Outlay*	*NPV*
	Rs	Rs
A	1,800,000	750,000
B	1,500,000	600,000
C	1,200,000	500,000
D	750,000	360,000
E	600,000	300,000

Projects *B* and *C* are mutually exclusive. Other projects are independent.

Given the above information the feasible combinations and their *NPV* s are shown below:

Feasible combination	*Outlay*	*NPV*
	Rs	Rs
A	1,800,000	750,000
B	1,500,000	600,000
C	1,200,000	500,000
D	750,000	360,000
E	600,000	300,000
A and *C*	3,000,000	1,250,000
A and *D*	2,550,000	1,110,000
A and *E*	2,400,000	1,050,000
B and *D*	2,250,000	960,000
B and *E*	2,100,000	900,000
C and *D*	1,950,000	860,000
C and *E*	1,800,000	800,000
B, *D* and *E*	2,850,000	1,260,000
C, *D* and *E*	2,550,000	1,160,000

The most desirable feasible combination consists of projects *B*, *D* and *E* as it has the highest *NPV*.

15.3 MATHEMATICAL PROGRAMMING APPROACH

The feasible combinations procedure described above becomes increasingly cumbersome as the number of projects increases and as the number of years in the planning horizon increases. To cope with a problem of this kind, it is helpful to use mathematical programming models. The advantage of mathematical programming models is that they help in

determining the optimal solution (the most desirable combination of investments) without explicitly evaluating all feasible combinations.

A mathematical programming model is formulated in terms of two broad categories of equations: (i) the objective function, and (ii) the constraint equations. The objective function represents the goal or objective the decision maker seeks to achieve. Constraint equations represent restrictions—arising out of limitations of resources, environmental restrictions, and managerial policies—which have to be observed. The mathematical model seeks to optimise the objective function subject to various constraints.

The objective function and constraint equations are defined in terms of parameters and decision variables. Parameters represent the characteristics of the decision environment which are given. Decision variables represent what is amenable to control by the decision makers.

Out of the wide variety of mathematical programming models, we shall discuss three types:

- Linear programming model.
- Integer programming model.
- Goal programming model.

15.4 LINEAR PROGRAMMING MODEL

The most popular mathematical programming model, the linear programming model is based on the following assumptions:

- The objective function and the constraint equations are linear.
- All the coefficients in the objective function and constraint equations are defined with certainty.
- The objective function is unidimensional.
- The decision variables are considered to be continuous.
- Resources are homogeneous. This means that if 100 hours of direct labour are available, each of these hours is equally productive.

Linear Programming Model of a Capital Rationing Problem

The general formulation of a linear programming model for a capital rationing problem is:

Maximise

$$\sum_{j=1}^{n} NPV_j X_j \tag{15.1}$$

Subject to

$$\sum_{j=1}^{n} CF_{jt} X_j \leq K_t \ (t = 0, 1, \cdots, m) \tag{15.2}$$

$$0 \leq X_j \leq 1 \tag{15.3}$$

where NPV_j = net present value of project j

X_j = amount of project j accepted

CF_{jt} = cash outflow required for project j in period t

K_t = capital budget available in period t.

The following features of the model may be noted.

1. All the input parameters—NPV_j, CF_{jt}, K_t—are assumed to be known with certainty.
2. The X_j decision variables are assumed to be continuous but limited by a lower restriction (0) and an upper restriction (1).
3. The *NPV* calculation is based on a cost of capital figure which is known with certainty.

Lorie and Savage Problem

In their classic paper, "Three Problems in Rationing Capital," Lorie and Savage[4] discussed the following nine-project, two-period problem:

Project	*Net present value* (NPV_j)	*Cash outflow in period 1* (CF_{j1})	*Cash outflow in period 2* (CF_{j2})
1	14	12	3
2	17	54	7
3	17	6	6
4	15	6	2
5	40	30	35
6	12	6	6
7	14	48	4
8	10	36	3
9	12	18	3

The linear programming formulation of this problem is as follows:

Maximise $14X_1 + 17X_2 + 17X_3 + 15X_4 + 40X_5 + 12X_6 + 14X_7 + 10X_8 + 12X_9$

Subject to

$12X_1 + 54X_2 + 6X_3 + 6X_4 + 30X_5 + 6X_6 + 48X_7 + 36X_8 + 18X_9 + S_1 = 50$ Funds constraint for year 1

$3X_1 + 7X_2 + 6X_3 + 2X_4 + 35X_5 + 6X_6 + 4X_7 + 3X_8 + 3X_9 + S_2 = 20$ Funds constraint for year 2

4. J.H. Lorie and L.J. Savage, "Three Problems in Rationing Capital," *Journal of Business*, vol. 28 (Oct 1955), pp. 227–239.

$$\left.\begin{array}{lll} X_1 + S_3 = 1 & X_4 + S_6 = 1 & X_7 + S_9 = 1 \\ X_2 + S_4 = 1 & X_5 + S_7 = 1 & X_8 + S_{10} = 1 \\ X_3 + S_5 = 1 & X_6 + S_8 = 1 & X_9 + S_{11} = 1 \end{array}\right\} \begin{array}{l} \text{Upper limit} \\ \text{Upper limit} \\ \text{on project} \\ \text{acceptance} \end{array}$$

$$X_j \geq 0 \ (j = 1, 2, \cdots, 9)$$

$$S_i \geq 0 \ (i = 1, 2, \cdots, 11)$$

The linear programming solution for the above problem is shown in Exhibit 15.6. From Exhibit 15.6 we find that

1. The basic variables (variables which take a positive value in the optimal solution) are X_1, X_3, X_4, X_6, X_7, X_9, S_4, S_7, S_8, S_9, and S_{10}. Their values are shown in the last column of the tableau ($X_1 = 1.0$; $X_3 = 1.0$; $X_4 = 1.0$; $X_6 = .969697$, and so on).
2. The rest of the variables (X_2, X_5, X_8, S_1, S_2, S_3, S_5, S_6, and S_{11}) are non-basic variables, which means that they take a zero value. A value of zero for X_1, X_3, and X_8 means that these three projects are completely rejected in the optimal solution. A value of zero for S_1 and S_2 implies that the budgets of 50 in year 1 and 20 in year 2 are fully exhausted on the six accepted projects.

Extensions to Reflect Other Constraints

The above linear programming model may be extended to incorporate other constraints. Two such extensions are described here.

Carry Forward of Cash The funds constraint embodied in Eq. (15.2) appears somewhat rigid. In practice, funds may be shifted from one period to another. Such a possibility may be reflected in the funds constraint. To illustrate, consider the funds constraint for the first two years.

$$\sum_{j=1}^{n} CF_{j1} X_j \leq K_1 \tag{15.4}$$

$$\sum_{j=1}^{n} CF_{j2} X_j \leq K_2 \tag{15.5}$$

Now, suppose that surplus funds in year 1 can be shifted to year 2 and funds so shifted earn r percent return. This possibility calls for re-writing the above expressions as follows:

$$\sum_{j=1}^{n} CF_{j1} X_j + SF_1 = K_1 \tag{15.4a}$$

$$\sum_{j=1}^{n} CF_{j2} X_j \leq K_2 + SF_1 (1 + r) \tag{15.5a}$$

Exhibit 15.3 *Optimal Tableau for Linear Programming Formulation of Lorie-Savage Nine-Project Problem*

		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	RHS
	X_1	1.0											1.0									1.00
	X_3			1.0											1.0							1.00
	X_4				1.0											1.0						1.00
B	X_6		.455			5.91	1.0				–.015	.1818	–.364			–.273					–.273	.96969
a																						
s	X_7		1.068			–.114		1.0	.75		.023	–.023	–.205		–1.0	–.091					–.341	.04545
i																						
c	X_9									1.0											1.0	1.00
V	S_4		1.0											1.0								1.00
a																						
r	S_7					1.0											1.0					1.00
i																						
a	S_8		–.455			5.91					.015	.1818	.364		–1.0	.273		1.0			.273	.03030
b																						
l	S_9		–1.068			.114			–.75		–.023	.023	.205			.091			1.0		.341	.95454
e																						
	S_{10}								1.0											1.0		1.00
s	Z	0	3.41	0	0	29.32	0	0	.50	0	.1364	1.864	6.77	0	5.0	10.45	0	0	0		3.95	70.273
		μ_1	μ_2	μ_3	μ_4	μ_5	μ_6	μ_7	μ_8	μ_9	ρ^*_1	ρ^*_2	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	γ_8	γ_9	

In these expressions, SF_1 represents surplus funds in year 1 transferred to year 2. Since a negative SF_1 tantamounts to borrowing (which is not possible), we may add the constraint

$$SF_1 \geq 0 \tag{15.6}$$

to the above constraints.

Non-Financial Constraints Besides funds there may be other constraints pertaining to labour, material, and demand. These constraints can be readily incorporated in the linear programming model. An example of a material constraint is given below:

$$\sum m_j X_j \leq M \tag{15.7}$$

where m_j = material required for project j

X_j = proportion of project j accepted

M = total availability of material.

Illustration

Consider a firm which is evaluating seven projects with the following characteristics:

Project	*Net present value* (NPV_j)	*Cash outflow in period 1* (CF_{j1})	*Cash outflow in period 2* (CF_{j2})
1	6	5	7
2	8	9	5
3	8	12	4
4	7	3	10
5	4	4	6
6	12	10	15
7	9	13	9

The budget available to the firm is limited to 35 in year 1 and 30 in year 2.

There are two additional constraints: power constraint and managerial constraint. The requirements and constraints applicable in this respect are shown below:

Project	*Power requirement* (E_j)	*Managerial requirement* (M_j)
1	2	6
2	4	5
3	5	7
4	3	2
5	4	4
6	7	8
7	6	3
	$\sum X_j E_j \leq 18$	$\sum X_j M_j \leq 20$

The linear programming formulation of the capital budgeting problem under various constraints mentioned above is as follows:

Maximise $6X_1 + 8X_2 + 8X_3 + 7X_4 + 4X_5 + 12X_6 + 9X_7$

Subject to

$5X_1 + 9X_2 + 12X_3 + 3X_4 + 4X_5 + 10X_6 + 13X_7 + S_1$	$= 35$	Funds constraint for year 1
$7X_1 + 5X_2 + 4X_3 + 10X_4 + 6X_5 + 15X_6 + 9X_7 + S_2$	$= 30$	Funds constraint for year 2
$2X_1 + 4X_2 + 5X_3 + 3X_4 + 4X_5 + 7X_6 + 6X_7 + S_3$	$= 18$	Power constraint
$6X_1 + 5X_2 + 7X_3 + 2X_4 + 4X_5 + 8X_6 + 3X_7 + S_4$	$= 20$	Managerial constraint

$$\left.\begin{array}{ll} X_1 + S_5 = 1 & X_5 + S_9 = 1 \\ X_2 + S_6 = 1 & X_6 + S_{10} = 1 \\ X_3 + S_7 = 1 & X_7 + S_{11} = 1 \end{array}\right] \quad \text{Upper limits on project acceptance}$$

$$X_j \geq 0 \ (j = 1, 2, \cdots, 7)$$
$$S_i \geq 0 \ (i = 1, 2, \cdots, 11)$$

It may be noted that the approach taken in this formulation is similar to that represented in Eqs (15.1) through (15.3) above, except that 'slack variables' have been added to each inequality constraint to transform it into an equality constraint. Slack variables S_1 and S_2 represent the amounts unallocated in years 1 and 2; slack variable S_3 represents surplus power, slack variable S_4 represents surplus managerial capacity; slack variables S_5 through S_{11} represent the proportions of projects 1 through 7, respectively, which are not accepted.

15.5 INTEGER LINEAR PROGRAMMING MODEL

In his pioneering work on the application of mathematical programming to capital budgeting, Weingartner discussed the linear programming approach as well as the integer linear programming approach.[5] The principal motivation for the use of integer linear programming approach are: (i) It overcomes the problem of partial projects which besets the linear programming model because it permits only 0 or 1 value for the decision variables. (ii) It is capable of handling virtually any kind of project interdependency.

Integer Linear Programming Model for Capital Rationing

The basic integer linear programming model for capital budgeting under capital rationing is as follows:

5. Martin H. Weingartner, *Mathematical Programming and Analysis of Capital Budgeting Problems*, Englewood Cliffs, N.J.: Prentice-Hall, 1963.

Maximise

$$\sum_{i=1}^{n} X_i NPV_i \tag{15.8}$$

Subject to

$$\sum_{j=1}^{n} CF_{jt} X_j \leq K_t \ (t = 0, 1, \cdots, m) \tag{15.9}$$

$$X_j = (0, 1) \tag{15.10}$$

It may be noted that the only difference between this integer linear programming model and the basic linear programming model discussed earlier is that the integer linear programming model ensures that a project is either completely accepted ($X_j = 1$) or completely rejected ($X_j = 0$).

Incorporating Project Interdependencies in the Model

By constraining the decision variables to 0 to 1, the integer linear programming model can handle almost any kind of project interdependency. To illustrate, let us see how the following kinds of project interdependencies are incorporated in the integer linear programming model:

- Mutual exclusiveness
- Contingency
- Complementariness

Mutual Exclusiveness If two or more projects are mutually exclusive, acceptance of any one project out of the set of mutually exclusive projects, automatically precludes the acceptance of all other projects in the set. From an economic point of view, mutually exclusive projects are substitutes for each other. Mutual exclusiveness is reflected in the integer programming model by the following constraint:

$$\sum_{j \in J} X_j \leq 1 \tag{15.11}$$

where J = the set of mutually exclusive projects under consideration

$j \in J$ = an expression which means that project j belongs to set J

Constraint (15.16) means that the upper limit on the number of projects that can be selected from the set J is 1. This, of course, means that the firm may not select any project from the set J. If it is necessary to choose one project, but only one project, constraint (15.11) would become:

$$\sum_{j \in J} X_j = 1 \tag{15.12}$$

An important variant of the mutual exclusiveness condition is one in which the firm may delay a project for one or more years. Consider, for example, project X:

Time	*Cash flow*
0	– 10,000
1	3,000
2	3,000
3	3,000
4	3,000
5	3,000

The *NPV* of this project, given a cost of capital of 12 percent, is 814. If the firm can delay this project by 1 or 2 years, two new projects X' and X'' can be defined:

Time	*Cash flow of X'*	*Cash flow of X"*
0	–	–
1	– 10,000	–
2	3,000	– 10,000
3	3,000	3,000
4	3,000	3,000
5	3,000	3,000
6	3,000	3,000
7	–	3,000

The *NPV*'s of projects X' and X'' to be included in the objective function are respectively 727 and 649. These values naturally differ from the *NPV* of X because of delays in cash flows associated with X' and X''. Since at best only one of the projects—X, X' and X''—can be accepted, the following constraint is incorporated in the integer linear programming model:

$$X + X' + X'' \leq 1 \tag{15.13}$$

Contingency A contingency relationship between two or more projects implies that the acceptance of one project is contingent on the acceptance of some other project(s). For example, if project B cannot be accepted without accepting project A, we say that project B is contingent on project A. Put differently, project A is a prerequisite project for project B. Such a relationship is represented by the following constraint in the integer linear programming model:

$$X_B \leq X_A \tag{15.14}$$

It may be noted that as per constraint (15.14), project B can be accepted only when project A is accepted; project A, however, can be accepted independently.

A project may be contingent on not one but two (or even more) projects. Suppose, the acceptance of project R is contingent on the acceptance of projects P and Q. Such a contingency relationship is reflected in the following constraint.

$$2X_R \leq X_P + X_Q \tag{15.15}$$

Mutual Exclusiveness and Contingency Project dependency may reflect both mutual exclusiveness and contingency requirements. Some examples are described below:

1. M and N are mutually exclusive projects; a third project, P, is contingent on the acceptance of either M or N. This condition is reflected in the following constraints:

$$X_M + X_N \leq 1 \tag{15.16}$$

$$X_P \leq X_M + X_N \tag{15.17}$$

2. Out of the set of projects, A, B, C and D, only three projects can be accepted. Further, for accepting project E at least two projects out of the above set should be accepted. This condition is reflected in the following constraints:

$$X_A + X_B + X_C + X_D \leq 3 \tag{15.18}$$

$$2X_E \leq X_A + X_B + X_C + X_D \tag{15.19}$$

Complementariness If undertaking a project influences favourably the cash flows of another project, the two projects are complementary projects. To illustrate how complementarity is reflected in the integer linear programming model, consider two projects R and S. Either of them can be accepted individually. However, if both are accepted together the following benefits will accrue: (i) The cost will reduce by 5 percent. (ii) The net cash inflow will increase by 10 percent. To reflect a complementary relationship of this kind, a composite project RS representing the combination of R and S is set up; the cash inflows of RS would be 10 percent higher than the sum of the cash inflows of R and S. Further, since it is not possible to accept R and S as well as RS, because the latter is the composite project consisting of R and S, the following constraint is incorporated in the integer linear programming formulation:

$$X_R + X_S + X_{RS} \leq 1 \tag{15.20}$$

Integer Linear Programming Formulation: An Illustration

Consider the following nine projects.

Project	*Net present value* (NPV_j)	*Cash outflow in year 1* (CF_{j1})	*Cash outflow in year 2* (CF_{j2})
1	44	50	48
2	30	40	22
3	20	10	40
4	25	36	5
5	35	25	60
6	24	43	15
7	42	40	0
8	28	33	14
9	60	75	48

The budget constraints for the two years are 150 and 180 respectively. The following project interdependencies obtain:

1. Projects 1 and 2 are mutually exclusive.
2. Out of the set of projects 4, 5, and 6 at least two must be accepted.
3. Project 9 cannot be accepted unless projects 4 and 6 are accepted.
4. Project 7 can be delayed by one year. Such a delay would not change the cash outflows but reduce *NPV* to 35.
5. Projects 8 and 9 are complementary. If the two are accepted together, the total cash outflows will be less by 8 percent whereas the *NPV* will be more by 10 percent.

Given the nature of the problem, in addition to the decision variables X_1 through X_9 for the original 9 projects, few additional decision variables are required as follows:

X_{10} is the decision variable to represent the delay of project 7 by one year.

X_{11} is the decision variable for the composite project which represents the combination of projects 8 and 9.

The integer linear programming formulation is as follows:

Maximise $44X_1 + 30X_2 + 20X_3 + 25X_4 + 35X_5 + 24X_6$
$+ 42X_7 + 28X_8 + 60X_9 + 35X_{10} + 96.8X_{11}$

Subject to

$$50X_1 + 40X_2 + 10X_3 + 36X_4 + 25X_5 + 43X_6$$
$$+ 40X_7 + 33X_8 + 75X_9 + 0X_{10} + 99.4X_{11} \leq 150$$
$$48X_1 + 22X_2 + 40X_3 + 5X_4 + 60X_5 + 15X_6$$
$$+ 0X_7 + 14X_8 + 48X_9 + 40X_{10} + 47.88X_{11} \leq 180$$
$$X_1 + X_2 \leq 1$$
$$2X_9 \leq X_4 + X_6$$
$$X_7 + X_{10} \leq 1$$
$$X_8 + X_9 + X_{11} \leq 1$$
$$X_j = \{0, 1\} j = 1, 2, \cdots, 11$$

Evaluation

The principal strengths of the integer linear programming model, clearly demonstrated above, are:

1. It overcomes the problem of partial projects which besets the linear programming model.
2. It is capable of handling virtually any kind of project interdependency.

The major shortcomings of the integer linear programming model are:

1. The solution of an integer linear programming model takes considerably more time than the solution of the linear programming model. Pettway reported that for an integer linear programming model with 28 projects and 15 budget constraints, four out of six algorithms that he tried failed to reach an optimal solution in 5 minutes of CPU time on an IBM 360–65 system; the two algorithms which located the optimal solution took 118 seconds and 181 seconds. By contrast, the solution time for the linear programming model of the same problem would take just one to two seconds. Further, the solution time for integer linear programming tends to grow exponentially as the number of projects increases because of the combinatorial nature of the problem. Other frustrating aspects of the integer linear programming model are: (i) The solution time may be highly variable—a small problem may take much more time than a large problem. (ii) Minor variations in the problem may lead to significant increase in solution times. (iii) No single solution algorithm works best for all types of integer linear programming problems.

2. Meaningful shadow prices are not available for the integer programming formulation. This happens because the integer linear programming model permits only discrete variation, not continuous variation, of the decision variables. In the integer linear programming model, constraints which are not binding in the optimal solution are assigned zero shadow prices though the objective function would decrease when the availability of resources, representing non-binding constraints, is diminished. Gomory and Baumol summarise the problem of shadow prices in integer linear programming as follows:[3]

> In integer programming, inputs clearly must be thought of as coming in indivisible units. For that reason we cannot speak, e.g., of the marginal profit contribution of a small change in input, i.e., we must deal with $\Delta R/\Delta X$ rather than dR/dX (as we do in LP) where ΔX is an indivisible unit of input X and R is total profit. But a dual-price represents dR/dX which may change over the range of a unit change in X, and hence it may well give an incorrect evaluation of the marginal revenue of input X.

15.6 GOAL PROGRAMMING MODEL

Throughout this text we have assumed that the principal goal of financial management is to maximise the wealth of shareholders, which, under conditions of perfect capital market, can be realised by selecting the set of capital projects that maximise net present value.

However, in the real world, capital market imperfections (like capital rationing, differences in lending and borrowing rates, etc.) exist. Further, empirical observation show that managers pursue a multiple goal structure which includes, *inter alia*, the following:

3. R.E. Gomory and W.J. Baumol, "Integer Programming and Pricing", *Econometrica*, September 1966, pp. 521–550.

- Growth in sales and market share.
- Growth and stability of reported earnings.
- Growth and stability of dividends.

Therefore, a realistic representation of real life situations should reflect the multiple goals pursued by the management. The goal programming approach, a kind of mathematical programming approach, provides a methodology for solving an optimisation problem that involves multiple goals. This approach, originally proposed by Charnes and Cooper[4] in 1961, has been extended by Ijiri, Ignizio, and others.

To use the goal programming model, the decision maker must:

1. State an absolute priority order among his goals.
2. Provide a target value for each of his goals.

The goal programming methodology seeks to solve the programming problem by minimising the absolute deviations from the specific goals in order of the priority structure established. Goals at priority level one are sought to be optimised first. Only when this is done will the goals at priority level two be considered; so on and so forth. At a given priority level, the relative importance of two or more goals is reflected in the weights assigned to them.

Goal Programming Format

In general, the goal programming format is as follows:

$$\text{Minimise} = \{P_1 [f_1 (d_1^+, d_1^-)] + P_2 [f_2(d_2^+, d_2^-) + \cdots + P_m [f_m (d_m^+, d_m^-)]\} \quad (15.21)$$

Subject to

$$\Sigma a_{j1} X_j \leq C_1 \quad (15.22a)$$

$$\Sigma a_{j2} X_j \leq C_2 \quad (15.22b)$$

$$\Sigma a_{jk} X_j \leq C_k \quad (15.22k)$$

$$\vdots$$

$$\Sigma b_{j1} X_j + d_1^- - d_1^+ = G_1 \quad (15.23a)$$

$$\Sigma b_{j2} X_j + d_2^- - d_2^+ = G_2 \quad (15.23b)$$

$$\vdots$$

$$\Sigma b_{jm} X_j + d_m^- - d_m^+ = G_m \quad (15.23m)$$

$$X_j, d_i^+, d_i^- \geq 0 \quad (15.24)$$

The goal programming model is formulated in terms of three principal components: (i) the objective function, (ii) the economic constraints, and (iii) the goal constraints.

4. A. Charnes and W.W. Cooper, *Management Models and Industrial Applications of Linear Programming*, New York: John Wiley & Sons, 1961.

Objective Function The objective function, expressed as Eq. (15.26), seeks to minimise the weighted deviation from the target levels of various objectives in accordance with a priority structure. A formal representation of the objective function calls for specifying the following:

- The priority levels of goals.
- The relative weights attached to each goal where there are two or more goals at the same priority level.
- The relevant deviational variables which should be minimised with respect to each goal.

Economic Constraints The economic constraints embodied in Eqs (15.22a) through (15.27k) represent resource limitations or restrictions emanating from the decision environment which cannot be violated. Hence they are also referred to as 'hard constraints'. The economic constraints in a goal programming model are similar to the constraints found in a linear programming model. Hence, such constraints require the usual slack or surplus variables.

Goal Constraints The goal constraints, embodied in Eqs (15.28a) through (15.28m) represent target levels of various goals that are pursued by the decision maker. Defined as strict equalities, goal constraints contain, in addition to an expression showing the impact of decision variables on goal attainment, two deviational variables denoted by d_i^+ and d_i^-. d_i^+ indicates that the desired level of goal i has been over-achieved; d_i^- indicates that the desired level of goal i has been under-achieved. When the desired goal level has been over-achieved d_i^+ is non-zero and d_i^- is zero; when the desired goal level has been underachieved, d_i^+ is zero and d_i^- is non-zero; when the desired goal level is exactly achieved, both d_i^+ and d_i^- are zero. The deviational variables tie the goal constraints and the objective function. For each goal, the appropriate deviational variable(s) is (are) placed in the objective function.

Illustration

To illustrate the application of goal programming let us reconsider the example used in the context of our discussion on linear programming in which there were seven projects with the following characteristics:

Project	*Net present value* (NPV_j)	*Cash outflow in period 1* (CF_{j1})	*Cash outflow in period 2* (CF_{j2})	*Power requirement* (E_j)	*Managerial requirement* (M_j)
1	6	5	7	2	6
2	8	9	5	4	5
3	8	12	4	5	7
4	7	3	10	3	2
5	4	4	6	4	4
6	12	10	15	7	8
7	9	13	9	6	3
		$\Sigma X_j CF_{j1} \leq 35$	$\Sigma X_j CF_{j2} \leq 30$	$\Sigma X_j E_j \leq 18$	$\Sigma X_j M_j \leq 20$

The firm considering these projects now feels that in addition to the *NPV* objective, there are two other goals viz., net income objective and sales growth objective. The firm wants the net income from the set of projects selected to be 6 and 9 respectively in years 1 and 2. Further, the firm has set a sales growth target to 10 percent for the first two years.

The contribution of the projects to net income and sales growth is shown below:

	Net Income		Sales Growth	
Project	*Year 1*	*Year 2*	*Year 1*	*Year 2*
1	1.0	1.4	0.010	0.020
2	2.1	1.6	0.015	0.010
3	1.8	2.5	0.018	0.025
4	1.2	3.0	0.020	0.025
5	1.0	0.8	0.015	0.010
6	2.5	1.2	0.030	0.025
7	1.4	1.3	0.025	0.020

The priorities assigned to various goals are as follows:

Priority 1 : Net income

Priority 2 : Sales growth

Priority 3 : *NPV*

At priority level one, net income for year one is weighted 2 times as the net income for year two; at priority level two, sales growth for year one is considered three times as important as the sales growth for year two.

The goal programming formulation of the above problem is given below.

Goal Function

$$\text{Minimise} = [P_1 (2d_1^- + d_2^-) + P_2 (3d_3^- + d_4^-) + P_3 (d_5^- - d_5^+)]$$

Economic Constraints

$$5X_1 + 9X_2 + 12X_3 + 3X_4 + 4X_5 + 10X_6 + 13X_7 + S_1 = 35 \quad \text{Funds constraint for year 1}$$

$$7X_1 + 5X_2 + 4X_3 + 10X_4 + 6X_5 + 15X_6 + 9X_7 + S_2 = 30 \quad \text{Funds constraint for year 2}$$

$$2X_1 + 4X_2 + 5X_3 + 3X_4 + 4X_5 + 7X_6 + 6X_7 + S_3 = 18 \quad \text{Power constraint}$$

$$6X_1 + 5X_2 + 7X_3 + 2X_4 + 4X_5 + 8X_6 + 3X_7 + S_4 = 20 \quad \text{Managerial constraint}$$

$$X_1 + S_5 = 1 \qquad X_3 + S_7 = 1$$

$$X_2 + S_6 = 1 \qquad X_4 + S_8 = 1$$

$$X_5 + S_9 = 1 \qquad X_7 + S_{11} = 1$$
$$X_6 + S_{10} = 1$$
$$X_j \geq 0 \ (j = 1, 2, \ldots, 7)$$
$$S_i \geq 0 \ (i = 1, 2, \ldots, 11)$$

Goal Constraints

$$1.0X_1 + 2.1X_2 + 1.8X_3 + 1.2X_4 + 1.0X_5 + 2.5X_6 + 1.4X_7 + d_1^- - d_1^+ = 6 \text{ Net income for year 1}$$

$$1.4X_1 + 1.6X_2 + 2.5X_3 + 3.0X_4 + 0.8X_5 + 1.2X_6 + 1.3X_7 + d_2^- - d_2^+ = 9 \text{ Net income for year 2}$$

$$0.01X_1 + 0.015X_2 + 0.018X_3 + 0.020X_4 + 0.015X_5 + 0.03X_6 + 0.025X_7 + d_3^- - d_3^+ = 0.10 \text{ Sales growth for year 1}$$

$$0.02X_1 + 0.01X_2 + 0.025X_3 + 0.025X_4 + 0.01X_5 + 0.025X_6 + 0.02X_7 + d_4^- - d_4^+ = 0.10 \text{ Sales growth for year 2}$$

$$6X_1 + 8X_2 + 8X_3 + 7X_4 + 4X_5 + 12X_6 + 9X_7 + d_5^- - d_5^+ = 50 \ NPV$$

It may be noted that the goal constraint of *NPV* is arbitrarily set equal to 50. In the objective function, the *NPV* goal, set at priority level 3, is defined as

$$\text{Minimise } (d_5^- - d_5^+)$$

This has the effect of striving for the maximum possible deviation from the target value this means *NPV* is sought to be maximised.

Appropriate Objective Function

The decision maker may be interested in pursuing varied actions relative to different goals. The objective function term should reflect the character of the desired action. Here is a list of objective function terms corresponding to various desired actions.

Desired Action	Objective Function Term
• Attain a minimum level of some goal	Minimise d^-
• Do not exceed a given level of some goal	Minimise d^+
• Minimise the deviation from a specified goal level	Minimise $(d^+ + d^-)$

• Maximise the value achieved in relation to a given goal level	Minimise $(d^- - d^+)$
• Minimise the value achieved in relation to a given level	Minimise $(d^+ - d^-)$

SUMMARY

- Because of constraints like project dependence, capital rationing, and project indivisibility, investment projects cannot be viewed in isolation.
- Two projects are said to be economically dependent if the acceptance or rejection of one changes the cash flow stream of the other or affects the acceptance or rejection of the other. The types of economic dependency found among projects are: mutual exclusiveness, negative dependency, and positive dependency (complementariness).
- Capital rationing exists when funds available for investment are inadequate to undertake all projects which are otherwise acceptable. Capital rationing may arise because of an internal limitation or an external constraint.
- Capital projects are generally indivisible. This means that a capital project has to be accepted or rejected in total—a project cannot be accepted partially.
- Because of economic dependency, capital rationing, or project indivisibility, a need arises for comparing projects in order to accept some and reject others. Two approaches are available for this purpose: the method of ranking, and the method of mathematical programming.
- Fairly simple, the method of ranking consists of two steps: (i) Rank all projects in decreasing order according to their individual *NPV*'s, *IRR*'s, or *BCR*'s. (ii) Accept projects in that order until the capital budget is exhausted.
- The method of ranking, originally proposed by Joel Dean, is seriously impaired by two problems: (i) conflict in ranking as per discounted cash flow criteria, and (ii) project indivisibility.
- In a given set of projects, preference ranking tends to differ from one criterion to another. Ranking conflicts are traceable to differing assumptions about the rate of return at which intermediate cash flows are reinvested.
- To select a set of projects, one may define all combinations of projects which are feasible given the capital rationing constraint and project dependencies, and then choose that combination which has the highest *NPV* associated with it. This procedure may be called as the feasible combinations procedure.

- The feasible combinations procedure described above becomes increasingly cumbersome as the number of projects increases and as the number of years in the planning horizon increases. To cope with a problem of this kind, it is helpful to use mathematical programming models.
- A mathematical programming model is formulated in terms of two broad categories of equations: (i) the objective function, and (ii) constraint equations.
- Out of the wide variety of mathematical programming models, three types have greater applicability to the capital budgeting problem: linear programming model, integer linear programming model, and goal programming model.
- The most popular mathematical programming model, the linear programming model, assumes, *inter alia*, that the objective function and constraint equations are linear and the decision variables are continuous.
- The integer linear programming model, which assumes that the decision variables assume a value of 0 or 1, has two advantages: (i) It overcomes the problem of partial projects which besets the linear programming model. (ii) It is capable of handling virtually any kind of project interdependency like mutual exclusiveness, contingency, and complementarity.
- The goal programming model is a method for solving an optimisation problem with multiple goals. This method seeks to solve the programming problem of minimising the absolute deviations from the specific goals in order of the priority structure established.

Questions

1. **Discuss different kinds of project dependency.**
2. **Discuss the sources of capital rationing.**
3. **Construct a set of five projects for which there is conflict in ranking as per the *NPV*, *IRR*, and *BCR* criteria.**
4. **"The *NPV* method assumes that the intermediate cash flows are reinvested at a rate of return equal to the cost of capital of the firm". Demonstrate.**
5. **Describe the feasible combinations approach. Illustrate it with a numerical example.**
6. **What assumptions underlie the linear programming model?**
7. **Critically evaluate the integer linear programming model as a tool for capital budgeting.**
8. **Discuss the following in the context of a goal programming model: objective function, economic constraints, and goal constraints.**

Problems

1. Consider a set of five projects:

Project	*Investment outlay*	*Expected annual cash inflow*	*Project life*
	Rs	Rs	Years
M	50,000	18,000	10
N	100,000	50,000	4
O	120,000	30,000	8
P	150,000	40,000	16
Q	200,000	30,000	25

Rank the five projects on the dimensions of *NPV*, *IRR*, and *BCR*. Discount rate is 10%.

2. Consider a set of six projects:

Project	*Investment outlay*	*Expected annual cash inflow*	*Project life*
	Rs	Rs	
A	70,500	20,000	12
B	400,000	80,000	15
C	300,000	75,000	18
D	300,000	90,000	5
E	250,000	60,000	9
F	500,000	100,000	10

Rank the projects on the dimensions of NPV, and BCR. Discount rate is 10%.

3. Give two hypothetical 3-year projects for which the *NPV* (at discount rate 10 percent) and *IRR* give different ranking.
4. Give two hypothetical 4-year projects for which the *BCR* and *IRR* criteria give different rankings. Assume that the discount rate is 12 percent.
5. Five projects, *A*, *B*, *C*, *D*, and *E* are available to a company.

	A	*B*	*C*	*D*	*E*
Initial investment	Rs 20,000	50,000	75,000	100,000	150,000
Annual cash inflow	Rs 6,000	8,000	15,000	15,000	25,000
Life	5 years	10	8	12	7
Salvage value	Rs 5,000	–	–	15,000	50,000

Project *B* is a prerequisite for project *E* and projects *C* and *D* are mutually exclusive. Otherwise the projects are independent. If the cost of capital for the firm is 10 percent, which projects should be chosen at the following budget levels: Rs 200,000 and Rs 250,000. Assume that the decision criterion is the net present value. Use the feasible combinations approach.

6. A firm is evaluating six investment opportunities:

Project (j)	*Net present value* (NPV_j)	*Cash outflow in period 1* (CF_{j1})	*Cash outflow in period 2* (CF_{j2})
	Rs	Rs	Rs
1	10,000	15,000	5,000
2	15,000	12,000	13,000
3	25,000	8,000	40,000
4	40,000	35,000	25,000
5	60,000	100,000	10,000
6	100,000	50,000	110,000

The budget available is limited to Rs 150,000 in year 1 and Rs 200,000 in year 2. Any amount not spent in year 1 can be transferred to year 2. The amount so transferred will earn a post-tax return of 8 percent.

There are two additional constraints: working capital constraint and managerial constraint. The requirements and constraints applicable in this respect are:

Project (j)	*Power requirement* (W_j)	*Managerial requirement* (M_j)
1	5,000	15
2	6,000	20
3	5,000	30
4	10,000	35
5	12,000	40
6	40,000	60
	$\Sigma X_j W_j \leq 60{,}000$	$\Sigma X_j M_j \leq 120$

Develop a linear programming formulation of the above capital budgeting problem.

7. Consider the following ten investment projects.

Project (j)	*Net present value* (NPV_j)	*Cash outflow in period 1* (CF_{j1})	*Cash outflow in period 2* (CF_{j2})
1	55	75	40
2	75	80	85
3	50	75	8
4	60	35	100
5	105	80	160
6	12	20	9
7	60	70	5
8	120	155	100
9	50	55	20
10	40	10	90

The budget constraints for years 1 and 2 are 400 and 350 respectively. The following project interdependencies exist:

(i) Projects 3 and 7 are mutually exclusive.
(ii) Out of the set of projects 5, 8, 9, and 10 at least two must be accepted.
(iii) Project 6 is a prerequisite for project 2.
(iv) Project 8 can be delayed by one year. Such a delay would shift the cash outflows by one year and reduce the *NPV* of project 8 by 20. No fund constraint applies to year 3.
(v) Projects 4 and 5 are complementary. If the two are accepted together, the total cash outflows will be less by 5 percent whereas the *NPV* will be more by 8 percent.
(vi) If project 8 is accepted, project 9 must also be accepted.

Develop the integer linear programming formulation of the above problem.

8. Delta International is considering seven projects with the following characteristics:

		Contribution to Net Income			*Contribution to Sales Growth (percentage)*			
Project	*Initial outlay*	*Year 1*	*Year 2*	*Year 3*	*Year 1*	*Year 2*	*Year 3*	*NPV*
1	12	1.2	1.1	1.6	1.0	1.5	1.8	4
2	14	1.6	1.2	1.5	1.2	1.0	1.2	5
3	15	0.6	1.2	2.0	0.5	1.2	2.5	6
4	16	1.5	1.6	1.8	1.8	2.0	2.2	8
5	11	0.5	1.2	1.5	0.6	1.4	1.8	4
6	23	0.9	2.5	4.0	1.0	3.0	3.5	9
7	20	1.8	2.0	2.2	2.0	3.0	3.5	7

The capital budget constraint is 65. The goals sought by management are as follows: (i) maximisation of *NPV*, (ii) contribution to net income of 6.0, 8.0, and 10.0 in years 1, 2, and 3, and (iii) contribution to sales growth of 6, 8, and 10 percent in years 1, 2, and 3. The priorities assigned to various goals are as follows:

Priority 1 : Net income
Priority 2 : Sales growth
Priority 3 : *NPV*

At priority level 1, the relative weights attached to the net income of years 1, 2, and 3 are 3, 2, and, 1 respectively. At priority level 2, the relative weights attached to the contribution to sales growth of years 1, 2, and 3 are 4, 2, and 1 respectively.

Formulate the above problem as a goal programming problem.

9. The Premier Company draws a 2-year capital budget. The amount available for the next two years is Rs 2.5 million, Rs 2 million is on hand now and Rs 0.5 million will be available after a year. Some projects can be undertaken now, some after a year. The *BCR* of the projects calculated at the point of investment is as follows:

(in million)

Projects Available Now			*Projects Available After a Year*		
Number	*Initial investment*	*BCR*	*Number*	*Initial investment*	*BCR*
1	0.8	1.08	6	0.5	1.09
2	0.2	1.35	7	0.4	1.21
3	0.4	1.20	8	0.6	1.17
4	0.3	1.09	9	0.3	1.01
5	0.2	0.98			

The tax rate of the company is 50 percent and its post-tax cost of capital is 10 percent. One year bank deposit carries 6 percent of interest. Develop an integer linear programming formulation of the problem.

CHAPTER 16

Valuation of Real Options

In capital budgeting, the discounted cash flow model is the basic framework for evaluation. According to the discounted cash flow model the value of a project is equal to the net present value of cash flows expected over its economic life.

The conventional discounted cash flow model, however, has a serious deficiency: It fails to reflect the options that are embedded in real life capital projects.

The important real options found in capital projects are: the option to expand the project; the option to delay the project; the option to abandon the project; and the option to change the output or production methods. These options give managers flexibility to amplify gains or to reduce losses.

Given the fact that these options are found in most capital projects, finance theorists and practitioners now argue that these options must be considered in analysing capital budgeting decisions.

Option pricing model, developed originally for valuing financial options, has been applied for valuing real options embedded in capital projects. However, at the outset, let us note that valuing real options is far more difficult than valuing financial options.

This chapter discusses the basics of option pricing and shows how the same may be applied for valuing fairly simple real options. The examples given in this chapter ignore many complexities encountered in real projects.

The chapter is organised into ten sections as follows:

- What are options?
- Options and their payoffs just before expiration
- Factors determining option values

- Binomial model for option valuation
- Black-Scholes model
- Value of an option to make a follow on investment
- Value of an option to abandon
- Value of a vacant land
- Value of a natural resource option
- Judgmental assessment of options

16.1 WHAT ARE OPTIONS?

An option is a special contract under which the option owner enjoys the right to buy or sell something without the obligation to do so. For example, you may enjoy the option to buy a certain apartment on or before any time before December 31 of the current year at a price of Rs 3 million.

There can be as many different option contracts as the number of items to buy or sell. Stock options, commodity options, foreign exchange options, and interest rate options are traded on and off organised exchanges across the globe.

Options have a special terminology associated with them.

- The option to buy is a *call option* (or just call) and the option to sell is a *put option* (or just put).
- The *option holder* is the buyer of the option and the *option writer* is the seller of the option.
- The fixed price at which the option holder can buy and/or sell the underlying asset is called the *exercise price* or *striking price*.
- The date when the option expires or matures is referred to as the *expiration date* or *maturity date*. After the expiration date, the option is worthless.
- The act of buying or selling the underlying asset as per the option contract is called *exercising the option*.
- A *European option* can be exercised only on the expiration date whereas an *American option* can be exercised on or before the expiration date.
- Options traded on an exchange are called *exchange-traded options* and options not traded on an exchange are called *over-the-counter options*.

Exchange-traded options are standardised in terms of quantity, exercise price, and expiration date. For example, on the Chicago Board of Options Exchange (CBOE), where American options are traded, a single call option gives its holder the right to buy 100 shares of the underlying stock. At the time of origination, CBOE options have maturities that range from three months to three years and they all expire on the third Friday of the month in which they mature. Exhibit 16.1 shows an illustrative list of IBM option prices.

Exhibit 16.1 *Listing of IBM Option Prices*

IBM (IBM) — Underlying Stock Price: $120^{1}/_{16}$

		Call			Put		
Strike	Expiration	Volume	Last	Open Interest	Volume	Last	Open Interest
115	Jun	1372	7	4483	756	$1^{3}/_{16}$	9692
115	Oct	...	...	2584	10	5	967
115	Jan	...	...	15	53	$6^{3}/_{4}$	40
120	Jun	2377	$3^{1}/_{2}$	8049	873	$2^{7}/_{8}$	9849
120	Oct	121	$9^{5}/_{8}$	2561	45	$7^{1}/_{8}$	1993
120	Jan	91	$12^{1}/_{2}$	8842	...	...	5259
125	Jan	1564	$1^{1}/_{2}$	9764	17	$5^{3}/_{4}$	5900
125	Oct	91	$7^{1}/_{2}$	2360	...	...	731
125	Jan	87	$10^{1}/_{2}$	124	...	...	70

The closing price of IBM stock is shown on the top at the right-hand side. On May 28, 1998 it was $\$120^{1}/_{16}$. Turn to row 4. The first column shows the strike price, 115; the second the expiration month, June; the third the volume of call options traded that day, 1372; the fourth the last price at which the call option was traded, $7; and the fifth the 'open interest', reflecting the number of CBOE contracts of that type in existence on May 28, 1998. The remaining three contracts pertain to put options giving the trading volume, closing price, and open interest.

The value of an option, if it were to expire immediately, is called its *intrinsic value*. What is the intrinsic value of June IBM $115 option if it were to expire immediately? Since the price of IBM is $\$120^{1}/_{16}$ and the option exercise price is $115, the intrinsic value of the call is $\$5^{1}/_{16}$ per share. The market price of the call option is $7 and it exceeds its intrinsic value by $\$1^{15}/_{16}$. This difference is referred to as the *time value of the option*.

Depending on how the exercise price compares with the market price, options are said to be *at the money* or *in the money* or *out of the money*, as shown below.

	Call option	*Put option*
At the money	Exercise price = Market price	Exercise price = Market price
In the money	Exercise price < Market price	Exercise price > Market price
Out of the money	Exercise price > Market price	Exercise price < Market price

16.2 OPTIONS AND THEIR PAYOFFS JUST BEFORE EXPIRATION

This section looks at the features of call and put options and their payoffs just before expiration, from the point of view of the option holder as well as the option writer. In addition, it discusses combination options.

Call Option

The most common type of option, the *call option*, gives the option holder the right to buy an asset at a fixed price during a certain period. While there is no restriction on the kind of asset, the most popular type of call option is the option on stocks. For example, investors can buy call options on General Motors stock (and many other stocks) on the Chicago Board of Options Exchange. A typical call option on General Motors stock entitles the investor to buy 100 shares of General Motors on or before say July 15, 200X at an exercise price of $Y. Such an option is valuable if there is some likelihood that the price of the common (equity) stock of General Motors will rise above $Y on or before July 15, 200X. (To provide protection to the option holder, the option contract generally specifies that the exercise price and the number of shares will be adjusted for stock splits and stock dividends. For example, if the General Motors stock splits 4 to 1, the option contract will be for 400 shares at an exercise price of $Y/4. Of course, no adjustment is made for cash dividends. Remember that the holder of a call option is not entitled to receive cash dividends.

Payoff of a Call Option

What is the payoff of a European call option? To answer this question let us look at the possible payoffs of the call option just before expiration[1]. The payoff of the call option (C) just before expiration depends on the relationship between the stock price (S_1) and the exercise price (E). Formally

$$C = S_1 - E \quad \text{if} \quad S_1 > E \tag{16.1}$$

$$C = 0 \quad \text{if} \quad S_1 \leq E \tag{16.2}$$

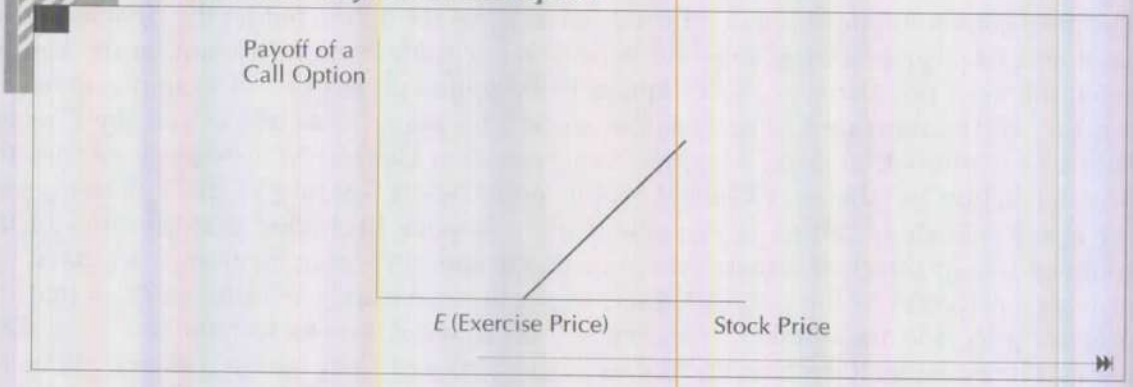
This means $C = \text{Max}\ (S_1 - E, 0)$. Exhibit 16.2 graphically shows the value of a call option. When $S_1 \leq E$, the call is said to be "out of money" and is worthless. When $S_1 > E$, the call is said to be "in the money" and its value is $S_1 - E$.

Put Option

The opposite of a call option is a *put option*. While the call option gives the holder the right to buy a stock at a fixed price, the put option gives the holder the right to sell a stock at a fixed price. For example, a put option on the IBM stock may give its holder the right to sell 100 shares of IBM on or before July 15, 200X at a price of $Y per share. Such an option is valuable if there is some possibility that the price of IBM stock will fall below $Y per share on or before July 15, 200X.

1. Recall that such an option can be exercised only on the expiration date, not before.

Exhibit 16.2 ***Payoff of a Call Option***



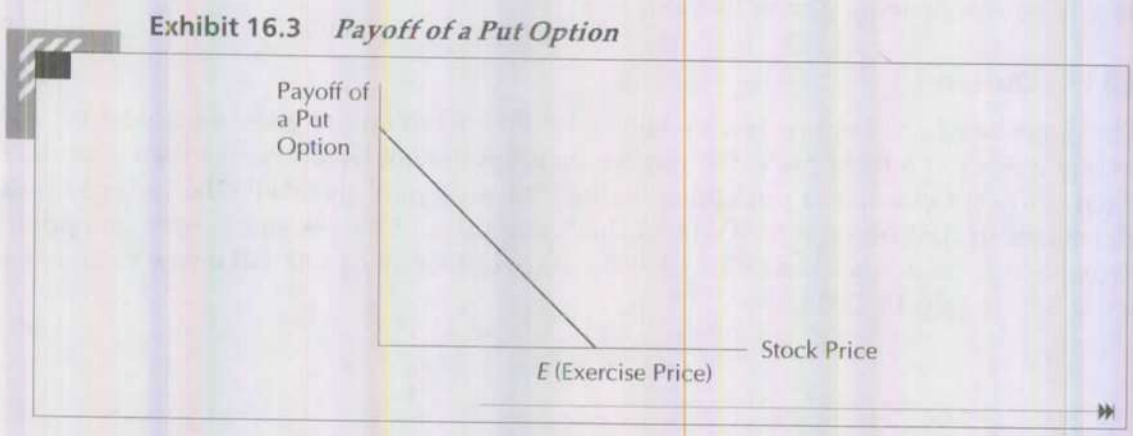
Payoff of a Put Option

The payoff of a put just before expiration depends on the relationship between the exercise price (E) and the price of the underlying stock (S_1). If $S_1 < E$, the put option has a value of $S_1 - E$, and is said to be "in the money". On the other hand if $S_1 \geq E$, the put option is worthless and is said to be "out of money". Thus the payoff of a put option just before expiration is:

	If $S_1 < E$	If $S_1 \geq E$
Value of the put option	$E - S_1$	0

Put differently, just before expiration the payoff of a put option is Max $(E - S_1, 0)$. Exhibit 16.3 plots the relationship between the value of the underlying stock and the payoff of the put option.

Exhibit 16.3 ***Payoff of a Put Option***



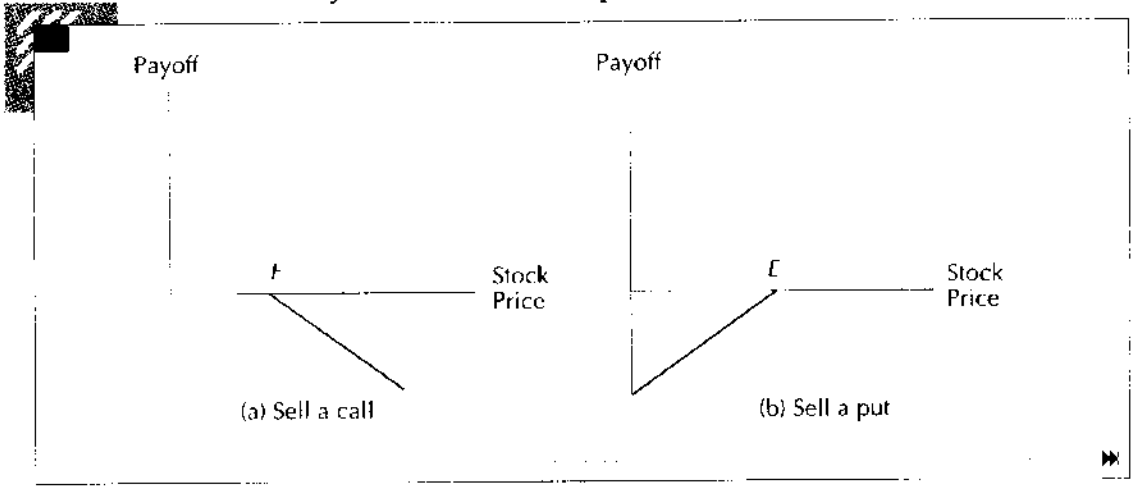
Seller's Position

We discussed the payoff of call and put options from the point of view of the option buyer (or holder). Let us now look at the options from the point of view of the option writer (or seller).

A writer of a call option collects the option premium from the buyer (holder) of the option. In return, he is obliged to deliver the shares, should the option buyer exercise the option. If the stock price (S_1) is less than the exercise price (E) on the expiration date, the option holder will not exercise the option. In this case, the option writer's liability is nil. On the other hand, if the stock price (S_1) is more than the exercise price (E), the option holder will exercise the option. Hence the option writer loses $S_1 - E$.

What is the payoff from the point of view of the seller (or writer) of a put option? If the price of the stock (S_1) is equal to or more than the exercise price (E), the holder of the put option will not exercise the option. Hence the option writer's liability is nil. On the other hand, if $S_1 < E$, the holder of the put option will exercise the option. Hence the option writer loses $E - S_1$. The payoffs for "selling a call" and "selling a put" from the sellers' point of view are plotted in Exhibit 16.4.

Exhibit 16.4 ***Payoffs to the Seller of Options***



Combinations

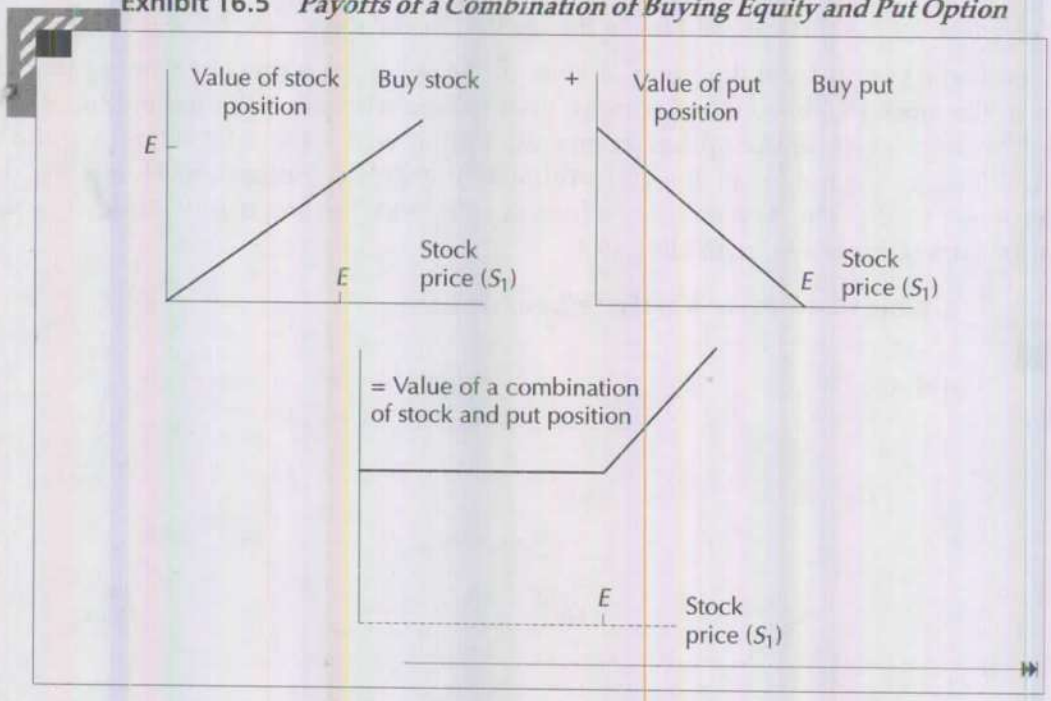
Puts and calls represent basic options. They serve as building blocks for developing more complex options. Exhibit 16.5 shows the payoff for a combination of (i) buying a stock, and (ii) buying a put option on the stock.

The algebra corresponding to this combination is as follows:

	Payoffs Just Before Expiration Date	
	If $S_1 < E$	*If* $S_1 > E$
(1) Put option	$E - S_1$	0
+		
(2) Equity stock	S_1	S_1
= Combination	E	S_1

Thus, if you buy a stock along with a put option on that stock (exercisable at price E), your payoff will be E if the price of the stock is less than E; otherwise your payoff will be S_1.

Exhibit 16.5 ***Payoffs of a Combination of Buying Equity and Put Option***

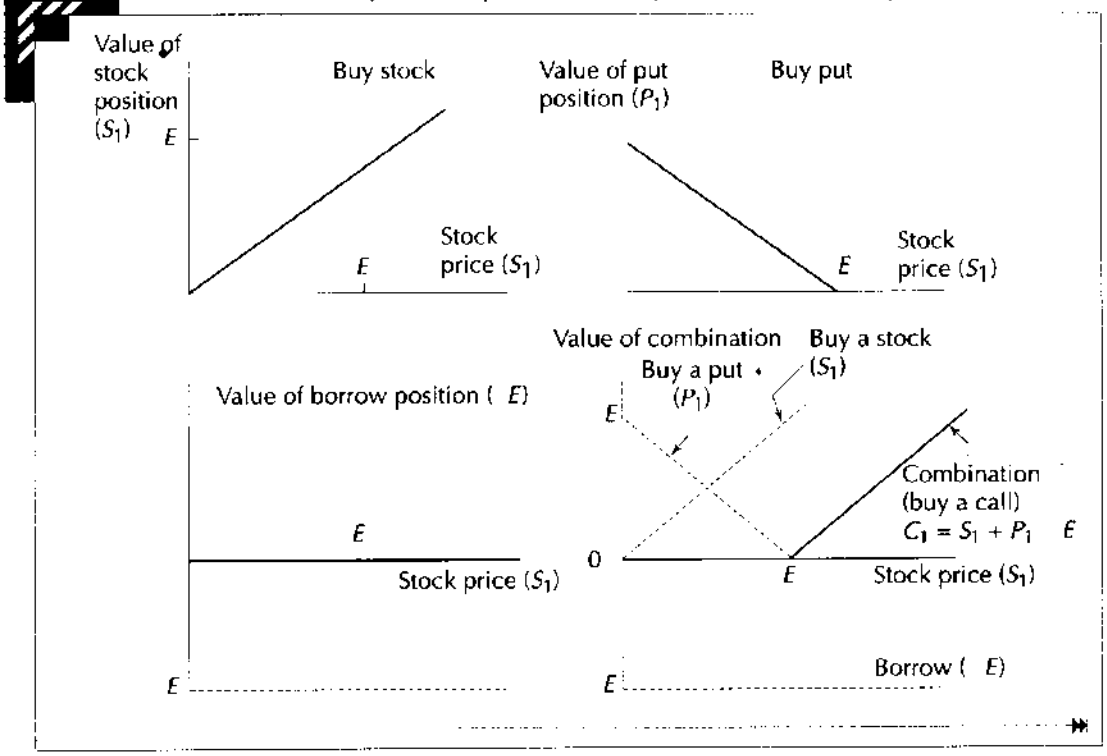


Consider a more complex combination that consists of (i) buying a stock, (ii) buying a put option on that stock, and (iii) borrowing an amount equal to the exercise price. The payoff from this combination is identical to the payoff from buying a call option. The algebra of this equivalence is shown as follows:

	Payoffs Just Before Expiration Date	
	If $S_1 < E$	*If* $S_1 > E$
(1) Buy the equity stock	S_1	S_1
(2) Buy a put option	$E - S_1$	0
(3) Borrow an amount equal to the exercise price	$-E$	$-E$
(1) + (2) + (3) = Buy a call option	0	$S_1 - E$

The payoffs from the individual components and the combination are shown in Exhibit 16.6.

Exhibit 16.6 ***Graphical Representation of the Put Call Parity Theorem***



If C_1 is the terminal value of the call option (remember that C_1= Max $(S_1 - E)$, 0), P_1 the terminal value of the put option (remember that P_1 = Max $(E - S_1)$, 0), S_1 the price of the stock, and E the amount borrowed, we know from the preceding analysis that:

$$C_1 = S_1 + P_1 - E \tag{16.3}$$

This is referred to as the *put-call parity* theorem.

16.3 FACTORS DETERMINING OPTION VALUES

In the previous section, we looked at the payoffs of options just before the expiration date. Now we determine the present value of options.

Boundaries

Before we identify the factors determining option values, it is helpful to specify the boundaries within which the value of an option falls.

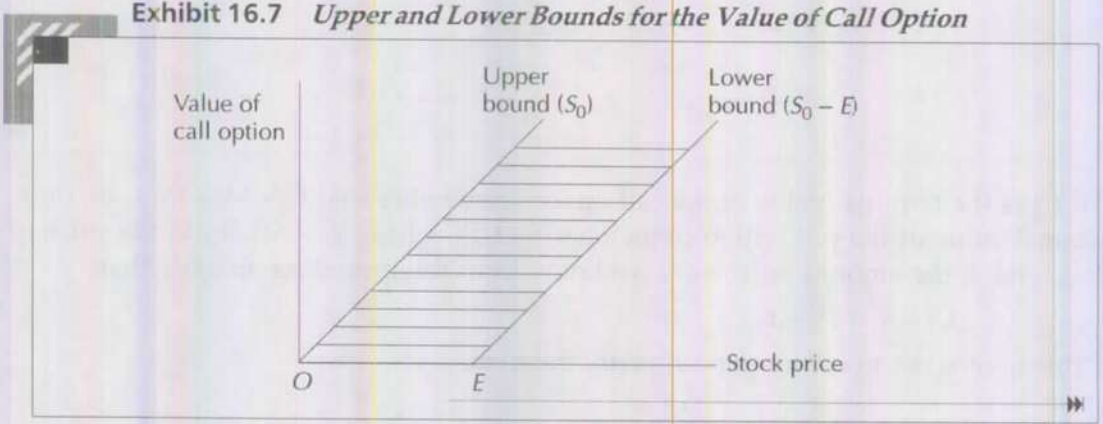
The minimum value at which a call option sells before the expiration date, say, at time zero, is Max $(0, S_0 - E)$. This means that C_0, the value of a call option, can never fall below zero (this happens when $S_0 < E$). Also, it means that the value of a call option cannot fall below $S_0 - E$ (this happens when $S_0 > E$). To see why this is so, consider a call option with $E = 150$, $S_0 = 250$, and $C_0 = 75$. In this case it pays an investor to buy the call option for 75, exercise it for 150, and finally sell the stock for 250. By doing so he earns a profit of:

$$S_0 - (C_0 + E) = 250 - (75 + 15) = 25$$

This profit, reflecting arbitrage profits, comes without incurring any risk or cost. Such a profit cannot occur in a well functioning financial market. Hence in such a market C_0 cannot sell for less than $S_0 - E$.

What is the upper limit for the option price? A call option entitles the holder to buy the underlying stock on payment of a certain exercise price. Hence its value cannot be greater than that of the underlying stock. If it were so, the investor would be better off by buying the stock directly. The upper and lower bounds for the value of a call option are shown in Exhibit 16.7.

Exhibit 16.7 ***Upper and Lower Bounds for the Value of Call Option***



Key Factors

As indicated above, the price of a call option must fall in the shaded region of Exhibit 16.7. Put formally,

$$\text{Max } (S_0 - E, 0) \leq C_0 \leq S_0 \qquad (16.4)$$

Where exactly in the shaded region will the value of a call option be? The precise location of the option value depends on five key factors:

- Exercise price
- Expiration date
- Stock price
- Stock price variability
- Interest rate.

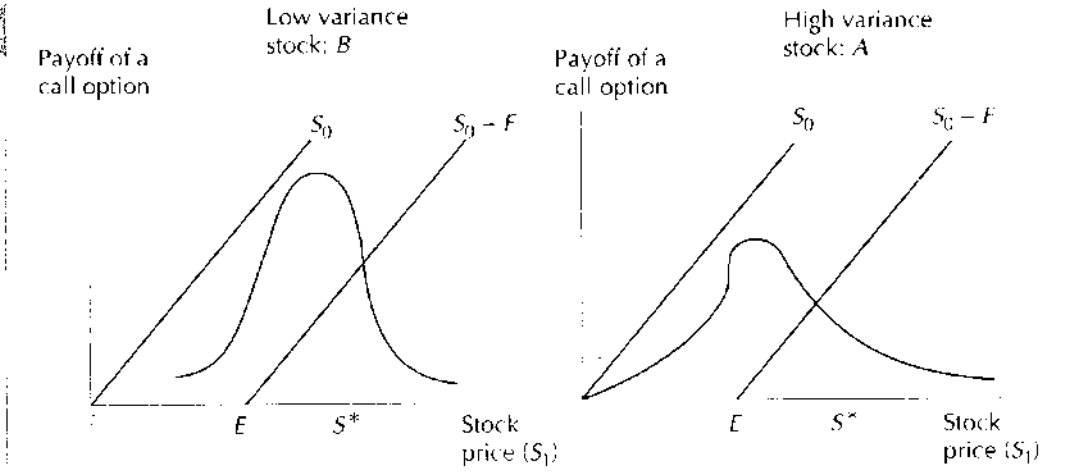
Exercise Price By now it is obvious that, other things being constant, the higher the exercise price the lower the value of the call option. Remember that the value of a call option can never be negative, regardless of how high the exercise price is set. Further it has a positive value if there is some possibility that the stock price will be higher than the exercise price before the expiration date.

Expiration Date Other things being equal, the longer the time to expiration date the more valuable the call option. Consider two American calls with maturities of one year and two years. The two year call obviously is more valuable than the one year call because it gives its holder one more year within which it can be exercised.

Stock Price The value of a call option, other things being constant, increases with the stock price. This point is obvious from the figures showing the relationship between the stock price and the value of a call option.

Variability of the Stock Price A call option has value when there is a possibility that the stock price exceeds the exercise price before the expiration date. Other things being equal, the higher the variability of the stock price, the greater the likelihood that the stock price will exceed the exercise price. This point is graphically illustrated in Exhibit 16.8.

Exhibit 16.8 ***Value of Call Options for Low Variability and High Variability Stocks***



In this figure the price distribution of two stocks, A and B, is given. While both A and B have the same expected value, A has a higher variance than B. Given an exercise price of E, a call option on A is more valuable than that on B. This is so because the holder of a call option gains when the stock price exceeds the exercise price and does not lose when the stock price is less than the exercise price.

So fundamental is this point that it calls for another illustration. Consider the probability distribution of the price of two stocks, P and Q, just before the call option (with an exercise price of 80) on them expires.

P		Q	
Price	*Probability*	*Price*	*Probability*
60	0.5	50	0.5
80	0.5	90	0.5

While the expected price of stock Q is the same as that of stock P, the variance of Q is higher than that of P. The call option (exercise price: 80) on stock P is worthless as there is no likelihood that the price of stock P will exceed 80. However, the call option on stock Q is valuable because there is a distinct possibility that the stock price will exceed the exercise price.

Remember that there is a basic difference between holding a stock and holding a call option on the stock. If you are a risk-averse investor you try to avoid buying a high variance stock, as it exposes you to the possibility of negative returns. However, you will like to buy a call option on that stock because you receive the profit from the right tail of the probability distribution, while avoiding the loss on the left tail. Thus, regardless of your risk disposition, you will find a high variance in the underlying stock desirable.

Interest Rate When you buy a call option you do not pay the exercise price until you decide to exercise the call option. Put differently, the payment, if any, is made in the future. The higher the interest rate, the greater the benefit will be from delayed payment and vice versa. So the value of a call option is positively related to the interest rate.

Functional Relationship

The manner in which the five variables discussed above influence the value of a call option is shown in the following relationship:

$$\underset{}{C_0} = f\underset{+}{[S_0,} \underset{-}{E,} \underset{+}{\sigma^2,} \underset{+}{t,} \underset{+}{r_f}] \qquad (16.5)$$

where C_0 = value of the call option

S_0 = price of the underlying stock (or asset in general)

E = exercise price

σ^2 = variance of the return on the underlying asset

t = time left to expiration

r_f = risk-free interest rate

The sign (+,–) put below a variable denotes the nature of its influence on the value of the call option. You must be eager to know the precise relationship between these variables and the value of a call option. Black and Scholes developed their celebrated option pricing model which expresses this relationship. Before we look at their model, it is helpful to understand the two-state or binomial option valuation model.

16.4 BINOMIAL MODEL FOR OPTION VALUATION

The standard DCF (discounted cash flow) procedure involves two steps, viz., estimation of expected future cash flows and discounting of these cash flows using an appropriate cost of capital. There are problems in applying this procedure to option valuation. While it is difficult (though feasible) to estimate expected cash flows, it is impossible to determine the opportunity cost of capital because the risk of an option is virtually indeterminate as it changes every time the stock price varies.

Since options cannot be valued by the standard DCF method, financial economists struggled to develop a rigorous method for valuing options for many years. Finally, a real break- through occurred when Fisher Black and Myron Scholes[2] published their famous model in 1973. The basic idea underlying their model is to set up a portfolio which imitates the call option in its payoff. The cost of such a portfolio, which is readily observed, must represent the value of the call option.

The key insight underlying the Black and Scholes model may be illustrated through a single-period binomial (or two-state) model. The following assumptions may be employed to develop this model.

- The stock, currently selling for S, can take two possible values next year, uS or dS ($uS > dS$).
- An amount B can be borrowed or lent at a rate of r the risk-free rate. The interest factor $(1 + r)$ may be represented, for the sake of simplicity, as R.
- The value of R is greater than d but smaller than $u (d < R < u)$. This condition ensures that there is no risk-free arbitrage opportunity.
- The exercise price is E.

The value of the call option, just before expiration, if the stock price goes up to uS, is

$$C_u = \text{Max } (uS - E, 0) \tag{16.6}$$

2. Fisher Black and Myron Scholes,"The Pricing of Options and Corporate Liabilities", *Journal of Political Economy*, vol. 81, May – June 1973, pp. 63–654.

Likewise, the value of the call option, just before expiration, if the stock price goes down to dS is

$$C_d = \text{Max}\ (dS - E, 0) \tag{16.7}$$

Let us now set up a portfolio consisting of Δ shares of the stock and B rupees of borrowing. Since this portfolio is set up in such a way that it has a payoff identical to that of a call option at time 1, the following equations will be satisfied:

Stock price rises : $\Delta uS - RB = C_u$ (16.8)

Stock price falls : $\Delta dS - RB = C_d$ (16.9)

Solving Eqs (16.8) and (16.9) for Δ and B, we get

$$\Delta = \frac{C_u - C_d}{S(u-d)} = \frac{\text{Spread of possible option prices}}{\text{Spread of possible share prices}} \tag{16.10}$$

$$B = \frac{dC_u - uC_d}{(u-d)R} \tag{16.11}$$

Since the portfolio (consisting of Δ shares and B debt) has the same payoff as that of a call option, the value of the call option is

$$C = \Delta S - B \tag{16.12}$$

Note that the value of option is found out by looking at the value of a portfolio of shares and loan that imitates the option in its payoff. So this may be referred to as the option equivalent calculation.

To illustrate the application of the binomial model consider the following data for Pioneer's stock:

$$S = 200,\ u = 1.4,\ d = 0.9$$

$$E = 220,\ r = 0.10,\ R = 1.10$$

$$C_u = \text{Max}\ (uS - E, 0) = \text{Max}\ (280 - 220, 0) = 60$$

$$C_d = \text{Max}\ (dS - E, 0) = \text{Max}\ (180 - 220, 0) = 0$$

Given the above data, we can get the values of Δ and B by using Eqs (16.10) and (16.11)

$$\Delta = \frac{C_u - C_d}{(u-d)S} = \frac{60}{0.5\,(200)} = 0.6$$

$$B = \frac{dC_u - uC_d}{(u-d)R} = \frac{0.9\,(60)}{0.5\,(1.10)} = 98.18$$

Thus the portfolio consists of 0.6 of a share plus a borrowing of 98.18 (entailing a repayment of 98.18(1.10) = 108 after one year). The identity of the payoffs of the portfolio and call option is shown below:

	Portfolio	*Call Option*
When u occurs	$1.4 \times 200 \times 0.6 - 108 = 60$	$C_u = 60$
When d occurs	$0.9 \times 200 \times 0.6 - 108 = 0$	$C_d = 0$

Given the equivalence of the call option and the portfolio, the value of the call option is:

$$C = \Delta S - B = 0.6 \times 200 - 98.18 = 21.82$$

Note that we could establish the value of the call option without any idea about the probability that the stock would go up or come down. An optimistic investor may think that the probability of an upward move is high whereas a pessimistic investor may think that it is low. Yet the two will agree that the value of the call option is 21.82. Why? The answer lies in the fact that the current stock price of 200 already incorporates the views of the optimists as well as the pessimists. And the option value, in turn, depends on the stock price.

Risk-Neutral Valuation

Why should the call option on Pioneer stock sell for Rs 21.82? If the option price exceeds Rs 21.82, you can make a certain profit by borrowing Rs 98.18, selling a call option, and buying 0.6 of a share of Pioneer's stock. Likewise, if the option price is less than Rs 21.82, you can make a certain profit by selling 0.6 of a share of Pioneer's stock, lending Rs 98.18, and buying a call option. In either case you have an opportunity to make money without incurring any risk. Put differently, you have a money machine.

Since there cannot be a money machine, the equilibrium price of the call option is Rs 21.82. Note that we established the equilibrium price of the call option without knowing anything about the attitude of investors towards risk. The price of the option does not depend on the investor attitude towards risk. It does not matter whether investors love risk or hate risk.

This suggests that there is an alternative method for valuing the option. In this alternative method, called the risk-neutral valuation method, we assume that investors are risk-neutral (indifferent to risk), calculate the expected future value of the option, and convert it into its present value by using the risk-free rate.

If investors are risk-neutral, the expected return on the equity stock of Pioneer must be equal to the risk-free rate.

Expected return on Pioneer's stock = 10 percent

Since Pioneer's stock can either rise by 40 percent to 280 or fall by 10 percent to 180, we can calculate the probability of a price rise in the hypothetical risk-neutral world.

Expected return = [Probability of rise $\times$ 40 %] + [(1 – Probability of rise $\times$ –10%)] = 10%

Therefore the probability of rise is 0.40^3. This is called the risk-neutral probability.

We know that if the stock price rises, the call option has a value of Rs 60 and if the stock price falls the call option has a value of Rs 0.

Hence, if investors are risk-neutral, the call option has an expected future value of:

(Probability of rise × Rs 60) + (1 – Probability of rise × Rs 0)

$= 0.40 \times \text{Rs } 60 + 0.60 \times \text{Rs } 0 = \text{Rs } 24.$

The current value of the call option is the present value of the expected future value:

$$\frac{\text{Expected future value}}{1 + \text{Risk-free rate}} = \frac{\text{Rs } 24}{(0.10)} = \text{Rs } 21.82$$

Not surprisingly, this is exactly the answer we got by using the option equivalent method.

Thus, we have two ways of calculating the value of an option in the binomial world.

Option Equivalent Method Find a portfolio of shares and loan that imitates the option in its payoff. Since the two alternatives have identical payoffs in the future, they must command the same price today.

Risk Neutral Method Assume that investors are risk-neutral, so that the expected return on the stock is the same as the interest rate. Calculate the expected future value of the option and discount it at the risk-free interest rate.

16.5 BLACK AND SCHOLES MODEL

The above analysis was based on the assumption that there were two possible values for the stock price at the end of one year. If we assume that there are two possible stock prices at the end of each 6-month period, the number of possible end-of-year prices increases. As the period is further shortened (from 6 months to 3 months or 1 month), we get more frequent changes in stock price and a wider range of possible end-of-year prices. Eventually, we would reach a situation where prices change more or less continuously, leading to a continuum of possible prices at the end of the year. Theoretically, even for this situation we could set up a portfolio which has a payoff identical to that of a call option. However, the composition of this portfolio will have to be changed continuously as the year progresses.

Calculating the value of such a portfolio and through that the value of the call option in such a situation appears to be an unwieldy task, but Black and Scholes developed a formula that does precisely that. Their formula is:

3. Note that this is the probability of rise in our hypothetical risk-neutral world. Since real world investors are risk-averse and not risk-neutral, they will require a higher expected return from a risky stock. Hence the true probability of rise will be greater than 0.40.

$$C_0 = S_0\, N(d_1) - \frac{E}{e^{rt}} N(d_2) \tag{16.13}$$

where C_0 = equilibrium value of a call option now

S_0 = price of the stock now

E = exercise price

e = base of natural logarithm

r = continuously compounded risk-free annual interest rate

t = length of time in years to the expiration date

$N(d)$ = value of the cumulative normal density function

$$d_1 = \frac{l_n\left(\frac{S_0}{E}\right) + \left(r + \frac{1}{2}\sigma^2\right)t}{\sigma\sqrt{t}} \tag{16.14}$$

$$d_2 = d_1 - \sigma\sqrt{t} \tag{16.15}$$

where l_n = natural logarithm

σ = standard deviation of the continuously compounded annual rate of return on the stock

Though one of the most complicated formulae in finance, it is one of the most practical. The formula has great appeal because four of the parameters, namely, S_0, E, r, and t are observable. Only one of the parameters, namely, σ^2, has to be estimated. Note that the value of a call option is affected by neither the risk aversion of the investor nor the expected return on the stock.

Assumptions

You may have guessed by now that the Black and Scholes model, like other important models in economics and finance, is based on a set of simplifying assumptions. Yes, you are right. The assumptions underlying the Black and Scholes model are as follows:

- The call option is the European option.
- The stock price is continuous and is distributed lognormally.
- There are no transaction costs and taxes.
- There are no restrictions on or penalties for short selling.
- The stock pays no dividend.
- The risk-free interest rate is known and constant.

These assumptions may appear very severe. However when some of them do not hold, a variant of the Black and Scholes model applies. Further, empirical studies indicate that the Black and Scholes model applies to American options as well.

Applying the Black-Scholes Formula

Though the Black-Scholes formula appears difficult it is fairly easy to apply. This may be illustrated with an example.

Consider the following data for a certain stock:

- Price of stock now = S_0 = Rs 60
- Exercise price = E = Rs 56
- Standard deviation of continuously compounded annual returns = $\sigma = 0.3$
- Years to maturity = $t = 0.5$
- Interest rate per annum = 0.14

Application of the Black-Scholes formula involves four steps. These are:

Step 1 Calculate d_1 and d_2

$$d_1 = \frac{\left(l_n \frac{S_0}{E}\right) + \left(r + \frac{\sigma^2}{2}\right) t}{\sigma\sqrt{t}}$$

$$= \frac{.068993 + 0.0925}{0.2121} = \frac{0.161493}{0.2121} = 0.7614$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$$= 0.7614 - 0.2121 = 0.5493$$

Step 2 Find $N(d_1)$ and $N(d_2)$. $N(d_1)$ and $N(d_2)$ represent the probabilities that a random variable that has a standardised normal distribution will assume values less than d_1 and d_2. The simplest way to find $N(d_1)$ and $N(d_2)$ is to use the Excel function NORMSDIST. Alternatively, you can use Table A.5 in Appendix A at the end of the book.

$$N(d_1) = N\ (0.7614) = 0.7768$$

$$N(d_1) = N\ (0.5493) = 0.7086$$

Step 3 Estimate the present value of the exercise price, using the continuous discounting principle.

$$\frac{E}{e^{rt}} = \frac{\text{Rs } 56}{e^{0.14 \times 0.5}} = \text{Rs } 52.21$$

Step 4 Plug the numbers obtained in the previous steps in the Black–Scholes formula.

$$C_0 = \text{Rs } 60 \times 0.7768 - \text{Rs } 52.21 \times 0.7086$$

$$= \text{Rs } 46.61 - \text{Rs } 37.00 = \text{Rs } 9.61$$

Replicating Portfolio

Note that the principle of replicating portfolio used in the binomial model also undergirds the Black-Scholes model. Exhibit 16.9 shows the replicating portfolios for calls and puts, in the binomial and the Black-Scholes models.

Exhibit 16.9 ***Replicating Portfolio for Calls and Puts***

Option Position	*Replicating Portfolio*	
	Binomial Model	*Black-Scholes Model*
Buy Call Option	Borrow B	Borrow $Ee^{-rt} N(d_2)$
	Buy Δ shares of stock	Buy $N(d_1)$ shares of stock
Sell Call Option	Lend B	Lend $Ee^{-rt} N(d_2)$
	Sell short Δ shares	Sell short $N(d_1)$ shares
Buy Put Option	Lend B'	Lend $Ee^{-rt}(1 - N(d_2))$
	Sell short Δ' shares	Sell short $(1 - N(d_1))$ shares
Sell Put Option	Borrow B'	Borrow $Ee^{-rt}(1 - N(d_2))$
	Buy Δ' shares	Buy $(1 \quad N(d_1))$ shares

Adjustment for Dividends

The Black-Scholes model given in Eq. (16.13) assumes that the stock pays no dividend. When dividend is paid stock price diminishes. Hence, call options become less valuable and put options become more valuable. To reflect dividend payments, two adjustments are commonly made, one for options that have a short life and the other for options that have a long life.

Short-term Options When options expire in less than one year, the present value of dividends expected during the life of the option is subtracted from the current value of the stock to obtain a 'dividend-adjusted value', which is then used as the input for S in the Black-Scholes model.

$$\text{Adjusted stock price} = S' = S - \sum \frac{Div_t}{(1+r)^t} \tag{16.14}$$

$$\text{Value of call} = S'N(d_1) - Ee^{-rt} N(d_2) \tag{16.15}$$

where
$$d_1 = \frac{ln\left(\frac{S'}{E}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

Long-term Options Computing the present value of dividends and adjusting for the same is tedious and difficult in the case of long-term options. If the dividend yield (y = dividend/current stock price) is expected to remain fairly stable during the life of the option, the Black-Scholes model can be modified to reflect dividend payment.

$$C = Se^{-yt} N(d_1) - Ee^{-rt} N(d_2) \tag{16.16}$$

where $$d_1 = \frac{l_n \frac{S}{E} + \left(r - y + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

This adjustment essentially does two things: (i) It discounts the value of the stock to the present at the dividend yield to reflect the expected drop in value on account of dividend payments. (ii) It offsets the interest rate by the dividend yield to reflect the lower cost of carrying the stock (in the replicating portfolio).

16.6 VALUE OF AN OPTION TO MAKE A FOLLOW ON INVESTMENT

Your firm is looking at a proposal to manufacture an electronic educational aid called Electriad-I. The projected cash flows for this proposal are shown in Exhibit 16.10.

Exhibit 16.10 *Cash Flows and Financial Analysis for Electriad-I*

(Rs in million)

	Year					
	0	*1*	*2*	*3*	*4*	*5*
Initial outlay	(150)					
After-tax operating cash flow		20	40	50	50	40
Terminal cash flow						30
Net cash flow	(150)	20	40	50	50	70
Present value at 18 percent	(150)	16.9	28.7	30.5	25.8	30.6
Present value of cash inflows	= 16.9 + 28.7 + 30.5 + 25.8 + 30.6 = 132.5					
Investment outlay	= 150					
Net present value	= 132.5 – 150 = –17.5					

Although the proposal has a negative *NPV*, the chief executive of your firm thinks that the project may be worthwhile. He argues: "If we undertake Electriad-I now we will be in a position to make a follow on investment in an advanced version, Electriad-II, four years down the road. If conditions are favourable, such a follow on investment can be very profitable."

Sensing the possibility of applying the option pricing model for valuing the option to make the follow on investment, you request him to provide key financial estimates for the follow on investment opportunity. He furnishes the following information:

- Electriad-II will be double the size of Electriad-I. It will require an investment of Rs 300 million (this is akin to the exercise price of a call option).
- The expected cash inflows of Electriad-II too will be twice those of Electriad-I. Hence, they will have a present value of Rs 265 million as at the end of year four.

You need one more crucial piece of information: the degree of uncertainty characterising the cash inflows of Electriad-II. Your chief executive is not able to provide an estimate of this. You look at the stock price behaviour of your company and find that it has a standard deviation of 40 percent per year. In the absence of any other information, you assume that the cash inflows of Electriad-II too would have the same standard deviation.

The above information may be cast in terms of the inputs required by the Black–Scholes formula.

S_0 = present value of the asset = $265 \times e^{-.18 \times 4}$ = Rs 129 million

E = exercise price = Rs 300 million

σ = standard deviation of continuously compounded annual returns = 0.4

t = years to maturity = 4

r = interest rate per annum = 12 percent

Step 1 Calculate d_1 and d_2.

$$d_1 = \frac{ln\left(\frac{S_0}{E}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} = \frac{-0.843 + (.12 + (.16/2))\,4}{0.4\sqrt{4}} = -.05375$$

$$d_2 = d_1 - \sigma\sqrt{t} = -0.85375$$

Step 2 Find $N(d_1)$ and $N(d_2)$.

$N(d_1) = 0.4786$

$N(d_2) = 0.1966$

Step 3 Estimate the present value of the exercise price

$E \cdot e^{-rt} = 300 / 2.0544$ = Rs 146.03 million

Step 4 Plug the numbers obtained in the previous steps in the Black–Scholes formula.

C_0 = Rs 129 million × 0.4786 – Rs 146.03 million × 0.1966

= Rs 61.74 million – Rs 28.71 million = Rs 33.03 million

Based on this calculation you argue that a call value of Rs 33.03 million more than offsets the negative *NPV* of Rs 17.5 million and hence Electriad-I is a worthwhile proposition. Your chief executive too agrees with you because your quantitative evaluation squares with his intuitive reflection, though he is not sure how you came up with a value of Rs 33.03 million for the call option. Of course, you have a different concern about that number because you are not sure whether the assumptions underlying the calculation are realistic.

16.7 VALUE OF AN OPTION TO ABANDON

Your firm has decided to manufacture a new product labelled Titus. It is evaluating two alternative machines, both costing the same, to manufacture Titus.

Alternative *A* : A special purpose machine designed for Titus. While it reduces the cost of production, it does not have much resale value.

Alternative *B* : A general purpose machine. Though it involves a higher cost of production, it has a good resale value.

The demand for Titus may be strong or weak. The payoffs (measured as the project's cash flow for the first year plus the present value of future cash flows) to the two alternatives under different market conditions will be as follows:

	Payoff (Rs in million)	
	Alternative A	*Alternative B*
Strong demand	30.0	28.0
Weak demand	14.0	12.0

From the *DCF* point of view, alternative *A* is clearly superior to alternative *B*. However, alternative *B* offers an advantage in the form of valuable flexibility. If the demand turns out to be weak, the general purpose machine can be sold for Rs 16 million at the end of year 1, an amount that is greater than Rs 12 million, the payoff associated with weak demand. Note that alternative *A* does not offer valuable flexibility because the special purpose machine can be sold for only Rs 10 million at the end of year 1, an amount that is less than Rs 14 million, the payoff associated with weak demand.

Given the option to sell the machine, the payoffs to alternative *B* are as follows:

Strong demand → Continue production → Own a project worth Rs 28 million

Weak demand → Exercise the option to sell the machine → Receive Rs 16 million

Value of the Abandonment Put

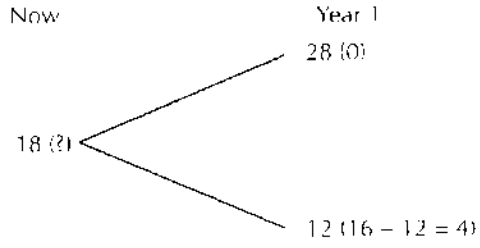
Suppose that the value of alternative *B*, ignoring the option of abandonment, is Rs 18 million. This represents the value of the underlying asset today, assuming that your firm is obliged to continue producing Titus irrespective of how profitable it turns out to be. If the demand turns out to be strong, the value at year 1 rises to Rs 28 million giving a return of 55.6 percent; on the other hand, if the demand turns out to be weak, the value at year 1 falls to Rs 12 million, giving a return of –33.3 percent.

Now let us introduce the put option. Clearly your company would like to continue with the project if the demand turns out to be strong. However, should the demand turn out to be weak, your company will be better off if it abandons the project and sells the machine. The put option in this case will have a value of Rs 4 million (Rs 16 million – Rs 12 million). The payoffs to the put option are summarised below:

	Year-end Values of the Project (Rs in million)	
	12	28
Value of put option	16 – 12 = 4	0

Exhibit 16.11 shows the present and future values of the underlying project. While the future values of the abandonment option are shown in the parentheses, the present value of the abandonment option has yet to be calculated it is shown as a question mark.

Exhibit 16.11 ***Binomial Tree***



As the project has only two possible outcomes, we can apply the binomial model. Recall that there are two methods of applying the binomial model: the option equivalent method and the risk-neutral method.

For our purposes we will apply the risk-neutral method. The return on the proposed project will be 55.6 percent or –33.3 percent. Hence the expected return is:

Expected return = (Probability of strong demand) × 55.6% + (1 – Probability of weak demand) × – 33.3%

The risk-neutral method assumes that investors do not care about risk. So the return required by them is simply the risk-free return. Suppose the risk-free return is 6 percent. Then the probability of strong demand in this hypothetical risk-neutral world can be calculated as follows:

Expected return = (Probability of strong demand) × 55.6% + (1 – Probability of strong demand) × –33.3%

= 6%

Probability of strong demand = 0.44

Probability of weak demand = 1 – 0.44 = 0.56

The payoff to the put option at the end of year 1 will be either 0 or Rs 4 million. Hence the expected payoff to the put option is:

Expected payoff to put option = (Probability of strong demand) × 0 + (1 – Probability of strong demand) × 4

= 0.44 × 0 + 0.56 × 4 = Rs 2.24 million

Discounting Rs 2.24 million for 1 year at 6 percent gives a value of 2.24/1.06 = Rs 2.11 million. Thus the abandonment option has a value of Rs 2.11 million.

16.8 VALUE OF A VACANT LAND

Vacant land has value because it can be used for a variety of purposes. For example, a particular plot of land may be used for building apartments or a shopping complex. Further, the construction can be done now or in the future. The developer would like to develop the property now or in the future so that the present value of the difference between benefits and costs is maximised. While the best possible use of land presently can be established easily, its best possible future use may not be known now.

The option valuation approach can be used to determine the value of a vacant land that provides the option to choose one of several possible uses now or in the future. The procedure for doing so involves the following steps:

1. Compute the risk-neutral probabilities associated with various outcomes by observing the market prices of traded investments (price of apartments or office blocks and the risk-free rate of interest).
2. Calculate the expected cash flow next year. For this calculation use the risk-neutral probabilities and assume that the best alternative will be chosen under each outcome.
3. Compute the current value of land by discounting the expected cash flow at the risk-free interest rate.

Illustration

A builder owns a plot of land that can be used for either eight or twelve apartment units. The construction cost for these two alternatives is Rs 3.6 million and Rs 6.2 million respectively. The current market price per apartment is Rs 0.6 million. The yearly rental (net of expenses) per unit is Rs 0.05 million and the risk-free interest rate is 12 percent per annum. If the market for apartments is buoyant next year, each apartment unit will sell for Rs 0.75 million; if the market is sluggish each apartment unit will sell for Rs 0.54 million. What is the value of the vacant plot? Assume that the construction cost will remain unchanged.

Presently, an eight unit building yields a profit of Rs 1.2 million (= 8 × 0.6 – 3.6) and a twelve unit building yields a profit of Rs 1.0 million (= 12 × 0.6 – 6.2). Hence an eight-unit building is the best alternative if the builder has to construct now.

However, if the builder waits for a year, his payoffs will be as follows:

Alternative	*Market Condition*	
	Buoyant (Apartment price: Rs 0.75 million)	*Sluggish (Apartment price: Rs 0.54 million)*
8-unit building	$0.75 \times 8 - 3.6 = 2.4$	$0.54 \times 8 - 3.6 = 0.72$
12-unit building	$0.75 \times 12 - 6.2 = 2.8$	$0.54 \times 12 - 6.2 = 0.28$

Thus, if the market turns out to be buoyant the best alternative is the 12-unit building (payoff: Rs 2.8 million) and if the market turns out to be sluggish the best alternative is the 8-unit building (payoff: Rs 0.72 million).

Given the above information, we can apply the binomial method for valuing the vacant land.

Step 1 *Calculate the risk-neutral probabilities The* binomial tree given below in Exhibit 16.12 shows that a Rs 0.6 million investment in an apartment this year yields a year end value of Rs 0.80 million (Rs 0.75 million plus Rs 0.05 million in rent) or Rs 0.59 million (Rs 0.54 million plus Rs 0.05 million in rent) depending on market conditions. Given a risk-free rate of 12 per cent, the risk-neutral probabilities must satisfy the following condition:

Rs 0.60 million = $[p \times$ Rs 0.80 million + $(1- p) \times$ Rs 0.59 million$]$ / (1.12)

Solving this we get $p = 0.39$ and $1- p = 0.61$

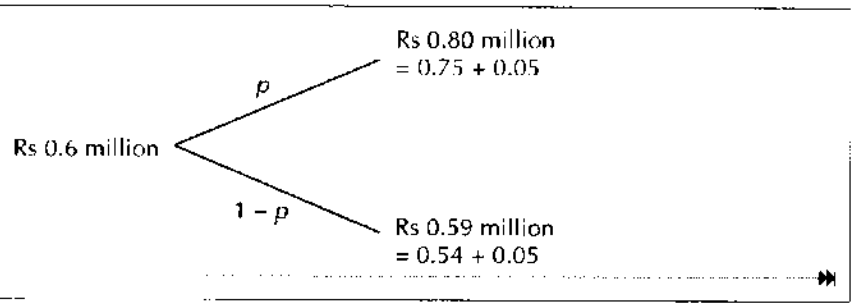
Step 2 *Calculate the expected cash flow next year* The expected cash flow next year is: $0.39 \times 2.8 + 0.61 \times 0.72 =$ Rs 1.531 million.

Step 3 *Compute the current value* The current value of land applying the risk-free rate of 12 percent is:

1.531 / 1.12 = Rs 1.367 million

Since Rs 1.367 million is greater than Rs 1.2 million the profit from constructing an 8-unit building now, it is advisable to keep the land vacant. The value of the vacant land is Rs 1.367 million.

Exhibit 16.12 ***Binomial Tree of Apartment Values***



16.9 VALUE OF NATURAL RESOURCE OPTIONS

An important application of real option valuation has been to natural resources. In a natural resource investment, the underlying asset is the natural resource and the exercise price is the cost of development. If the estimated value of the natural resource is V and the cost of development X, the potential payoffs from a natural resource are:

When	*Payoff*
$V > X$	$V - X$
$V \leq X$	0

Thus the payoff function of an investment in a natural resource option is similar to that of a call option.

To value a natural resource option, you have to estimate the following:

- Value of the available reserves of the resource.
- Development cost.
- Time to expiration of the option.
- Variance in value of the underlying asset.
- Dividend yield.

Value of the Available Resources The value of the available resources (the asset under consideration) is a function of the quantity and price of the natural resource. For instance, geologists can provide reasonably reliable estimates of the quantity of oil in a particular oil basin and oil economists can provide a forecast of the oil price.

Development Cost The development cost represents the exercise price of the option. A knowledge of past costs and an understanding of the specifics of the investment is required to get a handle on the development cost.

Time to Expiration of the Option The life of a natural resource option is usually defined in two ways: (i) The period over which the natural resource can be exploited. For example the government may grant a base period of 20 years for an oil basin. (ii) The time taken to exhaust the inventory of the natural resource. For example, if a gold mine has an inventory of 900,000 ounces and the capacity output rate is 60,000 ounces per year, the inventory will be exhausted in 15 years and this represents the life of the natural resource option.

Variance in the Value of the Underlying Asset The variance in the value of the underlying asset depends on the variability in the estimate of the available reserve and the variability in the price of the resource. If the quantity of the available reserve is known, the variance of the value of the asset depends on the variability of the price of the resource.

Cost of Delay Conceptually similar to the dividend yield in a stock, the cost of delay in a natural resource option represents the loss in production for each year of delay. It may be estimated as annual net production revenue as a percentage of the market value of the reserve.

For natural resource options, you have to consider the development lag as well. This is the time lag between the decision to extract the resource and the actual extraction. A simple way to adjust for this lag is to discount the value of the developed reserve for the time lag involved in development at a rate equal to the net production revenue/asset value ratio (or the dividend yield).

Valuing an Oil Reserve

ONG, an oil major, is assessing the value of the option to extract oil from a particular oil basin. The following information has been gathered:

- The estimated oil reserve in the basin is 100 million barrels of oil. It may be assumed that there is no variability characterising this quantity.
- The development cost is $1 billion.
- The right to exploit the basin will be enjoyed for 25 years.
- The marginal value per barrel of oil presently is $20—this represents the difference between the price per barrel of oil and the marginal cost of extracting a barrel of oil. The standard deviation of l_n (oil price) is estimated to be 0.2.
- Once developed, the net production revenue each year will be 4% of the value of the reserve.
- The risk-free rate is 8%.
- The development lag is two years.

Given the above information, the inputs to the Black-Scholes formula can be estimated as follows:

S_0 = current value of the asset – value of the developed reserve discounted back for two years (the development lag) at the dividend yield = $20 × 100 / $(1.04)^2$ = $ 1849.11 million.

E = exercise price = development cost – $ 1000 million. This is assumed to be fixed over time.

σ = standard deviation of the l_n (oil price) = 0.2.

t = life of the option = 25 years.

r = risk-free rate = 8%.

y = dividend yield = net production revenue / value of reserve = 4%.

Given these inputs, the call option is valued as follows:

Step 1 Calculate d_1 and d_2.

$$d_1 = \frac{l_n\left(\frac{S}{E}\right) + \left(r - y + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$= l_n\,(1849.11 \,/\, 1000) + [.08 - .04 + (.04/2)]\,25 \div 0.2\sqrt{25}$$

$$= 0.6147 + 1.5 = 2.1147$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$$= 2.1147 - 1.000 = 1.1147$$

Step 2 Find $N(d_1)$ and $N(d_2)$.

$N(d_1) = N\,(2.1147) = 0.9828$

$N(d_2) = N\,(1.1147) = 0.8675$

Step 3 Estimate the present value of the exercise price.

$E/e^{rt} = 1000 \,/\, e^{.08\times25} = \$\,135.33$ million

Step 4 Plug the numbers obtained in the previous steps in the Black–Scholes formula

$C = \$\,1849.11$ million $\times\, 0.9828 - \$\,135.33$ million $\times\, 0.8675$

$= \$1699.91$ million

16.10 JUDGMENTAL ASSESSMENT OF OPTIONS

Valuing the options embedded in real life projects with the help of the Black-Scholes model often requires heroic assumptions. Yet the insights provided by this model can be combined with well-informed, experienced judgment to get a handle over option values. If you can identify the options and specify the circumstances under which they would be exercised, you can make an informed estimate of their values. The procedure for doing this, thus, would broadly involve three steps:

- Identify options.
- Analyse environmental uncertainty.
- Value options.

Identify options

Options embedded in real life projects are basically of two types: incremental options and flexibility options.

An *incremental option* provides the firm opportunities to make profitable investments in the future. Michael Porter calls an investment as a "beach-head" if it opens up new opportunities in the future. For example, he refers to Procter and Gamble's acquisition of the Charmin Paper Company as a beach-head that enabled Procter and Gamble to launch a cluster of products like disposable papers, paper towels, and bathroom tissue.

A *flexibility option* in a project gives the firm a wider latitude in manufacturing so that it can cope better with unexpected changes and exploit profitable opportunities that come its way.

Analyse Environmental Uncertainty

Options are valuable in unpredictable environments. Uncertainty creates opportunities for exercising options. Incremental options multiply when future uncertainty increases. For example, most of the foreign investments made in Europe around 1990 were motivated by future uncertainty, not current profitability. Such investments provide the "thin end of the wedge" that facilitates the exploitation of opportunities that arise in an uncertain environment. By the same token, flexibility options tend to have greater value when the environment is more uncertain.

Value the Options

Once the options provided by the project are compiled and the environmental uncertainties delineated, the value of options may be assessed. While the Black–Scholes model may not be readily applicable to options embedded in many real life projects because of the difficulty in quantitatively specifying the inputs, the key ideas of this model may be combined with the experience and judgment of managers to develop a practical procedure for valuing options. Bear in mind the following insights provided by the Black–Scholes model:

- The greater the uncertainty characterising a project, the higher the value of the options embedded in the project.
- The longer the duration of a project, the higher the value of the options inherent in it.

Exhibit 16.13 presents a matrix showing the combined effect of environmental uncertainty and project duration on the relative values of cash flows and options. The percentages shown, however, are merely suggestive. They have to be, of course, specified by the project evaluator to reflect his subjective assessment.

Exhibit 16.13 ***Relative Values of Cash Flows and Options***

Duration of the Project		Low Environmental Uncertainty	High Environmental Uncertainty
	Long	Cash flows : 75 Options : 25	Cash flows : 75 Options : 25
	Short	Cash flows : 95 Options : 5	Cash flows : 75 Options : 25

SUMMARY

- The standard discounted cash flow analysis calls for evaluating a project on the basis of its cash flows over its economic life. Such an evaluation, however, does not capture the value of options embedded in the project. The insights provided by the option pricing theory may be applied for valuing options embedded in capital projects.
- The key terms and phrases employed in discussing options are as follows: option holder and option writer, exercise price or striking price, expiration date or maturity date, exercising the option, and European and American options.
- There are two basic types of options, call options and put options. A call option gives the option holder the right to buy a stock (or asset) at a fixed price on or before a certain date.
- Depending on how the exercise price compares with the market price, options are said to be *at the money* or *in the money* or *out of the money*.
- The payoff of a European call option (this is a call option that can be exercised only on the expiration date) just before expiration is equal to:

  Max [Stock price – Exercise price, 0]
- A put option—the opposite of a call option—gives the holder the right to sell stock (or some other asset) at a specified price on or before a certain date.
- The payoff of a European put option, just before expiration, is equal to:

  Max [Exercise price – Stock price, 0]
- Puts and calls represent basic options. They serve a s building blocks for developing more complex options.
- A call option is equivalent to a combination of the underlying stock, a put option on that stock, and a debt equal to the exercise price. This equivalence is referred to as the put-call parity.

- The price of a call option must lie between the following bounds:

$$\text{Max } (S_0 - E, 0) \leq C_0 \leq S_0$$

- The location of the option value (C_0) between the two bounds depends on five key factors: price of the underlying stock (S_0), exercise price (E), variance of the return on the underlying stock (σ^2), time left to expiration (t), and risk-free interest rate (r_f). The manner in which these five variables influence the value of a call option is shown in the following relationship:

$$C_0 = f\begin{pmatrix} S_0, E, \sigma^2, t, r_f \\ + \quad - \quad + \quad + \quad + \end{pmatrix}$$

- The sign (+, –) put below a variable denotes the nature of its influence on the value of the call option.
- The key insight underlying the Black and Scholes model may be illustrated through a single-period binomial (or two-state) model.
- There are two ways of calculating the value of an option in the binomial world: (i) *Option Equivalent Method*: Find a portfolio of shares and loan that imitates the option in its payoff. Since the two alternatives have identical payoffs in the future, they must command the same price today. (ii) *Risk-Neutral Method*: Assume that investors are risk-neutral, so that the expected return on the stock is the same as the risk-free interest rate. Calculate the expected future value of the option and discount it at the risk-free interest rate.
- Fisher Black and Myron Scholes published their celebrated option pricing model in 1973. Black and Scholes developed the following formula (referred to commonly as the Black-Scholes model) showing how the value of a call option is related to the basic factors:

$$C_0 = S_0 N(d_1) - \frac{E}{e^{rt}} N(d_2)$$

- The Black-Scholes model assumes that the stock pays no dividend. To reflect dividend payments, two adjustments are commonly made, one for options that have a short life and the other for options that have a long life.
- Options embedded in real life projects may be valued with the help of the binomial model or the Black-Scholes model, if suitable quantitative estimates can be defined.
- Where quantitative estimates cannot be defined with a measure of confidence, Black-Scholes model cannot be applied meaningfully. Yet, the insights provided by this model can be combined with well-informed, experienced judgment to get a handle over option values.

Questions

1. **Define the following terms: option holder, option writer, exercise price, maturity date.**
2. **What is the payoff of a European call option and put option?**

3. Define the payoffs of a call option and a put option from the point of view of the option writer (or seller).
4. What is *put-call parity* theorem? Demonstrate it.
5. Specify the boundaries within which the value of a call option falls.
6. Discuss the key factors that have a bearing on the value of a call option.
7. Show why a higher variability of the stock price has a positive effect on the value of the call option.
8. Derive the value of a call option in the binomial world using the option equivalent method.
9. What is the value of a call option as per the Black–Scholes model?
10. State the assumptions underlying the Black–Scholes model.
11. Describe the risk-neutral valuation method.
12. Discuss the adjustments made for dividend payment in the Black–Scholes model.
13. Discuss how the value of options embedded in capital projects may be judgmentally assessed.

Problems

1. Alpha Company's equity is currently selling for Rs 100 per share. In a year from now it can rise to Rs 150 or fall to Rs 90. The interest rate is 15 percent. What is the value of a call option on Alpha Company's equity as per the Binomial model? The exercise price is Rs 100.
2. Beta Company's equity is currently selling for Rs 60. In a year from now it can rise or fall. On the downside it may fall to Rs 45. The call option on Beta's equity has a value of Rs 5. If the interest rate is 16 percent, to what level would Beta's equity rise on the upside? Assume that the exercise price is Rs 60.
3. The following information is available for Abhishek Industries:

   S_0 = Rs 70, E = Rs 72, r = 0.12, σ = 0.30

   Calculate the price for a six month call option as per the Black–Scholes model.
4. What is the value of a European call option (no dividends) with an exercise price of Rs 50 and an expiration date 3 months from now if the stock price is Rs 40, the variance of the stock is 0.40, and the risk-free rate is 14 percent?
5. Your firm is looking at a proposal to manufacture a certain computer called Comp-I. The projected cash flows for this proposal are as shown below:

Rs in million

	Year				
	0	1	2	3	4
Initial outlay	(100)				
After-tax operating cash flow		20	50	50	20
Terminal cash flow					10

The discount rate applicable to this proposal is 20 percent.

If your firm undertakes the Comp-I proposal, it will be in a position to make a follow on

investment in an advanced version, Comp-II, four years from now. Comp-II will be double the size of Comp-I in terms of investment outlay and cash inflows. The cash inflows of Comp-II would have a standard deviation of 30 percent per year.

(a) What is the net present value of the cash flows of Comp-I?

(b) What is the value of the option to invest in Comp-II?

Assume that the risk-free rate is 12 percent.

6. A builder owns a plot of land that can be used for either nine or fifteen apartment units. The construction costs of these two alternatives are Rs 9 million and Rs 17 million respectively. The current price per apartment is Rs 1.2 million. The yearly rental (net of expense) per unit is Rs 0.10 million and the risk-free interest rate is 10 percent per annum. If the market for apartments is buoyant next year, each apartment unit will sell for Rs 1.5 million; if the market is sluggish each apartment unit will sell for Rs 1.1 million. What is the value of the vacant plot? Assume that the construction cost will remain unchanged.
7. Max Oil Limited is assessing the value of the option to extract oil from a particular oil basin. The following information has been gathered:
   - The estimated oil reserve in the basin is 100 million barrels of oil. Assume that there is no variability characterising this quantity.
   - The development cost is $600 million. This will be constant over time.
   - The right to exploit the basin will be enjoyed for 20 years.
   - The marginal value per barrel of oil presently is $22—this represents the difference between the price per barrel of oil and the marginal cost of extracting a barrel of oil. The standard deviation of l_n (oil price) is estimated to be 0.25.
   - Once developed, the net production revenue each year will be 5% of the value of the reserve.
   - The risk-free rate is 8%.
   - The development lag is 3 years.

   What is the value of the option to extract oil?

CHAPTER

17

Judgmental, Behavioural, Strategic and Organisational Considerations

So far we have discussed the framework for investment appraisal developed by financial economists. We assumed that cash flows and risks associated with a project can be estimated realistically, that a hurdle rate consistent with the risk exposure of the project can be established using a risk-return model, that the real options embedded in a project can be valued using the option pricing model, that the constraints characterising capital budgeting situations can be handled using mathematical programming models, that strategic planning and capital budgeting are reasonably well knit, that there is no informational asymmetry problem in organisations, and that managers act to maximise the value of the firm. In essence we assumed that all the relevant facts of a project can be quantified and managers act as rational economic agents.

In the real world, however, many facets of a project are not or often cannot be quantified, managerial judgment is expressed in a somewhat qualitative manner, strategic planning and financial analysis are not properly woven together, informational asymmetry leads to agency problems, and a variety of organisational considerations are relevant for investment decision making. Put differently, judgmental, strategic, behavioural, and organisational considerations—all of which are difficult to quantify and incorporate in a rational, economic model—have an important bearing on capital budgeting.

Just because these issues cannot be expressed and handled quantitatively, we cannot ignore them and sweep them under the carpet. Doing so will lead to a 'what counts counts' bias.

This chapter looks at these dimensions of capital budgeting and explores ways and means of weaving the quantitative and qualitative facets of investment decision making. It is organised into five sections as follows:

- Managerial intuition and judgment.
- Mission, strategy and capital budgeting.
- Bridging the gulf between strategic planning and financial analysis.
- Informational asymmetry and capital budgeting.
- Organisational considerations.

17.1 MANAGERIAL INTUITION AND JUDGMENT

Strategic investment decisions involve major resource commitments and they have a significant impact on the firm. Meant to enhance the long-term competitive position of the firm, such investments are characterised by many uncertainties that cannot be fully quantified. In making such decisions, managers look at quantitative information like cash flows and rate of return—which may be based on highly uncertain assumptions—and combine them with their subjective judgment about competitive dynamics and prospects of success. Intuition and judgment are often as important as formal economic analysis. Indeed the use of intuition in major business decisions, including capital expenditure decisions, is far more common than people think. Many chief executives admit that ultimately their decisions are based on gut-feeling. Robert Docktor conducted an experiment in which he wired up a group of chief executive officers to an electroencephalograph. He found that the brains of chief executive officers were more active in the right hemispheres, suggesting that they frequently relied on intuitive hunches to define complex problems in an open-ended state of ambiguity. Henry Mintzberg's study likewise showed that for making most of the strategic decisions, managers depend on the factor of judgment rather than explicit analysis. They are often guided by their intuition and are not able to explain adequately the how or why of their strategic decisions.

Bruce D. Henderson, a leading management expert, has expressed the importance of intuition as follows:

> The final choice in all business decisions is, of course, intuitive. It must be. Otherwise, it is not a decision, just a conclusion—a printout.[1]

Intuition can be awesome in its value at times. It is known as good judgment in everyday affairs. Intuition is in fact the subconscious integration of all the experiences, conditioning, and knowledge of a lifetime, including the emotional and cultural biases of that life time.[2]

1. and 2. Bruce D. Henderson, *Henderson on Corporate Strategy*, New York, The New American Library, 1979.

In a similar vein, Kenichi Ohmae, a Japanese authority on management, says:

Successful business strategies result not from rigorous analysis (which is necessary) but from a particular state of mind. In the mind of the strategist, insight and a consequent drive for achievement fuel a thought process which is basically creative and intuitive rather than rational.[3]

Factors Influencing Judgment

Judgment is influenced by a variety of factors such as:

- Quality of information.
- Track record of the sponsor.
- Internal politics.
- Intangible benefits.
- Opportunity cost.
- Cost of reversing the decisions.
- Superstition.

Quality of Information Large amounts of information must be analysed to evaluate strategic investments that shape a firm's competitive position. These include economic forecasts, market and demand analysis, technical assessment, cash flow forecasts, risk analysis, rate of return, and so on. Discerning managers evaluate the quality of information and analysis done by their staff assistants and external consultants. Have they considered the important variables and their interrelationships? Have they taken into account the potential reaction of competitors? Have they considered intangibles?

Almost invariably managers make judgmental adjustments to the numbers presented to them. The extent of adjustment depends on the degree of confidence they have in the quality of information and analysis submitted to them.

Track Record of the Sponsor A project cannot be divorced from its sponsor. Research on the decision making processes of the top management suggests that a decision at this level is likely to be a bet on the sponsor of the project. The facts, the projections, and even the project tend to be secondary in importance if the questions asked by the top management are: Who is the sponsor of the project? What is his commitment to the project? What is his track record? Will he be able to surmount obstacles on the way and deliver the goods?

Internal Politics Internal political elements often have an important bearing on capital budgeting decisions. Various levels of management tend to get divided into factions. Mutual loyalties among people belonging to the same faction may lead to acceptance of otherwise marginal or even sub-marginal projects. On the other hand, negative feelings among people

3. Kenichi Ohmae, *The Mind of a Strategist*, McGraw-Hill Book Company, 1982.

belonging to different factions may lead to the rejection of otherwise promising projects. Put differently, internal political games can mar the quality of decision making and investment proposals may not be viewed in an unbiased and objective manner.

Intangible Benefits A capital project may generate some benefits that cannot be easily quantified. It may increase the flexibility available to the organisation; it may improve the attractiveness of the product; it may give the organisation a sense of pride; it may make the work environment more pleasing; it may strengthen the technological capability of the firm; it may enhance the morale of the firm. Referred to generally as intangibles, these benefits cannot be translated into monetary terms. Yet, they are relevant and cannot be ignored in investment decision making.

Opportunity Cost Every investment has an opportunity cost associated with it. While exercising their judgment managers ask questions like: If resources are committed to this project which other projects will we have to sacrifice? If none of the current investment proposals is attractive should money be invested in mutual funds temporarily or even returned to share holders through share buybacks?

Apart from looking at the opportunity cost of an investment, managers also consider the cost of inaction. If we do not make this investment will a competitor pre-empt us? If so, are we likely to forfeit valuable prime mover advantages to rivals?

The opportunity cost of investment as well as the risk of inaction have a bearing on judgment.

Cost of Reversing the Decision A strategic investment often commits the business to a course of action for years to come. Smart managers would seek answers to questions like: What happens if this investment sours? Can we reverse it or modify it to contain the damage? How much would the reversal cost? It makes sense to develop a plan to exit.

Superstition Many businessmen consult astrologers or depend on some other superstitious counsel. Wit the following statements:

> What do businessmen have to lose if, plain business sense apart, they also want to know if the planets are favourably disposed toward them.
>
> The more money a businessman makes, the more insecure he feels. Consulting an astrologer is a therapeutic experience. If you are going through a bad phase and are told that it has been caused due to the adverse effects of planets in your horoscope, you do not completely blame yourself. Moreover, most Indian businessmen are by nature religious.

The dependence on astrological advice or superstitious counsel is not confined to India. It is pervasive globally. In a profoundly insightful book, Kenneth Boulding writes:

> The persistence of superstition even into a supposedly scientific age is testimony to the power of traditional images in ambiguous situations. It is a curious fact, for instance,

that even in the most advanced societies the daily paper frequently carries a column of astrological advice!![4]

Astrologers and psychologists have argued that magical rites and superstitious behaviour make the world look more deterministic and instil confidence in our ability to manage it. Superstitious beliefs seem to help in:

- Relieving anxiety.
- Imparting a sense of control.
- Encouraging necessary activity.

Hence, such beliefs persist. And the more unpredictable or uncertain the future appears to be, the greater may be the psychological urge to rely on superstitions.

17.2 MISSION, STRATEGY, AND CAPITAL BUDGETING

The mission of a firm provides the overarching perspective for its activities which naturally cover strategy formulation and capital budgeting. Most firms state their mission in formal terms. Here are some examples of mission statements.

Merck : *To preserve and improve life.*
IBM : *To achieve value-added leadership position.*
McKinsey : *To help leading corporations and governments to be more successful.*
Ranbaxy : *To be a research-oriented international pharmaceutical company.*
HDFC : *To develop close relationships with individual households; maintain position as the premier housing finance institution in the country; transform ideas into viable and creative solutions.*

Firms may call their mission statements by different names such as credo or *raison détre* or statement of purpose. Irrespective of the label assigned, a mission statement is meant to communicate the larger purpose of the organisation, ignite the collective imagination and passion of its employees, and inspire them to achieve more. The mission of a business serves as a backdrop for formulating its strategy. The word strategy is used in different ways. For our purpose, it is useful to look at the distinction between corporate strategy and business strategy.

Corporate strategy is concerned with where resources should be invested. The key corporate level resource allocation questions are: Which business should the firm invest in? What should be the allocation of the firm's resources across various businesses in its portfolio?

Business strategy by contrast is concerned with how the firm should compete in its chosen product markets. A firm may choose to follow a strategy of cost leadership or product differentiation or both. In an interesting paper published in the *Harvard Business Review*,

4. Kenneth Boulding, *The Meaning of the 20th Century*, New York: Harper & Row, 1964, p. 44.

William K. Hall argued that firms which prospered in the hostile environment of the 1970s essentially followed a strategy of cost leadership or meaningful product differentiation or both. For example, Inland Steel prospered thanks to its position of cost leadership whereas National Steel succeeded because of its edge in product differentiation. Similarly, General Motors did well due to its cost leadership whereas Daimler Benz fared well thanks to its ability to meaningfully differentiate its products. In the cigarette business, Phillip Morris did exceedingly well because of its edge in cost leadership as well as product differentiation.

William K. Hall naturally argues that a firm should tailor its investments to achieve a position of cost leadership and/or product differentiation. As he puts it:

- Become the lowest total delivered cost producer in the industry, while maintaining an acceptable service/quality combination relative to competition.
- Develop the highest product/service/quality differentiated position within the industry, while maintaining an acceptable delivered cost structure.

To assure a regular supply of value-creating investments, the firm must institutionalise its strategy of product differentiation and/or cost reduction. Indeed, successful firms do this by fostering a corporate culture that stresses the most critical facet of their performance. For example, McDonald emphasises quality control, IBM, customer service, 3M, innovation, Chapparal Steel, low-cost manufacture, and Raymond Woollen, product quality.

Strengthening the Links between Strategy and Capital Budgeting

Capital budgeting is the principal instrument for implementing strategy. While well-managed firms align capital budgeting to strategy, in many firms the tie-in between strategy and capital budgeting is somewhat loose and tenuous. Wit the following:

- Investment proposals are often considered as self-contained projects and viewed more or less in isolation. The rationale proferred for this approach is that if individual proposals are sound, a collection of such proposals should represent a meaningful commitment of funds.
- The sponsors of proposals, particularly operating personnel, tend to, quite understandably, view the proposals from their limited perspective. An operating person, for example, may justify an investment in terms of increase in output and decrease in unit cost. The effect of the investment on the break-even point or inventory level may be beyond his concern.
- Many investment proposals, suggested by people down the line and apparently fulfilling certain standards of profitability, may be rejected by the capital budgeting committee because they conflict with the rationale of the firm's strategy. This may breed frustration and cynicism about the role of formal analysis.

In order to ensure that strategy and long-range plans firmly undergird the capital budgeting process, the following ought to be done:

- Long-range planning should precede capital budgeting.

- Long-range plans should be formalised and communicated to all persons involved in the process of capital budgeting.
- During the capital budgeting exercise, investment proposals should be viewed in the context of the critical premises of long-range plans.

A suggested time table linking business planning and capital budgeting is given in Exhibit 17.1.

Exhibit 17.1 ***Linkages between Business Planning and Capital Budgeting***

	Business Planning		*Capital Budgeting*
April–August	Several scenarios are explored		
September	Initial premises are agreed to		Initial capital budgeting guidelines are formulated
October–December	Work is continued toward developing a final formal business plan	October – January	Capital budget selection is carried out in divisions and departments
January	Final business plan is adopted	February	Capital budget is approved by the executive committee
		March	Capital budget is approved by the board

Missions and Funds Allocation

In the context of our present discussion which is concerned with the linkage between strategy and capital budgeting, it is somewhat relevant to mention the use of strategic missions as the basis of funds allocation at the Department of Defence, US. Traditionally, the approach used for budgetary allocation at the Department of Defence, US, was to allocate the budgetary pie to the three services, Army, Navy, and Air Force. When Robert McNamara took office as Secretary, Department of Defence, he introduced, a new approach to budgetary allocation, which was based on nine program elements reflecting the major missions of the Department of Defence. Program Element No.1, for example, represented development of a "Strategic Retaliatory Force" and the budget for this program covered bombers, polaris submarines, and land-based intercontinental ballistic missiles.

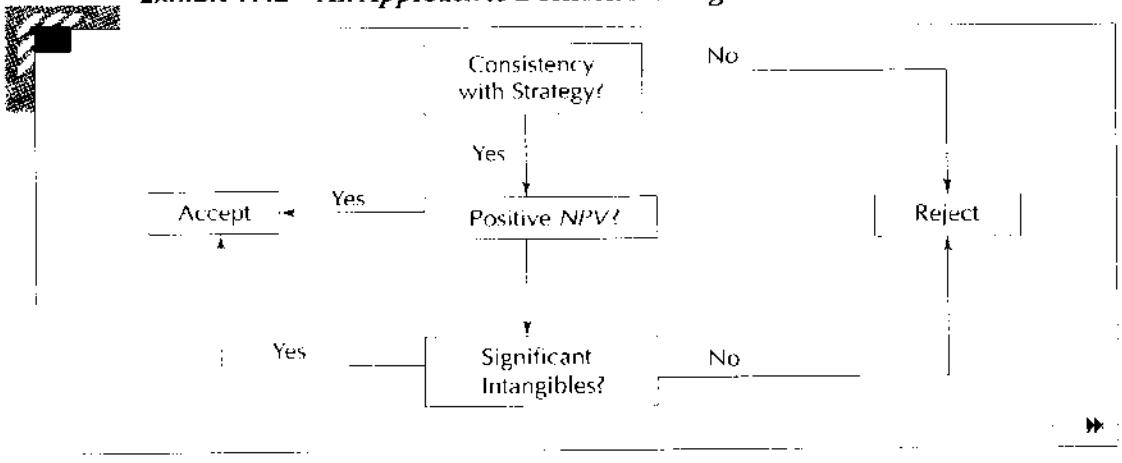
The approach adopted by the Department of Defence, US can be meaningfully applied to a corporate entity. Determining corporate missions admittedly is a significant managerial challenge. Once the missions are delineated and communicated they serve as the base for resource allocation. If missions are not properly developed and communicated, funds allocation becomes, as Tilles puts it, "a gamesmanship rather than a rational matching of means and ends".

An Approach to Decision Making

To determine whether a project is worthwhile or not, strategic factors, financial payoffs, and intangible benefits may be combined in the manner shown in Exhibit 17.2. The key guidelines underlying the approach displayed in this exhibit are:

- In a decision involving measurement as well as judgment, as far as possible, separate the quantifiable and intangible factors.
- Don't rely exclusively on measurable factors and spurious over-quantification. Put differently, avoid the 'what counts counts' bias.

Exhibit 17.2 ***An Approach to Decision Making***



17.3 BRIDGING THE GULF BETWEEN STRATEGIC PLANNING AND FINANCIAL ANALYSIS

Strategic planning, among other things, is concerned with the issue of allocating a firm's resources across different lines of business. In this sense, strategic planning may be viewed as capital budgeting on a grand scale. Yet we find that strategic planning is often naïve from the financial point of view and/or the results of strategic planning and financial analysis are not properly reconciled.

This section explores why a gulf exists between strategic planning and financial analysis and shows how the differences between the two may be reconciled.

Different Frameworks

The frameworks employed in strategic planning and financial analysis differ. The salient differences are highlighted below:

	Strategic planning	*Financial analysis*
Objective	Achieve a balanced goal structure	Maximise shareholder value
Responsibility		
– Internal	Corporate planning department	Finance department
– External	Consultant	Investment banker
Type of analysis	Primarily qualitative	Primarily quantitative
Advantage	Comprehensive qualitative assessment	Disciplined quantitative reasoning
Disadvantage	Lacking in rigour	Omission of hard-to-quantify factors

Mistakes Committed in Financial Analysis

In applying DCF analysis the following mistakes are commonly committed[5]:

Mechanical Projection of Cash Flows Forecasting cash flows over an extended period of time (say 7 to 15 years, as is required in most DCF calculations) calls for incorporating the effects of factors like competition, technical change, inflation, and so on. This is an inherently difficult task. Hence, in practice, short-run forecasts are often mechanically extrapolated to get long-run forecasts.

Optimistic Bias in Cash Flows Knowledgeable observers of capital budgeting believe that profitability is overstated because the initial investment is understated and the operating cash flows are exaggerated. The principal reasons for such optimistic bias appear to be (i) intentional overstatement, (ii) lack of experience, (iii) myopic euphoria, and (iv) capital rationing.

Emphasis on IRR IRR is the most commonly used DCF criterion in practice. It is preferred because it is a relative measure and it seems more appropriate when the investment funds are limited. *IRR*, however, is biased against long-lived capital-intensive projects which may be of greater strategic significance to the firm. Ideally, *NPV*, conceptually superior to all other criteria, should be used as it has no bias against such projects.

Inconsistent Treatment of Inflation Often inflation is treated inconsistently in DCF analysis. While discount rates are defined in nominal terms to reflect the factor of inflation, cash flows are expressed in real terms or only partially adjusted for inflation. Such an inconsistency clearly discriminates against long-lived projects which may have substantially positive *NPV*s.

Unreasonably High Discount Rates Discount rates used in *DCF* calculations are sometimes set unrealistically high. This may be because of one or more of the following reasons: (i) Management may lack familiarity with what the normal returns in the capital market are. (ii) Premiums are asked for risk that can be easily diversified away. (iii) Required returns are

5. S. C. Myers, "Finance Theory and Financial Strategy", *Interfaces*, January–February 1984.

raised to compensate for the optimism of project sponsors. Such an adjustment makes sense only if the sponsor bias increases geometrically over time. This, however, is rarely true.

Inadequacy of DCF Analysis

Even if the mistakes alluded to in the preceding discussion are avoided, DCF analysis is deficient for evaluating projects which have options embedded in them. Consider a project which is in the nature of a "beach-head". If the firm succeeds in this project, it can make a follow on investment. In other words, there is a second-stage investment opportunity—indeed, there may be opportunities beyond the second-stage as well. The DCF method is not enough for evaluating a project like this because it does not take into account the value of the option(s) embedded in the project. DCF analysis must be combined with option valuation. Fortunately, option pricing models promise help in valuing options inherent in real life projects.

Financial Naïveté of Strategic Planning

Strategic planning is often naïve from the financial point of view. Wit the following:

- Strategic analysis focuses on variables like earnings per share and book rate of return which are considered irrelevant by modern finance theory.
- Strategic planning is sometimes based on the premise that a firm should, by and large, depend on internally available funds. Put differently, the existence of the capital market is ignored.
- The hurdle rates applied in strategic planning are often not related to the opportunity cost of capital.
- Strategic planning typically emphasises a diversified business portfolio while the finance theory suggests that investors can resort to a more efficient "home made" diversification.

Reconciling the Differences

To bridge the gap between strategic planning and financial analysis, a conscious effort is required on both the sides.

- Financial analysts must avoid the mistakes commonly committed by them and expand the scope of their work to reflect the values of options embedded in investments of strategic significance.
- Strategic planners must understand the logic of DCF analysis, acquire familiarity with the meaning of the capital market data, and calculate the *NPV*s, at least as a rough check on the results of their analysis.

While a complete reconciliation is not practical, a sincere attempt to see each other's point of view and to unearth hidden premises will facilitate better communication and

understanding. This will ensure that strategic analysis is not financially naïve and financial analysis is not insensitive to strategic issues.

17.4 INFORMATIONAL ASYMMETRY AND CAPITAL BUDGETING

The conventional 'textbook' approach to capital budgeting is starkly simple: accept projects which have a positive *NPV*. It does not make any difference whether the investment decision making is centralised or decentralised; it is irrelevant whether the existing firm implements it or a newly set up firm executes it; it does not matter what mix of financing is employed.

The behaviour of firms, however, is not always in conformity with what has been said above. In the real world:

- Firms often ration capital and do not invest in all projects that have positive *NPV*s.
- A lot of attention is paid to the extent to which capital budgeting decisions are centralised.
- Often, new projects are organised as separate corporate entities.
- The mix of financing is considered to be very important.

Why does a discrepancy exist between what the conventional model says and how the real world firms behave? Informational asymmetries of various sorts seem to create such a hiatus. Informational asymmetry exists if the transacting parties have unequal information, *ex ante* or *ex post*.

We may classify informational asymmetry into three broad types:

- Informational asymmetry between shareholders and bondholders.
- Informational asymmetry between current shareholders and prospective shareholders.
- Informational asymmetry between managers and shareholders.

A brief discussion of the distorting effects of different types of informational asymmetries follows:[6]

Informational Asymmetry between Shareholders and Bondholders

Informational asymmetry between shareholders and bondholders has two possible distorting consequences

Asset substitution moral hazard : Shareholders may prod management to substitute riskier assets for safer assets, at the expense of bondholders

Underinvestment moral hazard : In firms with risky debt, shareholders have an incentive to avoid investing in new projects that have a positive *NPV*, because they would not like the cash flows of new projects to be diverted for servicing existing risky debt.

6. Anjan V. Thakor, "Corporate Investments and Finance", *Financial Management*, Summer 1993.

Informational Asymmetry between Current Shareholders and Prospective Shareholders

When there is informational asymmetry between current shareholders and prospective shareholders, the latter will not fully appreciate the future payoffs of various resource commitments. As the firm's stock price may not fully reflect the benefits of such resource commitments, the new shareholders will not fully share the cost of resource commitments even though they partake in the benefits arising from them. If the firm is interested in maximising the wealth of present shareholders, it may choose projects that are likely to be different from those that would be chosen in a symmetric information setting. The common distortions resulting from such informational asymmetry are:

- Preference for projects with shorter payback period.
- A greater degree of capital rationing.
- Centralisation of capital budgeting.
- Accumulation of liquidity despite the existence of positive *NPV* projects.

Informational Asymmetry between Managers and Shareholders

Managers are interested in maintaining and building their reputation. Since, as compared to shareholders, they are typically better informed about the payoffs of projects they can trade on the relative ignorance of the latter. This gives them latitude to choose investments aimed at building their reputation rather than enhancing the wealth of shareholders. As David Hirshleifer[7] has suggested, the concern for managerial reputation may lead to three kinds of distortions in investment decisions, namely:

Visibility Bias Managers seek to improve short-term indicators of performance.

Resolution Preference Managers attempt to advance the arrival of good news and delay the announcement of bad news.

Mimicry and Avoidance Managers try to imitate the actions of superior managers and avoid the actions of inferior managers.

These incentives may lead to the following investment biases:

- Squeezing of an investment to improve short-term cash flows.
- Premature liquidation of assets to show that they are worth a lot.
- Adoption of projects with earlier payoffs.
- Avoidance of worthwhile projects that carry risk of early failure to protect short-term reputation.
- Escalation of inferior projects to avoid admission of failure.

7. David Hirshleifer, "Managerial Reputation and Corporate Investment Decisions", *Financial Management*, Summer 1993, pp.145–159.

- Undertaking projects which are supposed to have benefits in the distant future to protect short-term reputation.
- Conformity with other managers to avoid the 'odd manager' label.
- Deviation from other managers to avoid seeming mediocre.

17.5 ORGANISATIONAL CONSIDERATIONS

In order to be meaningful and viable, the capital budget of a firm must satisfy some conditions: These are:

- It must be compatible with the resources of the firm.
- It must be controllable.
- It must be endorsed by the executive management.

Compatibility with Resources

The capital budget of a firm must be compatible with its resources—financial capacity and managerial capability.

Financial Capacity The financial capacity of a firm may be estimated as follows: operating cash flow – fixed funding requirements + potential funding sources.

Operating Cash Flow The operating cash flow of a firm is defined as: profit after tax + depreciation + other non-cash charges – increase in working capital (or + decrease in working capital).

Fixed Funding Requirement This is equal to: debt repayment obligation + preference capital repayment obligation + preference dividend + normal equity dividend.

Potential Funding Sources These consist of: excess cash balance + saleable fixed assets + reserve borrowing capacity + new equity issue.

Managerial Capability The managerial capability of every organisation has its own limitation. Management competence in one industry does not necessarily imply competence in another industry. This sets a limit—which of course can be overcome over a period of time—on investment in unrelated lines of activity. Further, imbalances in organisational skills may be an inhibiting factor. A firm may have outstanding engineering and production expertise that may not be matched by marketing skills, which may be, at least in the short-run, a factor limiting growth.

Assessing the managerial capability is more difficult than estimating the financial capacity. The methods of evaluation in this area being weak, there may be a tendency to gloss over it or side-step it. However, the inability to identify critical managerial limitations and organisational imbalances can seriously vitiate funds allocation. Indeed, this is one of the most vulnerable facets of capital budgeting.

Controllability

As the business environment is continually changing and evolving, even the best conceived business plans may turn out to be ill-advised and poorly timed. Hence, sound controls should be instituted in the process of capital budgeting. This involves the following:

- The base level spending and the expansion investments should be segregated.
- Sound profitability criteria should be applied to expansion investments.
- Projects included in the capital budget should be thoroughly reviewed prior to actual implementation.
- Major projects should be divided into sub-phases for the purpose of controlling expenditures.
- Actual costs must be periodically compared against planned costs.

Base Level Spending and Expansion Investments The segregation of base level spending and expansion investments, a major aspect of control, deserves some elaboration. Base level spending, representing outlays on 'required' investments (also referred to sometimes as 'maintenance' investments), should be carefully distinguished from expansion investments also referred to as 'discretionary' investments or 'growth' investments. Base level spending represents the minimum spending required for sustaining current operations. If the base level capital budget is not properly drawn up, current operations may be 'short-changed' or 'gold-plated'.

As against the base level spending, expansion projects are discretionary in nature. Selection of expansion projects is a test of managerial initiative, insight, imagination, and judgment. In view of the mistakes that can be made with respect to expansion investments, the capital budgeting process should give high visibility and prominence to such projects.

Executive Management Endorsement

The capital budget of the firm should be fully backed by the executive management. Without the endorsement of the executive management, the capital budgeting process may lack meaning and usefulness. Endorsement of the executive management is required at all stages: long-range planning, funds planning, planning to strengthen managerial capabilities and rectify organisational imbalances, and development of budgetary controls.

Endorsement of executive management means (i) conviction in the long-range strategy of the firm, (ii) strong desire to implement the approved capital budget, and (iii) willingness to be subjected to the discipline of capital budgeting. Conviction in the long-range strategy and the concomitant tactical plans may be developed by discussion leading to some general agreement. A difficult task, this is critical for generating enthusiasm and support for the capital budget. The desire to implement the approved capital budget is reflected by the initiatives taken by the management to expedite proposals, to arrest adverse developments, and to bring about organisational changes. The willingness to be subjected to the discipline of

capital budgeting is manifested in the schedules drawn, approval procedures established, and corrective mechanisms developed.

SUMMARY

- A mosaic of influences that can best be described qualitatively have an important bearing on capital expenditure decisions.
- Capital budgeting is the principal instrument for implementing a firm's strategy. Hence the two should be properly linked. In particular: (i) Long-range planning should precede capital budgeting. (ii) Long-range plans should be formalised and communicated to all persons involved in the process of capital budgeting. (iii) During the capital budgeting exercise, investment proposals should be viewed in the context of the critical premises of long-range plans.
- In a decision involving measurement as well as judgment, as far as possible, separate the quantifiable factors and the intangible factors.
- Strategic planning, among other things, is concerned with the issue of allocating a firm's resources across different lines of business. In this sense, strategic planning may be viewed as capital budgeting on a grand scale.
- Strategic planning is often naïve from the financial point of view and/or the results of strategic planning and financial analysis are not properly reconciled.
- The frameworks employed in strategic planning and financial analysis differ on several dimensions like objective, responsibility, type of analysis, and techniques of analysis.
- In applying DCF analysis, the following mistakes are commonly committed: mechanical projection of cash flows, optimistic bias in cash flows, emphasis on *IRR*, inconsistent treatment of inflation, and unreasonably high discount rates.
- To bridge the gap between strategic planning and financial analysis, a conscious effort is required on both the sides. Financial analysts must avoid the mistakes commonly committed by them and strategic planners must understand the logic of the DCF analysis.
- The behaviour of firms in the real world is often at variance with the textbook model. The discrepancy arises mainly because of informational asymmetries.
- Informational asymmetry exists if the transacting parties have unequal information, *ex ante* or *ex post*. There are three kinds of informational asymmetry: (i) information asymmetry between shareholders and bondholders, (ii) informational asymmetry between current shareholders and prospective shareholders, and (iii) information asymmetry between managers and shareholders.
- In order to be meaningful and viable, the capital budget of a firm must satisfy some conditions: (i) It must be compatible with the resources of the firm. (ii) It must be controllable. (iii) It must be endorsed by the executive management.

Questions

1. Discuss the influence of intuition and judgment in capital budgeting. What factors influence judgment?
2. "The tie-in between strategy and capital budgeting is often loose and tenuous." Comment.
3. Suggest ways and means of strengthening the linkage between long-range planning and capital budgeting.
4. What are the salient differences in the frameworks applied in strategic planning and capital budgeting?
5. Discuss the mistakes commonly committed in applying the DCF analysis.
6. What are the different kinds of informational asymmetries? What types of distortions do they introduce in project choices?
7. What conditions should the capital budget satisfy in order to be meaningful and viable?

Part V
Financing

18. Financing of Projects
19. Financing Infrastructure Projects
20. Venture Capital

CHAPTER

18

Financing of Projects

For pedagogic purposes we discuss project financing after project selection. In practice, however, project financing is considered in some way or the other right from the time of project conception. Indeed project financing is intertwined with project planning, analysis, and selection. As the project proposal progresses through the stages of planning, analysis, and selection, the contours of project financing become clearer.

A capital project entails investment in land, plant and machinery, miscellaneous fixed assets, technical know-how, distribution network, and working capital. Hence a capital project may be regarded as a mini-firm—after all when you look at the balance sheet of a firm you find that it has investments in similar assets.

So, the issues to be considered in financing a project are identical to those considered in financing a business firm. What is an appropriate capital structure? Which financing instruments make more sense? What are the pros and cons of public and private sources of capital? How much should the firm depend on the domestic capital market and how much on the international capital market?

Note that when financial institutions look at a project, they consider only the long-term sources of finance. We, however, prefer to look at all the sources of finance, long-term as well as short-term. In line with this perspective, this chapter discusses all the sources of finance required to set up a project. It is divided into eleven sections as follows:

- Capital structure.
- Menu of financing.
- Equity capital.
- Preference capital.
- Internal accruals.
- Term loans.

- Debentures.
- Working capital advance.
- Miscellaneous sources.
- Raising venture capital.
- Raising capital in international markets.

18.1 CAPITAL STRUCTURE

The two broad sources of finance available to a firm are: shareholders' funds and loan funds. Shareholders' funds come mainly in the form of equity capital and retained earnings and secondarily in the form of preference capital. Loan funds come in a variety of ways like debenture capital, term loans, deferred credit, fixed deposit, and working capital advance.

Ignoring preference capital (which is of minor significance) the basic differences between shareholders' funds (referred to as equity) and loan funds (referred to as debt) are as follows:

Equity	*Debt*
• Equity shareholders have a residual claim on the income and the wealth of the firm.	• Creditors (suppliers of debt) have a fixed claim in the form of interest and principal payment.
• Dividend paid to equity shareholders is not a tax deductible payment.	• Interest paid to creditors is a tax deductible payment.
• Equity ordinarily has an indefinite life.	• Debt has a fixed maturity.
• Equity investors enjoy the prerogative to control the affairs of the firm.	• Debt investors play a passive role—of course, they impose certain restrictions on the way the firm is run to protect their interest.

What are the key considerations in determining the debt equity ratio (the capital structure) of a firm? The important considerations in planning the capital structure are:

- Earnings per share
- Risk
- Control
- Flexibility
- Nature of assets

Earnings per Share

Earnings per share, which is simply equity earnings divided by the number of outstanding equity shares, is regarded as an important financial number that firms would like to im-

prove. Hence we need to understand how sensitive is earnings per share (*EPS*) to changes in profit before interest and tax (*PBIT*) under different financing alternatives.

To illustrate the relationship between *PBIT* and *EPS* under alternative financing plans, let us consider the following data for Falcon Limited:

- Existing capital structure : 10 million equity shares, par value Rs 10 each
- Tax rate : 50 percent

Falcon limited plans to raise an additional capital of Rs 100 million for financing an expansion project. In this context, it is evaluating two alternative financing plans: (i) issue of equity shares (10 million equity shares of Rs 10 per share), and (ii) issue of debentures carrying 14 percent interest.

What will be the *EPS* under the two alternative financing plans for two levels of *PBIT* say Rs 20 million and Rs 40 million? Exhibit 18.1 shows the value of *EPS* at these two levels of *PBIT* under the alternative financing plans.

Exhibit 18.1 ***Earnings per Share under Alternative Financing Plans***

	Equity Financing		*Debt Financing*	
	PBIT: 20,000,000	PBIT: 40,000,000	PBIT: 20,000,000	PBIT: 40,000,000
Interest	–	–	14,000,000	14,000,000
Profit before tax	20,000,000	40,000,000	6,000,000	26,000,000
Tax	10,000,000	20,000,000	3,000,000	13,000,000
Profit after tax	10,000,000	20,000,000	3,000,000	13,000,000
No. of equity shares	20,000,000	20,000,000	10,000,000	10,000,000
EPS	0.50	1.00	0.30	1.30

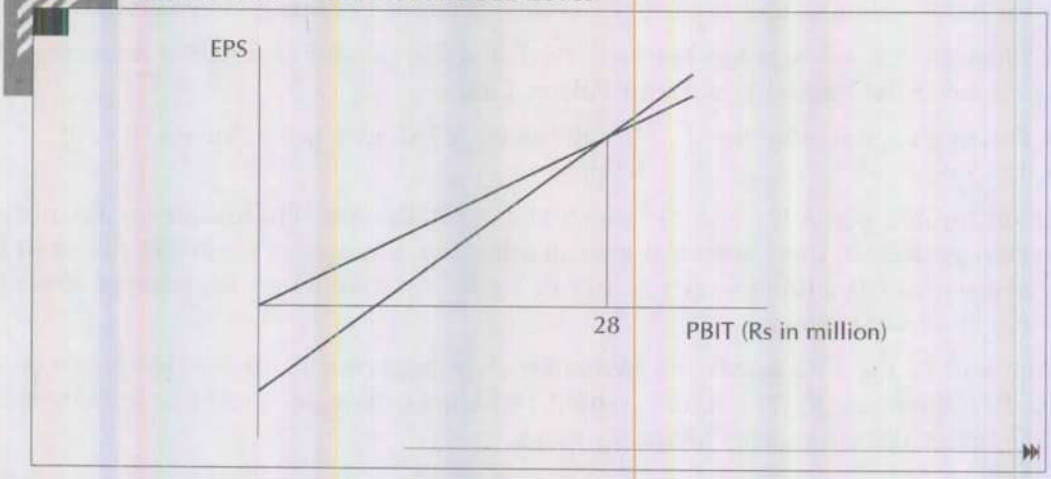
In general, the relationship between profit before interest and taxes and earnings per share is as follows:

Earnings per share

$$= \frac{[\text{Profit before interest and taxes} - \text{Interest}](1 - \text{Tax rate}) - \text{Preference dividend}}{\text{Number of equity shares}}$$

The break-even *PBIT* for the two alternative financing plans is the level of *PBIT* at which *EPS* is the same under both the financing plans. It can be graphically obtained by plotting the relationship between *PBIT* and *EPS* under the two alternatives and noting the point of intersection. This is shown in Exhibit 18.2 for the example of Falcon Limited. From this exhibit we find that the break-even level of *PBIT* is Rs 28 million. If *PBIT* is below Rs 28 million equity financing is preferable to debenture financing; if *PBIT* is higher than Rs 28 million, the opposite holds.

Exhibit 18.2 ***Break-even PBIT Level***



Risk

The two principal sources of risk in a firm are: business risk and financial risk.

Business Risk It refers to the variability of profit before interest and taxes. It is influenced, *inter alia*, by the following factors.

- *Demand Variability* Other things being equal the higher the variability of demand for the products manufactured by the firm, the higher is its business risk.
- *Price Variability* A firm which is exposed to a higher degree of volatility for the prices of its products is, in general, characterised by a higher degree of business risk in comparison with similar firms which are exposed to a lesser degree of volatility for the prices of their products.
- *Variability of Input Prices* When input prices are highly variable, business risk tends to be high.
- *Proportion of Fixed Costs* If fixed costs represent a substantial proportion of total costs, other things being equal, business risk is likely to be high. This is because when fixed costs are high, *PBIT* is more sensitive to variations in demand.

Financial Risk It represents the risk emanating from financial leverage. When a firm employs a high proportion of debt in its capital structure, i.e. when it has a high degree of financial leverage, it carries a high burden of fixed financial commitment. Equity shareholders, who have a residual interest in the income and wealth of the firm, are naturally exposed to the risk arising from such fixed commitments. Equity shareholders face this risk, also referred to as financial risk, in addition to business risk.

Generally, the affairs of the firm are, or should be, managed in such a way that the total risk borne by equity shareholders, which consists of business risk plus financial risk, is not unduly high. This implies that if the firm is exposed to a high degree of business risk, its financial risk should be kept low. On the other hand, if the firm has a low business risk profile, it can assume more financial risk.

Control

Consider the case of a firm which presently has an equity capital of 1000 owned entirely by the original promoters. If the firm wants to raise some additional capital, say another 1000, it may go for debt finance, or a rights issue of equity capital, or a public issue of equity capital, or a combination of two or more of these. The pros and cons of the three basic ways of raising additional finance are shown below:

	Pros	*Cons*
• *Rights issue of equity capital*	No dilution of control	Severe limits on the financing
	No financial risk	Higher cost
• *Debt capital*	Relatively limited dilution of control	Financial risk
	Lower cost	
• *Public issue of equity capital*	No financial risk	Dilution of control
		Higher cost
		More onerous regulation

Since the rights issue option severely limits the financing ability of the firm the present owners may lack resources or inclination or both—the options which may merit serious considerations are debt capital and public issue of equity capital. In evaluating these options, among other things, the issue of control is important.

Flexibility

Flexibility refers to the ability of a firm to raise capital from any source it wishes to tap. It provides manoeuvrability to the firm. Generally, if the return earned on equity is satisfactory, the firm can raise further equity capital as there is no restriction on the amount of equity capital a firm can raise. However, as the debt equity ratio is normally not permitted to exceed a certain level (which may be specified by some regulatory authority, or determined by financial institutions, or indicated by the capital market), the firm cannot presume that it can always raise further capital by issuing debt securities. Hence, flexibility for practical purposes may mean that the firm does not fully exhaust its debt capacity. Put differently, it implies that the firm maintains reserve borrowing power to enable it to raise debt capital to fund unforeseen needs.

Nature of Assets

The nature of a firm's assets has an important bearing on its capital structure. If the assets are primarily tangible (plant and machinery and buildings) and have a liquid resale/secondary market, debt finance is used more. For example, electric utility companies use more debt because their assets are mainly tangible, physical in nature. On the other hand, if the assets are primarily intangible (brands and technical know-how), debt finance is used less. For example, software companies use very little debt, as their assets are mainly intangible.

What explains the link between the nature of assets and the use of debt finance? The major explanation is that lenders are more willing to lend against tangible assets and less inclined to lend against intangible assets.

A Checklist

When should a firm use more equity and when should a firm use more debt. Here is a checklist:

Use more equity when	*Use more debt when*
• The corporate tax rate applicable to the firm is negligible.	• The corporate tax rate applicable to the firm is high.
• Business risk exposure is high.	• Business risk exposure is low.
• Dilution of control is not an important issue.	• Dilution of control is an issue.
• The assets of the firm are mostly intangible.	• The assets of the firm are mostly tangible.
• The firm has many valuable growth options.	• The firm has few growth options.

18.2 MENU OF FINANCING

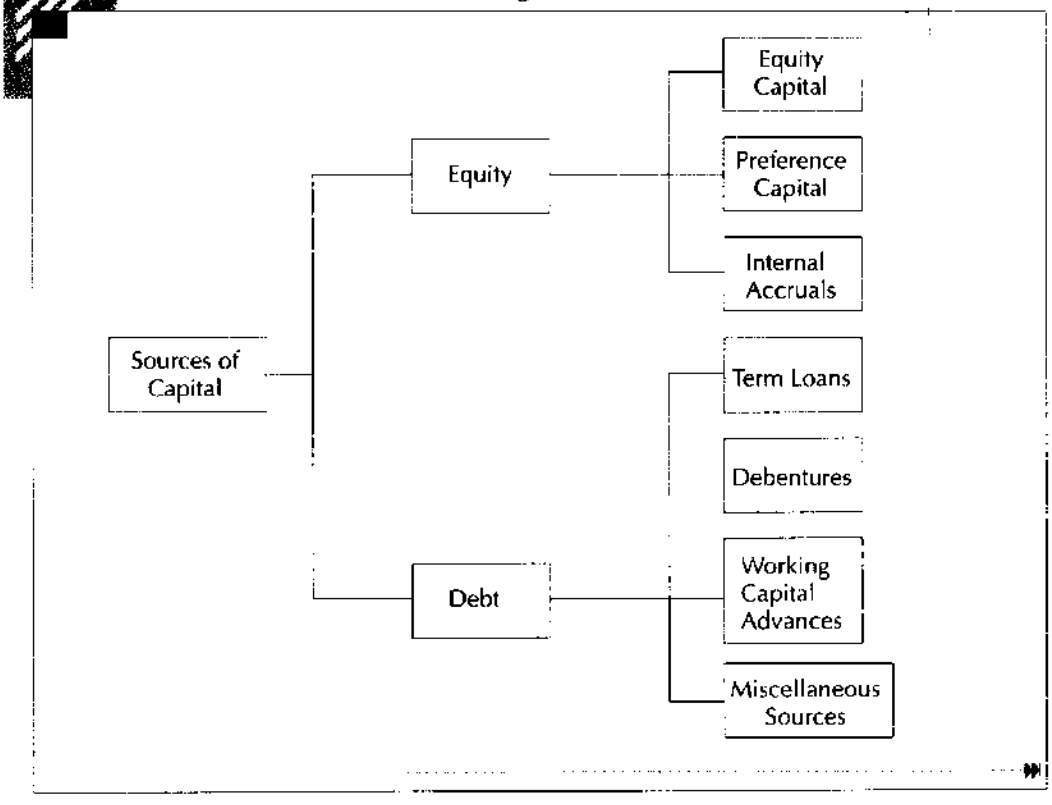
Equity and debt come in a variety of forms and are raised in different ways. The important forms are shown in Exhibit 18.3 which shows the menu of financing available to a firm. The various forms of financing are discussed in detail in the following sections.

Public and Private Sources of Capital

A firm can raise equity and debt capital from both public and private sources. Capital raised from public sources is in the form of securities offered to the public through an offer document filed with the Securities Exchange Board of India.[1] These securities can be traded on public secondary markets like the National Stock Exchange or the Bombay Stock Exchange, which are recognised stock exchanges that facilitate the trading of public securities.

1. This, however, does not apply when a firm raises fixed deposits or issues commercial paper.

Exhibit 18.3 *Menu of Financing*



Private capital comes either in the form of loans given by banks and financial institutions or in the form of securities like equity shares, preference shares, and debentures which are privately placed with a small group of sophisticated investors like venture capital firms, financial institutions, insurance companies, mutual funds, and wealthy individuals.

The Typical Pattern of Financing

When a company is formed, it first issues equity shares to the promoters (founders) and also, in most cases, raises loans from banks, financial institutions, and other sources. As the need for financing increases, the company may issue shares and debentures privately to promoters' relatives, friends, business partners, employees, financial institutions, banks, mutual funds, venture capital funds, and others—venture capital funds are likely to be an important source of finance for a nascent venture. Such investors are specific and small in number.

As the company grows further, it may have to raise capital from the public. The first issue of equity shares to the public by an unlisted company is called the initial public offering (IPO). Subsequent offerings are called seasoned offerings.

Apart from equity shares, a firm may issue preference shares[2] and debentures to the general investment public through a public issue.

18.3 EQUITY CAPITAL

Equity capital represents ownership capital as equity shareholders collectively own the company. They enjoy the rewards and bear the risks of ownership. However, their liability, unlike the liability of the owner in a proprietary firm and the partners in a partnership concern, is limited to their capital contributions.

Some Terms

Authorised, Issued, Subscribed, and Paid-up Capital The amount of capital that a company can potentially issue, as per its memorandum, represents the *authorised capital*. The amount offered by the company to the investors is called the *issued capital*. That part of issued capital which has been subscribed to by the investors represents the *subscribed capital*. The actual amount paid up by the investors is called the *paid-up capital*—typically the issued, subscribed, and paid-up capital are the same.

Par Value, Issue Price, Book Value, and Market Value The *par value* of an equity share is the value stated in the memorandum and written on the share scrip. The par value of equity shares is generally Rs 10 (the most popular denomination) or Rs 100. Infrequently, one comes across par values like Re 1, Rs 2, Rs 5, Rs 50, and Rs 1,000.

The *issue price* is the price at which the equity share is issued. Generally the issue price and par value are one and the same for new companies. An existing company may sometimes set its issue price higher than the par value. Sonata Software (India) Limited, for example, set its issue price at Rs 80 per share as against the par value of Rs 10 per share. When the issue price exceeds the par value, the difference is referred to as the share premium. It may be noted that the issue price cannot be, as per law, lower than the par value.[3]

The *book value* of an equity share is equal to:

$$\frac{\text{Paid-up equity capital} + \text{Reserves and surplus} - \text{Intangibles}}{\text{Number of outstanding equity shares}}$$

2. Over the years preference shares have declined in importance.

3. Technically, shares may be issued at a discount, although the procedural complexity makes it infrequent.

Quite naturally, the book value of an equity share tends to increase as the ratio of reserves and surplus to paid-up equity capital increases.

The *market value* of an equity share is the price at which it is traded in the market. This price can be easily established for a company which is listed on the stock market and actively traded. For a company which is listed on the stock market but traded very infrequently, it is difficult to obtain a reliable market quotation. For such a company, the market quotation may reflect the sale of a few shares in a past period and hence may not reflect the current market value of the firm. For a company which is not listed on the stock market, one can merely conjecture as to what its market price would be if it were traded. The market price is determined by a variety of factors like current earnings, growth prospects, risk, and company size.

Rights of Equity Shareholders

Right to Income The equity investors have a residual claim to the income of the firm. The income left after satisfying the claims of all other investors belongs to the equity shareholders. This income is simply equal to profit after tax minus preferred dividend.

The income of equity shareholders may be retained by the firm or paid out as dividends. It may be noted here that equity shareholders are entitled to dividend that is declared by the board of directors. The dividend decision is the prerogative of the board of directors.

Right to Control Equity shareholders as owners of the firm elect the board of directors and have the right to vote on every resolution placed before the company. The board of directors, in turn, selects the management which controls the operations of the firm. Hence, equity shareholders, in theory, exercise an indirect control over the operations of the firm. How effective is such indirect control? Often such indirect control is weak and ineffective because of the apathy and indifference of most of the shareholders who rarely bother to cast their votes, by post or through a proxy, let alone attend the annual general meetings. Scattered and ill-organised, equity shareholders fail to exercise their collective power effectively. Usually, the management of the firm, with the support of a well organised but not necessarily a very substantial group of shareholders, is able to hold the reins of control.

Pre-emptive Right The pre-emptive right enables existing equity shareholders to maintain their proportional ownership by purchasing the additional equity shares issued by the firm. The law requires companies to give existing equity shareholders the first opportunity to purchase, on pro rata basis, additional issues of equity capital. For example, if the company has 1,000,000 outstanding shares of equity stock and proposes to issue 200,000 additional equity shares, an equity shareholder owning 100 shares has the right to purchase 20 of the 200,000 new shares before those are offered to anyone else. The equity shareholders may, however, forfeit this right, partially or totally.

Right in Liquidation As in the case of income, equity shareholders have a residual claim over the assets of the firm in the event of liquidation. Claims of all others—debenture holders, secured lenders, unsecured lenders, other creditors, and preferred shareholders—are settled prior to the claim of equity shareholders. More often than not equity shareholders do not get anything in the event of liquidation because the liquidation value of assets is not adequate to fully meet the claims of others.

Methods of Raising Equity Capital

When a company is formed, it first issues equity shares to the promoters (founders) and also, in most cases, to a select group of investors. As the company grows, it may rely on the following methods of raising equity capital.

- Initial public offering.
- Seasoned offering.
- Rights issue.
- Private placement.
- Preferential allotment.

Initial Public Offering The first public offering of equity shares of a company, which is followed by a listing of its shares on the stock market, is called the initial public offering (IPO).

Decision to Go Public The decision to go public (or more precisely the decision to make an IPO so that the securities of the company are listed on the stock market and are publicly traded) is a very important issue. It is a complex decision which calls for carefully weighing the benefits against costs.

Benefits

- Access to larger pool of capital
- Respectability
- Lower cost of capital compared to private placement
- Liquidity

Costs

- Dilution
- Loss of flexibility
- Disclosures and accountability
- Periodic costs

Eligibility for IPOs An Indian company, excluding certain banks and infrastructure companies, can make an IPO if it satisfies the following conditions[4].

- The company has a certain track record of profitability and a certain minimum networth.
- The securities are compulsorily listed on a recognised stock exchange which means that a certain minimum percent of each class of securities is offered to the public.

4. The guidelines for making an IPO change over time. Readers are advised to get the latest guidelines at: www.sebi.com

- The promoter group (promoters to directors, friends, relatives, associates, etc.) is required to make a certain minimum contribution to the post-issue capital.
- The promoters' contribution to the equity subject to a certain lock-in period.

Principal Steps in a Public Issue A public issue involves sale of securities to the members of the public. It involves a fairly elaborate process involving the following steps after the proposed issue is approved by the board of directors and shareholders:

- Appoint the lead manager/s.
- Appoint other intermediaries like co-managers, underwriters, bankers, brokers, and registrars.
- Prepare the prospectus and file the same with the Registrar of Companies and SEBI.
- Print the prospectus and dispatch the same to the brokers.
- Make the statutory announcements.
- Collect and process the applications.
- Establish the liability of underwriters.
- Allot shares.
- Get the issue listed.

Cost of Public Issue The cost of a public issue is normally between 6 and 12 percent, depending on the size of the issue and the level of the marketing effort. The important expenses incurred for a public issue are: underwriting expenses, brokerage, fees for the managers and registrars, printing and postage expenses, advertising and publicity expenses, listing fees, and stamp duty.

Seasoned Offering For most companies, their IPO is seldom their last public issue. As companies grow, they are likely to make further trips to the capital market with issues of debt and equity. These issues are likely to be public issues offered to investors at large or rights issues or private placement or preferential allotment.

The procedure for a public issue by a listed company (seasoned offering) is similar to that of an IPO. Hence all the steps involved in an IPO are applicable to a public issue by a listed company. However, a public issue by a listed company is subject to fewer regulations when compared to an IPO (except when the post-issue net worth grows to more than five times the pre-issue net worth). This is evident from the following:

- A public issue by a company which has been listed on a stock exchange for at least three years and has a track record of dividend payment for at least three immediate preceding years does not require the promoters' contribution, provided the relevant information is disclosed in the offer document.
- There are no pricing norms for a public issue by a listed company.

Rights Issue A rights issue involves selling securities in the primary market by issuing rights to the existing shareholders. When a company issues additional equity capital, it has to be offered in the first instance to the existing shareholders on a pro rata basis. This is

required under Section 81 of the Companies Act, 1956. The shareholders, however, may by a special resolution forfeit this right, partially or fully, to enable a company to issue additional capital to the public.

Procedure for Rights Issue A company making a rights issue sends a letter of offer along with a composite application form consisting of four forms (A, B, C and D) to the shareholders. Form A is meant for the acceptance of the rights and application of additional shares. This form also shows the number of rights shares the shareholder is entitled to. It also has a column through which a request for additional shares may be made. Form B is to be used if the shareholder wants to renounce the rights in favour of someone else. Form C is meant for application by the renouncee in whose favour the rights have been renounced, by the original allottee, through Form B. Form D is to be used to make a request for split forms. The composite application form must be mailed to the company within a specific period, which is usually 30 days.

Rights Issue versus Public Issue A rights issue offers several advantages over a public issue: The floatation costs of a rights issue are significantly lower than those of a public issue. Theoretically, the subscription price of a rights issue is irrelevant because the wealth of a shareholder who subscribes to the rights issue or sells the rights remains unchanged, irrespective of what the subscription price is. Hence, the problem of transfer of wealth from existing shareholders to new shareholders does not arise in a rights issue.

Private Placement Private placement and preferential allotment involve sale of securities to a limited number of sophisticated investors such as financial institutions, mutual funds, venture capital funds, banks, and so on. What is the difference between private placement and preferential allotment? While there does not seem to be a very clear-cut distinction between the two in the Indian context we find that broadly: (i) private placement refers to sale of equity or equity related instruments of an unlisted company or sale of debentures of a listed or unlisted company, and (ii) preferential allotment refers to sale of equity or equity related instruments of a listed company.

Private placement in India is mostly of equity or equity-related instruments of unlisted companies and debt instruments of listed companies.

Preferential Allotment An issue of equity by a listed company to selected investors at a price which may or may not be related to the prevailing market price is referred to as preferential allotment in the Indian capital market. A preferential allotment is not related to a public issue and it should not be confused with reservations that may be made on a preferential basis for certain categories of investors in a public issue. Preferential allotment in India is given mainly to promoters or friendly investors to ward off the threat of a takeover.

This is now a very popular means of raising fresh equity capital because (a) the cost and uncertainty associated with the public issue is high, and (b) sophisticated investors like mutual funds and private equity investors are likely to pay a higher price.

Regulations Since preferential allotment is amenable to potential abuse, it is subject to the following regulations.

- The shareholders of the company must pass a special resolution or the central government must grant a special approval under Section 81(1A) of the Indian Companies Act before a company makes a preferential allotment.
- The price at which a preferential allotment of shares is made should not be lower than the higher of the average of the weekly high and low of the closing prices of the shares quoted on the stock exchange during the six months period before the relevant date or during the two week period before the relevant date.
- Securities issued to the promoter group by way of a preferential allotment are subject to a lock-in period of 3 years—this means that they are not transferable for that period. However, securities issued to other categories of investors by way of a preferential allotment are a subject to lock-in period of only one year.

How Do the Methods Compare How do the four methods compare broadly in terms of the amount that can be raised, the cost of issue, dilution of control, degree of underpricing, and market perception? Exhibit 18.4 presents a summary comparison for an equity issue. As far as a debt issue is concerned dilution of control is a non-issue and the market perception is positive under all the methods.

Exhibit 18.4 ***Summary Comparison of the Various Methods***

	Public Issue	*Rights Issue*	*Private Placement*	*Preferential Allotment*
• Amount that can be raised	Large	Moderate	Moderate	Moderate
• Cost of issue	High	Negligible	Negligible	Low
• Dilution of control	Yes	No	Yes	Depends
• Degree of underpricing	Large	Irrelevant	Small	No
• Market perception	Negative	Neutral	Neutral	Neutral

Advantages and Disadvantages of Equity Capital

An important source of long-term financing, equity capital offers the following advantages:

- There is no compulsion to pay dividends. If the firm has insufficiency of cash, it can skip equity dividends without suffering any legal consequences.
- Equity capital has no maturity date and hence the firm has no obligation to redeem.
- Because equity capital provides a cushion to lenders, it enhances the creditworthiness of the company. In general, other things being equal, the larger the equity base, the greater the ability of the firm to raise debt finance on favourable terms.
- Presently, equity dividends are tax-exempt in the hands of investors up to a certain extent.

The disadvantages of raising finances by issuing equity shares are as follows:

- Sale of equity shares to outsiders dilutes the control of existing owners.
- The cost of equity capital is high, usually the highest. The rate of return required by equity shareholders is generally higher than the rate of return required by other investors.
- Equity dividends are paid out of profit after tax, whereas interest payments are tax-deductible expenses. This makes the relative cost of equity more. Partially offsetting this disadvantage is the fact that equity dividends are tax-exempt up to a certain extent, whereas interest income is taxable in the hands of the investors.
- The cost of issuing equity shares is generally higher than the cost of issuing other types of securities. Underwriting commission, brokerage costs, and other issue expenses are high for equity issues.

18.4 PREFERENCE CAPITAL

Preference capital represents a hybrid form of financing—it partakes some characteristics of equity and some attributes of debentures. It resembles equity in the following ways: (i) preference dividend is payable only out of distributable profits; (ii) preference dividend is not an obligatory payment (the payment of preference dividend is entirely within the discretion of the directors); and (iii) preference dividend is not a tax-deductible payment.

Preference capital is similar to debentures in several ways: (i) the dividend rate of preference capital is usually fixed; (ii) the claim of preference shareholders is prior to the claim of equity shareholders; and (iii) preference shareholders do not normally enjoy the right to vote.

Features of Preference Capital

The important features of preference capital are as follows:

- Barring a few exceptions, preference shares in India carry a cumulative feature with respect to dividends. This means that unpaid dividends are carried forward and are payable in the future. It may be noted that a company cannot declare equity dividends unless preference dividends are paid with arrears.
- Preference shares are typically redeemable after ten to fifteen years.
- Preference shares do not carry voting rights. A preference shareholder, however, is entitled to vote under certain circumstances, if preference dividend is skipped.

Advantages and Disadvantages of Preference Capital

Preference capital offers the following advantages:

- There is no legal obligation to pay preference dividend. A company does not face bankruptcy or legal action if it skips preference dividend.
- There is no redemption liability in the case of perpetual preference shares. Even in the case of redeemable preference shares, financial distress may not be much because (i) periodic sinking fund payments are not required, and (ii) redemption can be delayed without significant penalties.
- Preference capital is generally regarded as part of net worth. Hence, it enhances the creditworthiness of the firm.
- Preference shares do not, under normal circumstances, carry voting rights. Hence, there is no dilution of control.
- No collateral is pledged in favour of preference shareholders. Hence, the mortgageable assets of the firm are conserved.

Preference capital, however, suffers from some serious shortcomings:

- Compared to debt capital, it is a more expensive source of financing because the dividend paid to preference shareholders is not, unlike debt interest, a tax-deductible expense.
- Though there is no legal obligation to pay preference dividends, skipping them can adversely affect the image of the firm in the capital market.
- Compared to equity shareholders, preference shareholders have a prior claim on the assets and earnings of the firm.
- If a firm skips preference dividends for three years, it has to grant voting rights to the preference shareholders, on matters affecting them.

18.5 INTERNAL ACCRUALS

The internal accruals of a firm consist of depreciation charges and retained earnings. Depreciation represents the allocation of capital expenditure to various periods over which the capital expenditure is expected to benefit the firm. Suppose a machine costs Rs 100,000 and has an economic life of 5 years at the end of which its expected salvage value is 0. If the machine is depreciated using the straight line method, the annual depreciation charge will be Rs 20,000. Each year a depreciation cost of Rs 20,000 is shown in the profit and loss account. This cost merely represents a periodic writeoff of a capital cost incurred in the beginning. Put differently, it is a non-cash charge. Hence, it is considered an internal source of finance.

Retained earnings are that portion of equity earnings (profit after tax less preference dividends) which are ploughed back in the firm. Because retained earnings are the sacrifice made by equity shareholders, they are referred to as internal equity. Companies normally retain

30 percent to 80 percent of profit after tax for financing growth. If you look at a sample of corporate balance sheets you will find that reserves and surplus (other than share premium reserve and revaluation reserve), which essentially represent accumulated retained earnings, are an important source of long-term financing. Even this is an understatement of the contribution of retained earnings to long-term financing because a portion of reserves and surplus would have been capitalised by the firm if it had issued bonus shares.

Advantages and Disadvantages of Internal Accruals

Internal accruals are viewed very favourably by most corporate managements for the following reasons:

- Internal accruals are readily available. Management does not have to talk to outsiders (shareholders or lenders).
- Use of internal accruals, in contrast to external equity, eliminates issue costs and losses on account of underpricing.
- There is no dilution of control when a firm relies on internal accruals.
- The stock market generally views an equity issue with skepticism. Internal accruals, however, do not carry any negative connotation.

The disadvantages of internal accruals include the following:

- The amount that may be available by way of internal accruals may be limited.
- The opportunity cost of retained earnings is quite high as it is equal to the cost of equity—remember that retained earnings, in essence, represent dividends foregone by equity shareholders.
- The opportunity cost of depreciation generated funds is equal to the weighted average cost of capital of the firm.
- Many firms do not fully appreciate the opportunity costs of retained earnings and depreciation-generated funds. They tend to impute a low cost to internal accruals. Comforted by the easy availability of internal accruals and the notion that they have a low cost, managements may invest in sub-marginal projects that have a negative impact.

18.6 TERM LOANS

So far we looked at the sources of finance which fall under the broad category of equity finance (or shareholders' funds). Now we turn our attention to long-term debt. Firms obtain long-term debt mainly by raising term loans or issuing debentures.

Historically, term loans given by financial institutions and banks have been the primary source of long-term debt for private firms and most public firms. Term loans, also referred to as term finance, represent a source of debt finance which is generally repayable in less than 10 years. They are employed to finance acquisition of fixed assets and working capital

margin. Term loans differ from short-term bank loans which are employed to finance short-term working capital need and tend to be self-liquidating over a period of time, usually less than one year.[5]

Features of Term Loans

The following features of term loans may be discussed.

- Currency.
- Security.
- Interest payment and principal repayment.
- Restrictive covenants.

Currency Financial institutions give rupee term loans as well as foreign currency term loans. The most significant form of assistance provided by financial institutions, rupee term loans are given directly to industrial concerns for setting up new projects as well as for expansion, modernisation, and renovation projects. These funds are provided for incurring expenditure for land, building, plant and machinery, technical know-how, miscellaneous fixed assets, preliminary expenses, preoperative expenses, and margin money for working capital.

Financial institutions provide foreign currency term loans for meeting the foreign currency expenditure towards import of plant, machinery and equipment, and payment of foreign technical know-how fees. The periodical liability for interest and principal remains in the currency/currencies of the loan and is translated into rupees at the prevailing rate of exchange for making payments to the financial institutions.

Security Term loans typically represent secured borrowing. Usually assets, which are financed with the term loan, provide the prime security. Other assets of the firm may serve as collateral security.

All loans provided by financial institutions, along with interest, liquidated damages, commitment charges, expenses, etc., are secured by way of:

1. First equitable mortgage of all immovable properties of the borrower, both present and future; and
2. Hypothecation of all movable properties of the borrower, both present and future, subject to prior charges in favour of commercial banks for obtaining working capital advance in the normal course of business.

Interest Payment and Principal Repayment The interest and principal repayment on term loans are definite obligations that are payable irrespective of the financial situation of the firm. To the general category of borrowers, financial institutions charge an interest rate that is related to the credit risk of the proposal, subject usually to a certain floor rate.

5. In practice, of course, due to the phenomenon of "roll over", their effective maturity may be longer.

Financial institutions impose a penalty for defaults. In case of default of payment of interest, the borrower is liable to pay further interest on interest (compound interest) at the document rate. For default in repayment of instalments of principal, the borrower is liable to pay by way of liquidated damages, additional interest at the rate of 2 per- cent per annum for the period of default on the amount of principal in default. In addition to interest, lending institutions levy an upfront fee on the sanctioned loan amount usually at the rate of one percent.

The principal amount of a term loan is generally repayable over a period of 4 to 7 years after an initial grace period of 1 to 2 years. Typically, term loans provided by financial institutions are repayable in equal semi-annual instalments or equal quarterly instalments.

Note that the interest burden declines over time, whereas the principal repayment remains constant. This means that the total debt servicing burden (consisting of interest payment and principal repayment) declines over time. This pattern of debt servicing burden, typical in India, differs from the pattern obtaining in western economies where debt is typically amortised in equal periodic instalments.

The latter pattern is relatively more acceptable to borrowers because it does not result in a heavy debt servicing burden in earlier years. However, presently, financial institutions in India do not follow the scheme of equal periodic amortisation. Yet they try to ensure, by suitably modifying the debt repayment schedule, within limits, that the debt servicing burden is not very onerous.

Restrictive Covenants In order to protect their interest, financial institutions impose restrictive conditions on the borrowers. While the specific set of restrictive covenants depends on the nature of the project and the financial situation of the borrower, loan contracts often require that the borrowing firm:

- Broad-base its board of directors and finalise its management set-up in consultation with and to the satisfaction of the financial institutions;
- Make arrangements to bring additional funds in the form of unsecured loans/ deposits for meeting overruns/shortfalls;
- Refrain from undertaking any new project and/or expansion or make any investment without the prior approval of the financial institutions;
- Obtain clearances and licences from various government agencies;
- Repay existing loans with the concurrence of the financial institutions;
- Refrain from additional borrowings or seek the consent of the financial institutions for additional borrowings.

Further, loan agreements impose restrictions on the transfer of shareholdings by promoters/associates.

Term Loan Procedure

The procedure associated with a term loan involves the following steps:

Submission of Loan Application The borrower submits an application form which seeks comprehensive information about the project. The application form covers the following aspects:

- Promoters' background.
- Particulars of the industrial concern.
- Particulars of the project (capacity, process, technical arrangements, management, location, land and buildings, plant and machinery, raw materials, effluents, labour, housing, and schedule of implementation).
- Cost of the project.
- Means of financing.
- Marketing and selling arrangements.
- Profitability and cash flow.
- Economic considerations.
- Government consent .

Initial Processing of Loan Application When the application is received, an officer of the financial institution reviews it to ascertain whether it is complete for processing. If it is incomplete, the borrower is asked to provide the required additional information. When the application is considered complete, the financial institution prepares a 'flash report' which is essentially a summarisation of the loan application. On the basis of the 'Flash Report', it is decided whether the project justifies a detailed appraisal or not.

Appraisal of the Proposed Project The detailed appraisal of the project covers the marketing, technical, financial, managerial, and economic aspects. The appraisal memorandum is normally prepared within two months after site inspection. Based on that a decision is taken whether the project will be accepted or not.

Issue of the Letter of Sanction If the project is accepted, a financial letter of sanction is issued to the borrower. This communicates to the borrower the assistance sanctioned and the terms and conditions relating thereto.

Acceptance of the Terms and Conditions by the Borrowing Unit On receiving the letter of sanction from the financial institution, the borrowing unit convenes its board meeting at which the terms and conditions associated with the letter of sanction are accepted and an appropriate resolution is passed to that effect. The acceptance of the terms and conditions has to be conveyed to the financial institution within a stipulated period.

Execution of Loan Agreement The financial institution, after receiving the letter of acceptance from the borrower, sends the draft of the agreement to the borrower to be executed by authorised persons and properly stamped as per the Indian Stamp Act, 1899. The agreement, properly executed and stamped, along with other documents as required by the financial institution must be returned to it. Once the financial institution also signs the agreement, it becomes effective.

Creation of Security The term loans (both rupee and foreign currency) and the deferred payment guarantee assistance provided by the financial institutions are secured through

the first mortgage, by way of deposit of title deeds, of immovable properties and hypothecation of movable properties. As the creation of mortgage, particularly in the case of land, tends to be a time consuming process, the institutions permit interim disbursements.[6] The mortgage, however, has to be created within a year from the date of the first disbursement. Otherwise the borrower has to pay an additional charge of 1 percent interest.

Disbursement of Loans Periodically, the borrower is required to submit information on the physical progress of the projects, financial status of the project, arrangements made for financing the project, contribution made by the promoters, projected funds flow statement, compliance with various statutory requirements, and fulfillment of the pre-disbursement conditions. Based on the information provided by the borrower, the financial institution will determine the amount of term loan to be disbursed from time to time. Before the entire term loan is disbursed, the borrower must fully comply with all terms and conditions of the loan agreement.

Monitoring Monitoring of the project is done at the implementation stage as well as at the operational stage. During the implementation stage, the project is monitored through: (i) regular reports, furnished by the promoters, which provide information about placement of orders, construction of buildings, procurement of plant, installation of plant and machinery, trial production, etc., (ii) periodic site visits, (iii) discussion with promoters, bankers, suppliers, creditors, and others connected with the project, (iv) progress reports submitted by the nominee directors, and (v) audited accounts of the company.

During the operational stage, the project is monitored with the help of (i) quarterly progress report on the project, (ii) site inspection, (iii) reports of nominee directors, and (iv) comparison of performance with promise.

The most important aspect of monitoring, of course, is the recovery of dues represented by interest and principal repayment.

Project Appraisal

Financial institutions appraise a project from the marketing, technical, financial, economic, and managerial angles. The principal issues considered and the criteria employed in such appraisal are discussed below.

Market Appraisal The importance of the potential market and the need to develop a suitable marketing strategy cannot be over-emphasised. Hence efforts are made to:

- Examine the reasonableness of the demand projections by utilising the findings of available surveys, industry association projections, Planning Commission projections, and independent market surveys (which may sometimes be commissioned).

6. The interim security, prior to the creation of the final security, usually comprises all the stipulated security, but the mortgage.

- Assess the adequacy of the marketing infrastructure in terms of promotional effort, distribution network, transport facilities, stock levels, etc.
- Judge the knowledge, experience, and competence of the key marketing personnel.

Technical Appraisal The technical review done by financial institutions focuses mainly on the following aspects:

- Product mix.
- Capacity.
- Process of manufacture.
- Engineering know-how and technical collaboration.
- Raw materials and consumables.
- Location and site.
- Building.
- Plant and equipment.
- Manpower requirements.
- Break-even point.

The technical review is done by qualified and experienced personnel available in the institutions and/or by outside experts (particularly where large and technologically sophisticated projects are involved).

Financial Appraisal The financial appraisal seeks to assess the following:

Reasonableness of the Estimate of Capital Cost While assessing the capital cost estimates, efforts are made to ensure that (a) padding or under-estimation of costs is avoided, (b) specification of machinery is proper, (c) proper quotations are obtained from potential suppliers, (d) contingencies are provided for, and (e) inflation factors are considered.

Reasonableness of the Estimate of Working Results The estimate of working results is sought to be based on (a) a realistic market demand forecast, (b) price computations for inputs and outputs that are based on current quotations and inflationary factors, (c) an approximate time schedule for capacity utilisation, and (d) cost projections that distinguish between fixed and variable costs.

Adequacy of Rate of Return The general norms for financial desirability are as follows:

- Internal rate of return : 3-5 per cent more than WACC and not less than 15 per cent
- Debt-service coverage ratio[7] : 1.5 to 2.0

7. The debt-service coverage ratio is defined as:

$$\frac{\text{Profit after tax} + \text{Depreciation} + \text{Interest on long-term loan}}{\text{Interest on long-term loan} + \text{Loan repayment instalment}}$$

In applying these norms, however, a certain degree of flexibility is shown on the basis of the nature of the project, the risks inherent in the project, and the status of the promoter.

Appropriateness of the Financing Pattern The institutions consider the following in assessing the financial pattern:

- A general debt-equity ratio norm of 1.5:1.
- A requirement that promoters should contribute a certain percentage of the project cost.
- Stock exchange listing requirements.
- The means of the promoter and his capacity to contribute a reasonable share of the project finance.

Economic Appraisal The economic appraisal looks at the project from the larger social point of view. The methodology adopted by financial institutions for the purpose of economic evaluation (also referred to as social cost benefit analysis) is labelled as 'Partial Little Mirrlees' approach. In addition to the calculation of the economic rate of return as per this approach, they also look at two other economic indicators: (i) effective rate of protection, and (ii) domestic resource cost. Admittedly, the economic review done by financial institutions is not very rigorous and sophisticated. Also, the emphasis placed on this review has diminished. Now it is hardly done.

Managerial Appraisal In order to judge the managerial capability of the promoters, the following questions are raised:

- How resourceful are the promoters?
- How sound is the promoters' understanding of the project?
- How committed are the promoters?

Resourcefulness This is judged in terms of the prior experience of the promoters, the progress achieved in organising various aspects of the project, the skill with which the project is presented, and the ability to raise committed capital and unforeseen shortfall in financing.

Understanding This is assessed in terms of the credibility of the project plan (including, *inter alia*, the organisation structure, the staffing plan, the estimated costs, the financing pattern, the assessment of various inputs, and the marketing programme) and the details furnished to the financial institutions.

Commitment This is gauged by the resources (financial, managerial, material, and other) applied to the project and the zeal with which the objectives of the project, short-term as well as long-term, are pursued. Managerial review also involves an assessment of the calibre of the key technical and managerial personnel working on the projects, the schedule for training them, and the remuneration structure for rewarding and motivating them.

18.7 DEBENTURES

For large publicly traded firms, debentures are a viable alternative to term loans. Akin to promissory notes, debentures are instruments for raising debt finance. Debenture holders are the creditors of a company. The obligation of a company towards its debenture holders is similar to that of a borrower who promises to pay interest and principal at specified times. Debentures often provide more flexibility than term loans as they offer greater choice with respect to maturity, interest rate, security, repayment, and special features.

Features

The important features of debentures are as follows:

- When a debenture issue is sold to the investing public, a trustee is appointed through a trust deed. The trustee, usually a bank or financial institution or insurance company, is supposed to ensure that the borrowing firm fulfills its contractual obligations.
- Debenture issues in India are typically secured by mortgages/charges on the immovable properties of the company and a floating charge on its other assets (subject to prior charges created in favour of the company's bankers over the current assets). However, the order of priority of mortgages/charges may vary across different debenture issues. Occasionally, companies issue unsecured debentures. These are debentures that are not backed by specific assets of the firm, but by its general credit.
- Corporate debt may be short-term, medium-term or long-term. Short-term corporate debt of less than one year is called commercial paper. Medium-term debentures may have a maturity of 1 year to 5 years. Long-term debentures typically have a maturity period of 5 to 12 years.
- Publicly issued debentures that have a maturity period of 18 months or more have to be compulsorily credit rated.
- Debentures are typically redeemable in nature. For all debenture issues with a maturity period of more than 18 months, a Debenture Redemption Reserve (DRR) has to be created. The company should create a DRR equivalent to at least 50 percent of the amount of issue before redemption commences.
- Debentures may carry a fixed rate of interest or floating rate of interest or zero rate of interest.
- Debentures may carry a 'call' feature which provides the issuing company the option to redeem the debentures at a certain price before the maturity period. Sometimes debentures may have a 'put' feature which gives the holder the right to seek redemption at specified times at predetermined prices.

Innovations in Debentures

Thanks to the latitude enjoyed by companies from the early 1990s, a variety of debt instruments have been employed. Here is a sampling:

Deep Discount Bonds A deep discount bond does not carry any coupon rate but is issued at a steep discount over its face value. It is also referred to as a 'zero interest (coupon) bond' or just a zero. For example in 1992, the Small Industries Development Bank of India (SIDBI) issued deep discount bonds. Each bond having a face value of Rs 100,000 was issued at a deep discounted price of Rs 2500 with a maturity period of 25 years from the date of allotment (i.e. February 1, 1993). The investor as well as SIDBI have the option to withdraw or redeem the bond respectively at the end of 5, 9, 12, 15, or 20 years from the date of allotment at the deemed value of Rs 5300, Rs 9600, Rs 15,300, Rs 25,000, and Rs 50,000 respectively.

Deep discount bonds appeal to issuers interested in conserving their cash flows during the life of the bonds. On the other side of the market, they appear attractive to investors who want to protect themselves against the reinvestment rate risk. Remember that the imputed interest on a deep discount bond is automatically reinvested at a rate equal to its yield to maturity.

Convertible Debentures A convertible debenture, as the name suggests, is a debenture that is convertible, partially or wholly, into equity shares. As per SEBI guidelines the provisions applicable to fully convertible debentures (FCDs) and partially convertible debentures (PCDs) are as follows:

- The conversion premium and the conversion timing shall be predetermined and stated in the prospectus.
- Any conversions, partial or full, will be optional at the hands of the debenture holder, if the conversion takes place at or after 18 months but before 36 months from the date of allotment.
- A conversion period of more than 36 months will not be permitted unless conversion is made optional with "put" and "call" options.
- Compulsory credit rating will be required if the conversion period for fully convertible debentures exceeds 18 months.

Convertible debentures are commonly used all over the world and are gaining currency in India as well. Why are they popular? The conventional explanations for their popularity are: (a) Convertible debentures are a cheaper source of finance because interest rate on them is typically lower than that on straight debentures. (b) Convertible debentures enable a company to effectively issue equity shares at a premium because the conversion price associated with a convertible debenture is typically higher than the price at which equity shares can be issued currently.

The conventional explanations have a "free lunch" flavour. So you should be suspicious of them.

Modern finance theory offers better explanations: (a) Convertible debentures improve cash flow matching. Firms prefer financing instruments that can be comfortably serviced. A growing but risky firm may find convertible debentures appealing because of a lower initial burden, though they may entail expensive dilution later; (b) Convertible debentures

generate financial synergy. They make sense when it is very costly or difficult to assess the risk characteristics of the issuing firm. Remember that these instruments have two components, the straight debenture component and the call option component. If the company turns out to be risky, the debenture instrument will have a low value but the call option component will have a high value. On the other hand, if the company turns out to be relatively risk-free, the debenture component will have a high value but the call option component a low value. Given this compensating behaviour of the two components, the required yield on the convertible debenture will not be very sensitive to default risk.

Floating Rate Bonds Conventional bonds carry a fixed rate of interest. Floating rate bonds, on the other hand, earn an interest rate that is linked to a benchmark rate such as the Treasury bill interest rate. For example, in 1993 the State Bank of India came out with the first ever issue of floating interest rate bonds in India. It issued 5 million (Rs 1000 face value) unsecured, redeemable, subordinated floating interest rate bonds in the nature of promissory notes carrying interest at 3 percent per annum over the bank's maximum term deposit rate.

Floating rate bonds have been essentially a response to inflation risk. They make sense to a borrower whose assets earn returns that fluctuate with interest rates. Financial institutions and banks which give variable rate interest loans find such bonds appealing. Who is interested in buying floating rate bonds? Investors concerned about the stability of their principal find floating rate bonds attractive. The prices of these bonds tend to be fairly stable and close to par value as compared to fixed interest bonds.

Secured Premium Notes In 1992, the Tata Iron and Steel Company Limited issued Secured Premium Notes (SPNs) of Rs 300 each. The principal amount of the SPN is to be repaid in four equal annual instalments of Rs 75 each from the end of the 4th year to the end of the 7th year, together with an equivalent additional amount of Rs 75 with each instalment. No interest or repayment of principal will become due or accrue on the SPN during the first three years after allotment. The additional amount as mentioned above will represent interest and/or premium on redemption, in such forms as may be in the interest of the SPN holders according to the then prevailing regulations. The company will offer, before the end of the third year, specific options (e.g. full interest or premium or combination thereof) to the SPN holders, which would have to be exercised at the end of the third year. Each SPN will have a detachable warrant against which the holder can get one equity share for Rs 80.

Structured Notes A debt obligation which is derived from another debt obligation is called a structured note. Perhaps the first structured notes were created in the early 1980s when investment bankers in the US bought large blocks of 30-year noncancellable Treasury bonds and stripped them to create a series of zero coupons (zeroes). The shortest zero was backed by the first interest payment on the T-bond issue, the second shortest zero was backed by the next interest payment, so on and so forth.

Another important type of structured notes are securitised debt instruments. These are securities backed by a designated pool of assets (mortgage loans, consumer loans, hire purchase receivables, and so on). There are two major types of securitised debt instruments: Pass Through Certificates (PTCs) and Collateralised Mortgage Obligations (CMOs). PTCs represent an undivided interest in a portfolio of assets whereas CMOs are prioritised in terms of their right to interest as well as principal repayment.

Indexed Bonds The payoff of a typical indexed bond consists of two parts. The first part represents a fixed amount and the second part represents a variable component whose value is dependent on some index. For example, ICICI issued Indexed Bonds in 1997 for Rs 6000 each. It is a composite instrument comprising two parts: a discount bond and a detachable index warrant. The face value of the discount bond is Rs 22,000 and its redemption date is May 27, 2009. The detachable warrant has a payoff that is linked to the BSE Sensex as follows: 2000 × BSE Sensex 2009/BSE Sensex 1997.

An indexed bond appeals to investors who are looking for an assured return along with capital appreciation that is linked to some index.

Private Placement of Debentures

Private placement of debentures, particularly by listed companies, has become very popular in India in recent years. The principal buyers of privately placed debentures are mutual funds, financial institutions, insurance companies, Army Group Insurance, Navy Group Insurance, Air Force Group Insurance, and so on.

The phenomenal growth of private placement of debt may be attributed to the following reasons:

Accessibility Almost every company, irrespective of whether it is a public limited company or a private limited company, or whether it is a listed company or an unlisted company, can access the private placement market. Further the private placement market can accommodate issues of smaller size whereas the public issues market does not permit an issue below a certain minimum size.

Informed observers of the private placement market for debt feel concerned about its unregulated character. They feel that institutional investors have taken a very liberal approach to lending as they do not often insist on credit rating or robust loan contracts.

Flexibility In a private placement, there is greater flexibility in working out the terms of the issue. For example, when a non-convertible debenture issue is privately placed, a discount may be given to institutional investors to make the issue attractive. The absence of such freedom in a public issue combined with interest rate ceilings (which applied till recently) appears to be the primary reason for the phenomenal growth of private placement of non-convertible debentures in India. In addition to greater flexibility at the time

of structuring the issue initially, there may be more latitude to re-negotiate the terms of the issue subsequently and even roll-over the debt. This is because the issuer has to deal with one or few institutional investors in the private placement market.

Speed The time required for completing a public issue cycle is usually 3 months or more because of several formalities that have to be gone through. On the other hand, a private placement requires lesser time, perhaps a month or two, as the elaborate procedure followed in a public issue is largely bypassed. Of course, it also means fewer hassles.

Lower Issue Costs A public issue entails several statutory and non-statutory expenses associated with underwriting, brokerage, printing, mailing, announcements, promotion, and so on. These costs can be quite high. As against this, the issue cost for a private placement is substantially less.

Given the above advantages of private placement, companies are likely to prefer private placement wherever feasible. Of course, if an issue is large in size it will have to be made in the public issues market. This is because institutional investors would like to limit their exposure of individual companies.

Institutional investors, before participating in a private placement, look into a number of factors like the net worth of the company, the interest cover, the level of profit before tax, the asset cover, the debt equity ratio, the dividend record, the percentage of unsecured deposits/borrowings, the price history of the company's stock, and the existence of carried forward loss.

Some of the important conditions that a company should ordinarily satisfy in order to be acceptable to institutional investors are:[8]

- The net worth of the company should be at least Rs 1 crore.
- The interest cover should be at least two times, as per the latest balance sheet. If not, the average interest cover for the preceding three years should at least be two times.
- The asset cover should be at least 1.25.
- The company must have paid dividend for at least two years in the preceding three years.
- In the case of a listed company, the stock price should be above par for six months prior to the issue.

Advantages and Disadvantages of Debt Financing

Term loans and debentures are two important ways of raising long-term debt. The advantages of debt financing are as follows:

- Interest on debt is a tax-deductible expense, whereas equity and preference dividend are paid out of profit after tax.

8. Note that these norms are not statutorily stipulated.

- Debt financing does not result in dilution of control because debt holders (term lending institutions and debenture-holders) are not entitled to vote.
- Debt holders do not partake in the value created by the company as payments to them are limited to interest and principal.
- If there is a precipitous decline in the value of the firm, shareholders have the option of defaulting on debt obligations and turning over the firm to debt holders.
- Issue costs of debt are significantly lower than those on equity and preference capital.
- The burden of servicing debt is generally fixed in nominal terms. Hence debt provides protection against high unanticipated inflation.

Debt financing is not an unmixed blessing. It has serious disadvantages associated with it:

- Debt financing entails fixed interest and principal repayment obligation. Failure to meet these commitments can cause a great deal of financial embarrassment and even lead to bankruptcy.
- Debt financing increases financial leverage which, according to CAPM, raises the cost of equity to the firm.
- Debt contracts impose restrictions that limit the borrowing firm's financial and operating flexibility. These restrictions may impair the borrowing firm's ability to resort to value-maximising behaviour.
- If the rate of inflation turns out to be unexpectedly low, the real cost of debt will be greater than expected.

18.8 WORKING CAPITAL ADVANCE

Working capital advance by commercial banks represents the most important source for financing current assets.

Forms of Bank Finance

Working capital advance is provided by commercial banks in three primary ways: (i) cash credits/overdrafts, (ii) loans, and (iii) purchase/discount of bills. In addition to these direct forms, commercial banks help their customers in obtaining credit from other sources through the letter of credit arrangement.

Cash Credits/Overdrafts Under a cash credit or overdraft arrangement, a pre-determined limit for borrowing is specified by the bank. The borrower can draw as often as required provided the outstanding does not exceed the cash credit/overdraft limit. The borrower also enjoys the facility for repaying the amount, partially or fully, as and when he desires. Interest is charged only on the running balance, not on the limit sanctioned. A minimum charge may be payable irrespective of the level of borrowing, for availing of this facility.

This form of advance is highly attractive from the borrower's point of view because while the borrower has the freedom of drawing the amount in instalments as and when required, interest is payable only on the amount actually outstanding.

Loans These are advances of fixed amounts to the borrower. The borrower is charged with interest on the entire loan amount, irrespective of how much he draws. In this respect, this system differs markedly from the overdraft or cash credit arrangement wherein interest is payable only on the amount actually utilised. Loans are payable either on demand or in periodical instalments. When payable on demand, loans are supported by a demand promissory note executed by the borrower. There is often a possibility of renewing the loan.

Purchase/Discount of Bills A bill arises out of a trade transaction. The seller of goods draws the bill on the purchaser. The bill may be either clean or documentary (a documentary bill is supported by a document of title to goods like a railway receipt or a bill of lading) and may be payable on demand or after a usance period which does not exceed 90 days. On acceptance of the bill by the purchaser, the seller offers it to the bank for discount/purchase. When the bank discounts/purchases the bill, it releases the funds to the seller. The bank presents the bill to the purchaser (the acceptor of the bill) on the due date and gets its payment.

Letter of Credit A letter of credit is an arrangement whereby a bank helps its customer to obtain credit from its (customer's) suppliers. When a bank opens a letter of credit in favour of its customer for some specific purchases, the bank undertakes the responsibility to honour the obligation of its customer, should the customer fail to do so.

Application and Processing

A customer seeking an advance is required to submit an appropriate application form—there are different types of application forms for different categories of advances. The information furnished in the application covers, *inter alia*, the following: the name and address of the borrower and his establishment; the details of the borrower's business; the nature and amount of security offered. The application form has to be supported by various ancillary statements like the financial statements and financial projections of the firm.

The application is processed by the branch manager or his field staff. This primarily involves an examination of the following factors: (i) ability, integrity, and experience of the borrower in the particular business, (ii) general prospects of the borrower's business, (iii) purpose of advance, (iv) requirement of the borrower and its reasonableness, (v) adequacy of the margin, (vi) provision of security, and (vii) period of repayment.

Sanction, and Terms and Conditions

Once the application is duly processed, it is put up for sanction to the appropriate authority. The sanctioning powers of various officials—like Branch Manager, Regional Manager, General Manager, etc.—are defined by virtue of the position they occupy.

If the sanction is given by the appropriate authority, along with the sanction of advance, the bank specifies the terms and conditions applicable to the advance. These usually cover the following: (i) the amount of loan or the maximum limit of the advance, (ii) the nature of the advance, (iii) the period for which the advance will be valid, (iv) the rate of interest applicable to the advance, (v) the primary security to be charged, (vi) the insurance of the security, (vii) the details of the collateral security, if any, to be provided, (viii) the margin to be maintained, and (ix) other restrictions or obligations on the part of the borrower. It is a common banking practice to incorporate important terms and conditions on a stamped security document to be executed by the borrower. This helps the bank to create the required charge on the security offered and also obligates the borrower to observe the stipulated terms and conditions.

Security

For working capital advances, commercial banks seek security either in the form of hypothecation or in the form of pledge.

Hypothecation Under this arrangement, the owner of the goods borrows money against the security of movable property, usually inventories. The owner does not part with the possession of property. The rights of the lender (hypothecatee) depend upon the arrangement between the lender and the borrower. Should the borrower default in paying his dues, the lender (hypothecatee) can file a suit to realise his dues by selling the goods hypothecated.

Pledge In a pledge arrangement, the owner of the goods (pledgor) deposits the goods with the lender (pledgee) as security for the borrowing. Transfer of possession of goods is a precondition for pledge. The lender (pledgee) is expected to take reasonable care of goods pledged with him. The pledge contract gives the lender (pledgee) the right to sell goods and recover dues, should the borrower (pledgor) default in paying debt.

Margin Amount

Banks do not provide hundred percent finance. They insist that the customer should bring a portion of the required finance from other sources. This portion is known as the margin amount. The margin amount tends to vary from asset to asset.

18.9 MISCELLANEOUS SOURCES

Apart from the above-mentioned sources of finance there are several other ways in which finance may be obtained. These include:

- Deferred credit.
- Lease and hire purchase finance.
- Unsecured loans and deposits.
- Special schemes of institutions.
- Subsidies and sales tax deferments and exemptions.
- Short-term loans from financial institutions.
- Commercial paper.
- Factoring.

Deferred Credit

Many a time the suppliers of machinery provide deferred credit facility under which payment for the purchase of machinery is made over a period of time. The interest rate on deferred credit and the period of payment vary rather widely. Normally, the supplier of machinery when he offers deferred credit facility insists that a bank guarantee should be furnished by the buyer.

Lease Finance and Hire Purchase

Leasing and hire purchase are currently a supplementary form of debt finance.

Lease Finance A lease represents a contractual arrangement whereby the lessor grants the lessee the right to use an asset in return for periodic lease rental payments. While leasing of land, buildings, and animals has been known from times immemorial, the leasing of industrial equipments is a relatively recent phenomenon, particularly on the Indian scene.

There are two broad types of lease: finance lease and operating lease. A *finance lease* or capital lease is essentially a form of borrowing. Its salient features are:

- It is an intermediate term to a long-term non-cancellable arrangement. During the initial lease period, referred to as the 'primary lease period', which is usually 3 years or 5 years or 8 years, the lease cannot be cancelled.
- The lease is more or less fully amortised during the primary lease period. This means that during this period, the lessor recovers, through the lease rentals, his investment in the equipment along with an acceptable rate of return. Thus, a finance lease transfers substantially all the risks and rewards incident to ownership to the lessee.
- The lessee is responsible for maintenance, insurance, and taxes.
- The lessee usually enjoys the option for renewing the lease for further periods at substantially reduced lease rentals.

An *operating lease* can be defined as any lease other than a finance lease. The salient features of an operating lease are:

- The lease term is significantly less than the economic life of the equipment.
- The lessee enjoys the right to terminate the lease at a short notice without any significant penalty.
- The lessor usually provides the operating know-how and the related services and undertakes the responsibility of insuring and maintaining the equipment. Such an operating lease is called a 'wet lease'. An operating lease where the lessee bears the costs of insuring and maintaining the leased equipment is called a 'dry lease'.

From the above features of an operating lease it is evident that this form of a lease does not result in a substantial transfer of the risks and rewards of ownership from the lessor to the lessee. The lessor structuring an operating lease transaction has to depend upon multiple leases or on the realisation of a substantial resale value (on expiry of the first lease) to recover the investment cost plus a reasonable rate of return thereon. Therefore, specialising in operating lease calls for an in-depth knowledge of the equipments and the secondary (resale) market for such equipments. Of course, the prerequisite is the existence of a resale market. Given the fact that the resale market for most of the used capital equipments in our country lacks breadth, operating leases are not in popular use. In the recent years there have been attempts to structure car lease and computer lease transactions in the operating lease format.

At present, the following are the key characteristics of lease finance in India:

- Most leases in India are finance leases not operating leases.
- Lease finance is available for identifiable performing assets.
- Lease finance is available in small volume.
- There is a great deal of flexibility in structuring lease finance.
- Lease of immovable assets is not possible by banks.
- Lease tenors up to 8 years are available.

Hire–Purchase Finance companies usually offer the facility of leasing as well as hire–purchase to its clients. What are the features of a hire–purchase arrangement? How are hire–purchase instalments split between interest and principal payments? How should the potential user of an asset choose between leasing and hire–purchase?

The main features of a hire–purchase arrangement are as follows:

- The hiree (the counterpart of lessor) purchases the asset and gives it on hire to the hirer (the counterpart of lessee).
- The hirer pays regular hire–purchase instalments over a specified period of time. These instalments cover interest as well as principal repayment. When the hirer pays the last instalment, the title of the asset is transferred from the hiree to the hirer.
- The hiree charges interest on a flat basis. This means that a certain rate of interest, usually around 8 percent, is charged on the initial investment (made by the hiree) and not on the diminishing balance.

- The total interest collected by the hiree is allocated over various years. For this purpose, the 'sum of the years digits' method is commonly employed.

The following differences between leasing and hire–purchase, from the point of view of the lessee (hirer), may be noted:

Leasing	*Hire–Purchase*
• The lessee cannot claim depreciation	• The hirer is entitled to claim depreciation.
• The entire lease rental is a tax-deductible expense for the lessee.	• Only the interest component of the hire–purchase instalment is a tax-deductible expense for the hirer.
• The lessee, not being the owner of the asset, does not enjoy the salvage value of the asset.	• The hirer, being the owner of the asset, enjoys the salvage value of the asset.

Unsecured Loans and Deposits

Unsecured loans are typically provided by the promoters to fill the gap between the promoters' contribution required by financial institutions and the equity capital subscribed to by the promoters. These loans are subsidiary to the institutional loans. The rate of interest chargeable on these loans is less than the rate of interest on the institutional loans. Finally these loans cannot be taken back without the prior approval of the financial institutions.

Deposits from the public, referred to as public deposits, represent unsecured borrowing of one to three years (five years in the case of non-banking finance companies) duration. Many existing companies prefer to raise public deposits instead of term loans from financial institutions because restrictive covenants do not accompany public deposits. However, it may not be possible for a new company to raise public deposits. Further, it may be difficult for it to repay public deposits within three years.

Special Schemes of Institutions

Financial institutions have designed special schemes to serve the varied needs of industry. The important ones are:

Bill Rediscounting Scheme Operated by the IDBI, the bill rediscounting scheme is meant to promote the sale of indigenous machinery on deferred payment basis. Under this scheme, the seller realises the sale proceeds by discounting the bills or promissory notes accepted by the buyer with a commercial bank which in turn rediscounts them with the IDBI. This scheme is meant primarily for balancing equipment and machinery required for expansion, modernisation, and replacement schemes.

Suppliers' Line of Credit Administered by the ICICI, the Suppliers' Line of Credit is somewhat similar to the IDBI's Bill Rediscounting Scheme. Under this arrangement, ICICI

directly pays to the machinery manufacturer against usance bills duly accepted or guaranteed by the bank of the purchaser.

Subsidies and Sales Tax Deferments and Exemptions

Governments and development agencies may provide subsidies for certain kinds of projects. Of late, however, these have decreased in importance. Previously, the central government as well as the state governments provided subsidies to industrial units located in backward areas. The central subsidy has been discontinued but the state subsidies continue. The state subsidies vary between 5 percent to 25 percent of the fixed capital investment in the project, subject to a ceiling varying between Rs 0.5 million and Rs 2.5 million depending on the location.

To attract industries, the states provide incentives, *inter alia*, in the form of sales tax deferments and sales tax exemptions.

Under the sales tax deferment scheme, the payment of sales tax on the sale of finished goods may be deferred for a period ranging between five to twelve years. Essentially it implies that the project gets an interest-free loan, represented by the quantum of sales tax deferred, during the deferment period.

Under the sales tax exemption scheme, some states exempt the payment of sales tax applicable on purchases of raw materials, consumables, packing, and processing materials from within the state which are used for manufacturing purposes. The period of exemption ranges from three to nine years depending upon the state and the specific location of the project within the state.

Short-term Loans from Financial Institutions

Financial institutions provide short-term loans to companies with a good track record. To be eligible for such a loan, a company must satisfy certain conditions relating to dividend track record, debt-equity ratio, current ratio, and interest coverage ratio.

Short-term loans provided by financial institutions have the following features:

- They are totally unsecured and are given on the strength of a demand promissory note.
- The loan is given for a period of one year and can be renewed for two consecutive years, provided the original eligibility criteria are satisfied.

Commercial Paper

A commercial paper represents short-term unsecured promissory notes issued by firms which enjoy a fairly high credit rating. Generally, large firms with considerable financial strength are able to issue a commercial paper. The important features of a commercial paper are as follows:

- The maturity period of a commercial paper ranges from 90 to 180 days.
- Commercial paper is sold at a discount from its face value and redeemed at its face value. Hence the implicit interest rate is a function of the size of the discount and the period of maturity.
- Commercial paper is directly placed with investors who intend holding it till its maturity. Hence there is no well developed secondary market for a commercial paper.

Factoring

A factor is a financial institution which offers services relating to management and financing of debts arising from credit sales. While factoring is well-established in Western countries, only two factors, the SBI Factoring and Commercial Services Limited and Canbank Factoring Limited, which have been mandated by the Reserve Bank of India to operate in the western region and the southern region respectively, have made some tangible progress. The Punjab National Bank and the Bank of Allahabad are expected to set up factoring agencies to serve the northern region and the eastern region, respectively.

Features of a Factoring Arrangement The key features of a factoring arrangement are as follows:

- The factor selects the accounts of the client that would be handled by it and establishes, along with the client, the credit limits applicable to the selected accounts.
- The factor assumes responsibility for collecting the debt of accounts handled by it. For each account, the factor pays to the client at the end of the credit period or when the account is collected, whichever comes earlier.
- The factor advances money to the client against not-yet-collected and not-yet-due debts. Typically, the amount advanced is 70 to 80 percent of the face value of the debt and carries an interest rate which may be equal to or marginally higher than the lending rate of commercial banks.
- Factoring may be on a recourse basis (this means that the credit risk is borne by the client) or on a non-recourse basis (this means that the credit risk is borne by the factor). Presently, factoring in India is done on a recourse basis.
- Besides the interest on advances against debt, the factor charges a commission which may be 1 to 2 percent of the face value of the debt factored.

18.10 RAISING VENTURE CAPITAL

A young company that is not yet ready or willing to tap the public financial market may seek venture capital. Such capital is provided by venture capital funds which are prepared to finance an untried company that appears to have promising prospects. Venture capital represents financial investment in a risky proposition made in the hope of earning a high rate of return.

Preparing a Business Plan

If you are approaching a venture capitalist to finance your project, how should you prepare your business plan? Here are some guidelines:

- Use simple and clear language. Avoid bombastic presentation and technical language.
- Focus on four basic elements, viz., people, product, market, and competition.
- Give projections for about two to five years with emphasis on cash flows.
- Identify risks and develop a strategy to cope with the same.
- Convince them that the management team is talented, experienced, committed, and determined.

18.11 RAISING CAPITAL IN INTERNATIONAL MARKETS

Thanks to the globalisation of capital markets, Indian firms can raise capital from euromarkets or from the domestic markets of various countries or from export credit agencies.

Euromarkets

The term euromarkets seems to be a misnomer because they do not have a physical location. *Euromarkets* refer to a collection of international banks that help firms in raising capital in a global market which is beyond the purview of any national regulatory body.

An Indian firm can access the euromarkets to raise a eurocurrency loan or issue a eurobond or issue global depository receipts.

Eurocurrency Loans Subject to certain terms and conditions, the Government of India permits Indian firms to resort to external commercial borrowings for the import of plant and machinery. The most common instrument of external commercial borrowing is the *eurocurrency loan*.

A eurocurrency is simply a deposit of currency in a bank outside the country of the currency. For example, a eurodollar is a dollar deposit in a bank outside the US. Likewise, a euroyen is a yen deposited in a bank outside Japan. How do eurocurrency deposits arise? This may be explained with an example. Suppose an American oil company buys oil from a Sheikh in the Middle East and pays US $10 million drawn on the Chase Manhattan Bank and the Sheikh deposits the cheque in his account with a Swiss bank. The dollar deposit, placed outside the United States, the country of the dollar currency, is a eurodollar deposit. The Swiss bank can use this deposit for granting eurodollar loans.

The main features of eurocurrency loans, which represent the principal form of external commercial borrowings are:

- Eurocurrency loans are often syndicated loans, wherein a group of lenders, particularly banks, participate jointly in the process of lending under a single loan agreement. The syndicate of lenders is represented by the lead bank. The borrower is required to pay a syndication fee, which is a front-end payment usually ranging between ½ percent and 2 percent to the lead bank. This represents the management fees payable to the lead bank, participation fee to the other banks, and other charges.
- The rate of interest on eurocurrency loans is a floating rate. It is usually linked to LIBOR (London Inter Bank Offer Rate) or SIBOR (Singapore Inter Bank Offer Rate). The spread over the LIBOR or SIBOR rate is mainly a function of the creditworthiness of the borrower and size of the loan. Air India International, for example, obtained a eurodollar loan of US $88 million in 1982, at an interest rate of 3/8 percent above the LIBOR. While the rate is determined at the beginning of each interest period, the interest is payable at the end of each period.
- The interest period may be 3, 6, 9, or 12 months in duration. It is largely left to the option of the borrower.
- The borrower often enjoys the multi-currency option which enables it to denominate the interest and principal in the new currency opted for. This option is exercisable at the end of each interest period.
- The eurocurrency loans are repayable in a bullet payment or in instalments, which are typically equal, over a period of time as agreed to by the parties. The borrower may prepay the loan after giving due notice to the lead bank. When prepayment is done, some premium is payable. The lender may also reserve the right to recall the outstanding loan under certain circumstances.

Exhibit 18.5 shows the features of eurocurrency loans raised by the Power Finance Corporation.

Exhibit 18.5 ***Syndicated Eurocurrency Loans Raised by Power Finance Corporation***

	1st Issue (January 1997)	*2nd Issue (July 1998)*
• Amount initially targeted	US $50 million	US $100 million
• Amount actually collected	US $75 million	US $100 million
• Actual pricing	50 bp over LIBOR	115 bp* over LIBOR
• Maturity	Average 5 years	7 years put 5
• Repayment Terms	Repayment in 5 equal instalments after end of 4 years	Bullet
• Other Costs (approx.)	0.07 bps annualised	0.20 bps annualised
• Lenders meet / Roadshows	Hong Kong, Singapore	Bombay, Bahrain, London, Singapore
• Availability Period	60 days from date of signing	30 days from date of signing
• Number of participating banks	Fourteen	Fourteen
• Lead Manager	NatWest Markets	ANZ Investment Bank

* One basis point (bp) is one-hundreth of one percent.

Evaluation Overseas debt, particularly in the form of eurocurrency loans offers the following advantages:

- Participating institutions have deep pockets and a very professional approach.
- There is a great deal of flexibility in structuring these loans.
- Tenors up to 10 years are easily available.

The disadvantages of overseas debt are:

- It is not economical for small projects due to high appraisal and syndication costs.
- Pricing of loans depends on risk perception.
- It may be difficult to negotiate changes with investors.

Eurobonds Firms using the euromarkets for debt financing can take out loans (called eurocurrency loans) or sell bonds (referred to as eurobonds). The important features of a eurobond are:

- It is issued outside the country in whose currency it is denominated. For example, eurodollar bonds are sold outside the US and euroyen bonds are sold outside Japan.
- It is usually managed by a syndicate of investment banks and offered to investors in many countries.
- It is a bearer bond. This means that it is unregistered and payable to the person who carries it.
- The interest on it is usually paid annually or half-yearly.

While the eurocurrency loan is the most popular form of external commercial borrowing, some firms have raised money by issuing eurocurrency bonds (or eurocurrency notes). Power Finance Corporation, for example, raised overseas debt by issuing euronotes in 1997 that had the following features:

Power Finance Corporation Limited
Euro Notes Issue

• Amount	:	US $ 100 million
• Maturity Period	:	12 years bullet
• Interest rate	:	7.5% p.a. fixed (135 bp over US Treasury) payable half yearly
• Type of Instrument	:	Unsecured Global Bond Issue tradable in Stock Exchanges abroad
• Other Costs (approx.)	:	.02 bp annualised
• Lenders Meet/Roadshows	:	Hong Kong, USA, UK
• Availability Period	:	On signing
• Lead Manager	:	ING Barings
• Other Agents	:	Paying agent, listing agent, Trustee

Note that the lending rates in the eurodebt market tend to be lower than those in the domestic markets. Why? There are several reasons. First, on eurodeposits banks have no reserve requirements. Second, borrowers in eurocurrency market are typically large,

reputed companies with good credit ratings. Third, banks price these loans aggressively as there are no regulators.

Global Depository Receipts From the early 1990s, Indian companies have issued global depository receipts (GDRs), which represent indirect equity investment, in the euromarkets.

In the depository receipts mechanism, the shares issued by a firm are held by a depository, usually a large international bank, who receives dividends, reports, etc. and issues claims against these shares. These claims are called depository receipts–in euromarkets they are called GDRs–with each receipt being a claim on a specified number of shares. The underlying shares are called *depository shares*. The GDRs are denominated in a convertible currency—usually US dollars. GDRs may be listed and traded on major stock exchanges or may trade in the OTC market. The issuer firm pays dividends in its home currency which is converted into dollars by the depository and distributed to the holders of GDRs. This way the issuing firm avoids listing fees and onerous disclosure and reporting requirements which would be obligatory if it were to be directly listed on the stock exchange. Holders of GDR can convert them into the underlying share by surrendering the depository receipts to the depository.

A company planning a GDR issue must obtain the approval from the ministry of finance as well as the FIPB (Foreign Investment Promotion Board) since GDR issues are deemed to be a foreign direct investment. The government periodically issues guidelines for GDR issues. These guidelines set out the criteria a potential issuer must satisfy, the permissible uses of the funds raised, and the manner in which the funds are to be deployed till the issuing company is ready to use them. The custodian is required to be an Indian institution.

Foreign Domestic Markets

A second way to raise money internationally is to sell securities directly in the domestic capital markets of foreign countries. This is referred to as direct issuance. For example, a British firm may issue dollar-denominated equity stocks in the US capital market or a German firm may issue yen-denominated bonds in the Japanese capital market. A foreign issuer has to satisfy all regulations applicable to the domestic firms. In addition, it may be required to fulfil certain special obligations applicable to foreign issuers.

Indian firms can also issue bonds and equities in the domestic capital market of a foreign country. Reliance Industries Limited, for example, issued bonds in the US domestic capital market. Such bonds are referred to as Yankee bonds. (Incidentally, bonds issued in the UK domestic market are called Bulldog bonds and those issued in the Japanese domestic market are called Samurai bonds.) In recent years, Indian companies like Infosys Technologies and ICICI have successfully tapped the US equity market by issuing American Depository Shares (ADSs). Like GDRs, ADSs represent claims on a specific number of shares. The

principal difference between the two is that the GDRs are issued in the euromarket whereas ADSs are issued in the US domestic capital market.

Export Credit Schemes

Export credit agencies have been established by the governments of major industrialised countries for financing exports of capital goods and related technical services. The prominent export credit agencies are US EXIM, JEXIM, HERMES, and COFACE. These agencies follow certain consensus guidelines for supporting exports under a convention known as the Berne Union. As per these guidelines, the interest rate applicable for export credits to Indian companies for various maturities are regulated. Two kinds of export credit are provided: buyer's credit and supplier's credit.

Buyer's Credit Under this arrangement, credit is provided directly to the Indian buyer for purchase of capital goods and/or technical services from the overseas exporter. The buyer's credit facility operates as follows:

- The overseas exporter and the Indian buyer negotiate a contract.
- An application for the buyer's credit facility is made to the export credit agency of the exporter's country along with relevant details (like the types of goods/services to be exported, approximate value of the contract, terms of payments, schedule of projected shipment of goods or provision of services, percentage of financing required, etc.)
- The buyer's credit facility is approved by the export credit agency of the exporter's country.
- A loan agreement delineating the terms and conditions of the buyer's credit is negotiated between the overseas exporter's bank, the Indian borrower, and where applicable the Indian guarrantor.

Supplier's Credit This is a credit provided to the overseas exporters so that they can make available medium-term finance to Indian importers. The supplier's credit facility operates as follows:

- The overseas exporter notifies his bank and the export credit agency of a potential export order of an Indian buyer who requires medium-term finance.
- The export credit agency communicates to the bank its willingness to provide the facility.
- The terms of the facility are incorporated in the contract between the overseas exporter and the Indian buyer.

Salient Features The salient features of finance provided by export credit agencies are:

- The finance is tied to import of goods and services.
- Up to 85 percent of the value of imports is available as finance.
- The finance is available for long tenors at reasonable cost.
- Export credit agencies insist on a bank guarantee.

SUMMARY

- A capital project may be regarded as a mini-firm. So the issues to be considered in financing a project are identical to those considered in financing a business firm.
- The two broad sources of finance available to a firm are: shareholders' funds (equity funds) and loan funds (debt funds).
- The important considerations in determining the capital structure (the debt–equity ratio) of a firm are: earnings per share, risk, control, flexibility, and nature of assets.
- A firm should use more equity when the corporate tax rate is negligible, the business risk exposure is high, the dilution of control is not an important issue, the assets of the firm are mostly intangible in nature, and the firm has many valuable growth options. The firm should use more debt under opposite circumstances.
- Equity and debt come in a variety of forms and are raised in different ways.
- Equity capital represents ownership capital, as equity shareholders collectively own the firm. Equity shareholders enjoy the rewards as well as bear the risk of ownership.
- The rights of equity shareholders consist of: (i) the right to residual income, (ii) the right to control, (iii) the pre-emptive right to purchase additional equity shares issued by the firm, and (iv) the residual claim over assets in the event of liquidation.
- When a company is formed, it first issues equity shares to the promoters (founders) and also, in most cases, to a select group of investors. As the company grows, it may rely on the following methods of raising equity capital: initial public offering, seasoned offering, rights issue, private placement, and preferential allotment.
- The first public offering of equity shares of a company, which is followed by a listing of its shares on the market, is called an initial public offering (IPO). A public issue by a listed company is called a seasoned offering. A rights issue involves selling securities in the primary market by issuing rights to the existing shareholders. Private placement and preferential allotment involve sale of securities to a limited number of sophisticated investors such as financial institutions, mutual funds, venture capital funds, banks, and so on.
- Preference capital represents a hybrid form of financing—it partakes some characteristics of equity and some attributes of debentures.
- The internal accruals of a firm consist of depreciation charges and retained earnings.
- Term loans represent a source of debt finance which is generally repayable in less than 10 years. They are employed to finance acquisition of fixed assets and working capital margin.
- Financial institutions give rupee term loans as well as foreign currency term loans. Term loans represent secured borrowing. Usually assets, which are financed with the term loan, provide the prime security. Other assets of the firm may serve as collateral security. The principal amount of a term loan is generally repayable over a period of 4 to 7 years after an

initial grace period of 1 to 2 years. In order to protect their interest, financial institutions impose restrictive covenants on the borrowers.

- Financial institutions appraise a project from the marketing, technical, financial, economic, and managerial angles.
- For large firms debentures are a viable alternative to term loans. Debentures are instruments for raising debt finance. Debentures often provide more flexibility than term loans as they offer greater choice with respect to maturity, interest rate, security, repayment, and special features.
- Thanks to the latitude enjoyed by companies, a variety of debt instruments like deep discount bonds, convertible debentures, floating rate bonds, secured premium notes, and indexed bonds have been employed.
- Private placement of debentures has become very popular in India in recent years. The principal buyers of privately placed debentures are mutual funds, financial institutions, insurance companies, Army Group Insurance, Navy Group Insurance, Air Force Group Insurance, and so on.
- Working capital advance by commercial banks represents the most important source for financing current assets. Working capital advance is provided by commercial banks in three primary ways: (i) cash credits/overdrafts, (ii) loans, and (iii) purchase/discount of bills.
- Apart from the principal sources like equity, internal accruals, term loans, debentures, and working capital advance there are several other ways in which finance may be obtained. These include deferred credit, lease finance, hire purchase, unsecured loans and deposits, special schemes of institutions, subsidies, sales tax deferments and exemptions, commercial paper, and factoring.
- Many a time the suppliers of machinery offer *deferred credit facility* under which payment for the purchase of machinery is made over time. A lease represents a contractual arrangement whereby the lessor grants the lessee the right to use an asset in return for periodic lease rental payments. In a *hire–purchase* arrangement the hiree (the counterpart of the lessor) purchases the asset and gives it on hire to the hirer (the counterpart of lessee). The hirer pays regular hire–purchase instalments over a specified period of time. When the hirer pays the last instalment, the title of the asset is transferred from the hiree to the hirer. *Unsecured loans* are typically provided by the promoters. Deposits from the public, referred to as *public deposits* represent unsecured borrowing of one to three years (five years in the case of non-banking finance companies) duration. Financial institutions have designed *special schemes* like the *bill rediscounting* scheme of IDBI and the *supplier's line of credit* of ICICI to serve the varied needs of industry. Governments may grant *subsidies* for certain kinds of projects and provide *sales tax deferments and exemptions*. Financial institutions provide short-term loans to companies with a good track record. *Commercial paper* represents short-term unsecured promissory notes issued by firms which

enjoy a fairly high credit rating. A *factor* is a financial institution which offers services relating to management and financing of debts arising from credit sales.

- A young company that is not yet ready or willing to tap the public financial market may seek venture capital which represents financial investment in a risky proposition made in the hope of earning a high rate of return.
- Thanks to globalisation of capital markets, Indian firms can raise capital from euromarkets or from the domestic markets of various countries or from export credit agencies.
- Euromarkets refer to a collection of international banks that help firms in raising capital in a global market which is beyond the purview of any national regulatory body.
- An Indian firm can access the euromarkets to raise a eurocurrency loan or issue a eurobond.
- Eurocurrency loans, which represent the principal form of external commercial borrowings are syndicated loans carrying a floating rate generally linked to LIBOR.
- While the eurocurrency loan is the most popular form of external commercial borrowing, Indian firms also raise money by issuing eurocurrency bonds (or notes).
- From the early 1990s, Indian companies have issued global depository receipts (GDRs), which represent indirect equity investment, in the euromarkets. In a depository receipts mechanism, the shares issued by a firm are held by a depository, usually a large international bank, which issues claims against these shares. These claims are called depository receipts—in euromarkets they are called GDRs—with each receipt being a claim on a specified number of shares.
- Indian firms can also issue bonds and equities in the domestic capital market of a foreign country.
- Export credit agencies have been established by the governments of major industrialised countries for financing exports of capital goods and related services. Two kinds of export credit are provided: buyer's credit and supplier's credit. ■

Questions

1. **Discuss the key considerations in determining the debt–equity ratio of a firm.**
2. **When should a firm use more equity and when should a firm use more debt?**
3. **Discuss the rights of equity shareholders.**
4. **What are the pros and cons of going public?**
5. **List the principal steps involved in a public issue.**
6. **Describe briefly a rights issue, a private placement, and a preferential allotment.**
7. **How do the four methods of raising finance, viz., public issue, rights issue, private placement, and preferential allotment compare?**
8. **What are the advantages and disadvantages of equity capital?**
9. **What are the advantages and disadvantages of internal accruals?**

10. Discuss the key features of term loans.
11. Describe the procedure involved in obtaining a term loan.
12. Discuss the key issues considered by financial institutions while appraising a project for term financing.
13. What are the features of debentures?
14. Describe the important innovations in debenture.
15. Discuss the conventional and modern finance explanations for convertible debentures.
16. Why is private placement of debentures so common in India?
17. What are the advantages and disadvantages of debt financing?
18. Describe the various ways in which banks provide working capital advance.
19. What are the salient features of a finance lease and an operating lease?
20. Discuss the features of hire-purchase. How does it differ from leasing?
21. What are the features of a commercial paper and factoring?
22. Discuss briefly the state of venture capital in India.
23. What are the main features of eurocurrency loans and eurobonds?
24. What is a GDR?
25. Discuss how the export credit schemes operate.

CHAPTER

19

Financing Infrastructure Projects[1]

Infrastructure includes the capital required to produce economic services from utilities (like electricity, gas, telecommunications, and water) and transport works (roads, bridges, urban transit systems, seaports, and airports) and is central to promoting economic activity. Good infrastructure helps in providing economic services efficiently, promotes economic competitiveness, and supports high productivity. Poor infrastructure, on the other hand, impedes economic growth and can be seriously detrimental to the efficient use of scarce resources.

Infrastructure projects, which typically provide essential services, have one or more of the characteristics mentioned below:

- They are highly capital-intensive. For example, a 500 MW power plant may cost Rs 2000 million
- They involve huge sunk costs
- They have a long operating life

The vital role of infrastructure in the economy, the essential nature of its services, the size of individual projects, and its important social dimensions call for governmental role in planning, promoting, and regulating the sector. When projects are operational, the role of the government can be determined by the ownership and the operational structure of the concerned project.

Traditionally, infrastructure projects in India were owned and managed by the government or a government undertaking. Given the massive investments required in infrastructure, which plays a pivotal role in economic development, there is now a broad consensus that private sector participation in this activity must be encouraged.

1. This chapter has been contributed by Suman Saha, Vice-President, Kotak Mahindra Capital

Private initiative in infrastructure projects can take many forms, ranging from contracted operation of public utilities to full ownership, operation and maintenance of these facilities. Some of the principal objectives of promoting private investment in the development and operation of infrastructure projects are ensuring greater economic efficiency and better availability of the facility itself. Depending on their nature, however, infrastructure projects are either more or less suitable for private participation and the level of such participation can be varied to reflect the same. Projects that are designed to provide significant social benefits such as low cost urban transportation systems may be more suited to traditional government ownership, whereas projects that have strong commercial attraction, like telecommunication, are more suited for private sector involvement.

Infrastructure financing is different from conventional project financing, primarily because most infrastructure projects are in the nature of private-public partnerships, and evaluation of projects requires a careful understanding and analysis of the complexities inherently embedded in such partnerships. Especially in transitional economies which are attempting to emerge from a historical environment where infrastructure was traditionally planned, developed, financed, implemented, and operated by the government and the public sector to a newer environment where private initiative in infrastructure holds the key to its rapid growth, project financiers need to carefully evaluate if a framework (regulatory, legal and financing) to support such initiatives exist. A perfect example of a private-public partnership is a private electricity generation project which is developed, financed, constructed, operated, and maintained by the private sector but has to rely completely for "offtake of power" (i.e. sale of electrical energy) and therefore receipt of payments on the state owned electricity board ("State Electricity Board" or "SEB"). For a project financier, it is important to understand the risks associated with the project's construction and operations; it is several times more important to appreciate the environment in which the concerned SEB functions, and the impact that such an environment may have on its continued ability to make payments for the energy that it purchases from the project.

Ownership and operations of infrastructure projects are separable and a variety of models exist to meet characteristics of projects and regulations. A typical example is an electricity generation project which the private sector builds, owns, operates for a certain period of time (called the "Concession Period") and finally transfers back to the government (this concept is called BOOT) whereas, say for a road project, the private sector may be invited simply to build the facility, operate it during the Concession Period and finally, at the end of the Concession Period, transfer the facility back to the government (BOT) without actually ever owning the same. In the latter case, the ownership of the road remains with the government and the private sector recovers its investment and a return thereon by charging a levy on users of the road during the Concession Period.

This chapter discusses various aspects of infrastructure financing. It is divided into six sections as follows :

- Typical project configuration
- Key project parties
- Project contracts
- Financial structure and corporate governance
- Financing a power project
- Financing telecommunication projects

19.1 TYPICAL PROJECT CONFIGURATION

Given the complexity of risks that need to be managed during the construction and operations phase of an infrastructure project, project sponsors have tended to follow some simple arrangements while implementing these projects:

- Projects are typically implemented in a Special Purpose Vehicle ("SPV"), which is a distinct corporate entity incorporated with the objective of implementing and operating the project.
- Project sponsors take an equity stake in the SPV; depending on the project cost, sponsors' ability and objectives as well as project lenders' requirements, the minimum stake could be in the range of 15–30% of the project cost and is referred to as the "Sponsors' Contribution".
- The SPV would enter into contractual arrangements with project contractors, operators, government, and project lenders (together referred to as "Project Parties"). In non-recourse project financing, project lenders would not have any fall-back on the resources/assets of the sponsors if the SPV fails to meet debt servicing obligations; however, in the case of limited-recourse financing, under certain circumstances, project sponsors would have certain contractual obligations towards project lenders. In most cases of project financing, other project parties would have no recourse to the project sponsors.
- Infrastructure projects can be financed at a relatively higher gearing (i.e. debt–equity) ratio vis-à-vis conventional projects, especially if offtake is assured by bankable entities. For example in Indian road projects, where private enterprise would construct, operate and maintain the road during the Concession Period and would earn an assured annuity from the National Highways Authority of India (NHAI) irrespective of the actual level of traffic, lenders may be willing to consider higher gearing of up to 4:1. In power projects where offtake was assured to the extent of a certain Plant Load Factor (PLF) by the concerned SEBs, lenders have traditionally financed on a debt-equity ratio (DER) of 2.33:1. For large conventional projects, where the project and hence the lenders are exposed to commercial risks, a typical DER would be in the 1:1 to 2:1 range.

In infrastructure projects, the effort on the part of the different project parties is to ensure that contracts are as ironclad as possible and as less left to subjective interpretation. The objective of the contracts is to establish project related obligations for each project party and ensure that certain risks are allocated to those parties who are in the best position to manage the risk. At the project development and financing stages, it is therefore important to have experienced financial and legal advisors who will advise the SPV and the sponsors on appropriate risk allocation and ensure that the legal and structural framework to enable the risk allocation is correctly defined.

19.2 KEY PROJECT PARTIES

As the project moves from the developmental stages to financing and thereafter to construction and finally to operations, several project parties get involved with the project. Some, like the financial advisors, exit once the financing is fully tied up and the project has drawn down loans from the lenders and equity from the investors, while others like the EPC contractor is extensively associated with the project during the construction phase and by contract during the "Defect Liability Period" post commercialisation of the project. A brief description of each of the project parties and their typical role is given below:

Project Parties	Fundamental Responsibilities
Project Sponsors	Project sponsors are responsible for converting a concept into a project and have a role in setting up a project vehicle, identifying and recruiting right managerial talent to implement and run the project, providing a clear mandate to such management on their expectations, and finally subscribing to a significant proportion of equity in the project vehicle.
Project Vehicle	The SPV is responsible for delivering a bankable project during the financing phase, implementing the project, and thereafter operating it in a manner that is financially viable. It selects and appoints all the project contractors, negotiates and executes the contracts, raises the financing, supervises construction and commissioning, and operates the project either directly or through an Operations and Maintenance (O&M) Contractor.
Project Lenders	Project lenders provide debt to finance the construction of the project. Typically a consortium of project lenders, led by a "Lead Bank", ascertains a bankable project cost and in consultation with the SPV and the project sponsors a "Means of Finance" to finance the same, disburses debt, and performs a monitoring role during the construction phase, and on commissioning monitors the performance and operation of the project till all debt is repaid.

Project lenders are secured by project assets and do not normally interfere in the day to day operations of the SPV. However, under conditions of default, the project lenders' rights increase substantially and in extreme cases of default, and if provided for in the Project Loan Documents, project lenders can take over the management of the project as well as the sponsors' equity.

EPC Contractor Typically an EPC contractor designs the project, procures all the engineering skills and equipment to construct the project, erects all the project facilities, ensures that test and trial-runs are completed, and finally commissions the project, all on a turnkey basis. The EPC contractor's key objective is to deliver a project, as per pre-defined specifications, within a certain cost and time frame. It also provides performance guarantees to the SPV. It may choose to sub-contract certain portions of the assignment to other contractors but such sub-contracting does not relieve it from its sole responsibility of delivering a constructed project to the SPV.

O&M Contractor As the name indicates, the O&M contractor is responsible for operating and maintaining the plant in line with industry best practices. Performance parameters that need to be achieved during operations are predefined in an O&M contract and the O&M contractor provides managerial skills and operations experience to achieve and possibly surpass the agreed parameters.

Government The government is a key project party. It provides a Concession to the SPV to set up the project and ensures that a proper legislative and regulatory framework exists that allows the concerned SPV to compete on a "level playing field" along with existing, possibly government owned entities, in the same field.

In some cases, like in the electricity generation sector, state governments have counter-guaranteed the performance of offtake obligations of the SEBs and in certain cases, the central government has counter-guaranteed the performance of the state government.

19.3 PROJECT CONTRACTS

A project company is unusual in the sense that it is set up to undertake a single project. However , there is nothing unusual about the parties that participate in the project. All companies have equity shareholders, lenders, contractors, suppliers, and customers, and all deal with the government. The key differentiating feature of project finance is the manner in which project risks are allocated to various parties involved in a project.

Through a comprehensive web of contracts, every major risk inherent in the project is allocated to the party/parties that is best able to assess and manage that risk. Since a party to a project will agree to assume risk at a reasonable price only if it understands that risk clearly, project finance is appropriate only for projects like power stations, roads , railway lines, airports, and telecom networks that involve established technologies. Project finance is not suitable for projects that involve complex or unproven technologies , as suggested by the inability of the U.K. government to arrange project finance for research and development projects.

Provisions of Key Project Contracts

Some of the fundamental provisions of key project contracts are given below:

Project Contract	Contents	Final Objective
Shareholders Agreement	An agreement between all of SPV's shareholders, including Project Sponsors that establishes: 1. Shareholding pattern 2. Shareholders' representation in management 3. Minority protection rights, if any 4. Decision making process in certain reserved matters 5. Proposed pattern of cash calls and remedies available against Funding Defaults by one shareholder 6. Shareholder's Exit Process and Right of First Refusal (ROFR) to other shareholders	• Ensures that equity funding is fully tied up and available to the SPV as per its financing requirements • Attempts to ensure a smooth functioning of the SPV; ensures that certain decisions are made with the concurrence of all shareholders as opposed to a simple majority of the SPV's Board • Lays down an unambiguous process by which a shareholder can monetise its shareholding and the rights of other shareholders in such an event
EPC Contract	An agreement between the SPV and the EPC contractor that establishes: 1. The EPC contractor's sole responsibility in designing, procuring, constructing, testing, and finally commissioning the plant/facility according to specifications laid down in the contract within a specified date and at a certain cost	• Reduces the risk of time and cost escalations for the SPV • By selecting a properly qualified contractor, the SPV can mitigate, to a large extent, non-performance risks • By seeking warranties from the contractor the SPV ensures that for an adequate "Defects Liability Period", spare parts are available and repairs are carried out by experienced personnel at zero or low cost

2. Guaranteed and Minimum Performance parameters.
3. Responsibility of the contractor to rectify the plant if it fails to meet Guaranteed Performance Parameters and Penalties/Liquidated Damages (LDs) payable if the plant fails to meet Minimum Performance Parameters. Typically maximum LDs are capped at 20-30% of the EPC contract value [2]

Project Loan Agreements

An agreement between the SPV and the project lenders that establishes:

1. Certain Conditions Precedent ("CPs") on fulfillment of which an approved loan is drawable by the SPV.
2. The amount of loan approved.
3. Loan tenor, moratorium, repayment obligations, interest rates, and upfront/management fees.
4. Security and Credit Enhancements.
5. Events of Default and Remedies available to Lenders under conditions of default.
6. Sponsor covenants in full recourse /limited recourse financing conditions

- Ensures that conditions under which the loan is drawable is clear to the SPV as well as the Lenders
- Ensures that the security and credit enhancement mechanisms are documented and therefore enforceable by contract
- Ensures that lenders have additional rights in the operation and management of the company under conditions of default and can accelerate loan repayments, if required

2. It has been argued that Contractors' liability should be capped at much higher levels say 50-75% of the Contract Value. However, this is not very common, as inevitably in such events, Contractors attempt to balance out the risk by inflating the Base Contract Price itself. The Project, by trying to insulate itself from a potential non-performance risk, may actually find itself priced out of the market on account of a higher capital cost. A better way to negotiate is to ensure that EPC contract price is competitive and once the price has been negotiated, try and convince the contractor to subscribe to some equity in the project, in which case the Contractor is incentivised to implement the project with great diligence.

O&M Contract	An agreement between the SPV and the O&M contractor that establishes 1. Responsibility of the O&M contractor to operate the plant/facility to ensure the project/facility's availability 2. Maintenance obligations that will ensure that the project/facility is maintained as per industry best practices. 3. Bonus payments to the O&M contractor, for exceeding pre-determined performance parameters and penalties for under achievement	• Ensures certain level of mitigation of operating and performance risks

19.4 FINANCIAL STRUCTURE AND CORPORATE GOVERNANCE

Many argue that the essence of project finance is the web of contracts meant to ensure that all parties work in concert for the success of the project, to distribute risks efficiently, and to prevent the abuse of monopoly power.

This argument is valid but incomplete as it does not explain the organisational structure, the ownership structure, and the financial leverage of the project. Put differently it does not explain why the project is handled as a separate company, why operators, contractors, suppliers, and consumers typically participate in the equity of the project company, and why the project company relies heavily on debt in the form of non-recourse financing or limited recourse financing. Indeed a government interested in a certain infrastructure project can raise money on its own and enter into contracts with various parties.

However, it is not possible to write comprehensive contracts (which can envisage every possible contingency) and efficiently monitor them. For example, when the operator and the main contractor have a significant stake in the equity of the project, they have an incentive to be efficient. After all, as equity shareholders their profit depends on the success of their project. To quote Richard A. Brealey et. al : "Thus it is desirable to tie ownership and the provision of management services wherever it is difficult to specify ex ante the required level of services, or the acceptable level of costs, and to monitor them. This can be achieved through the use of project finance."

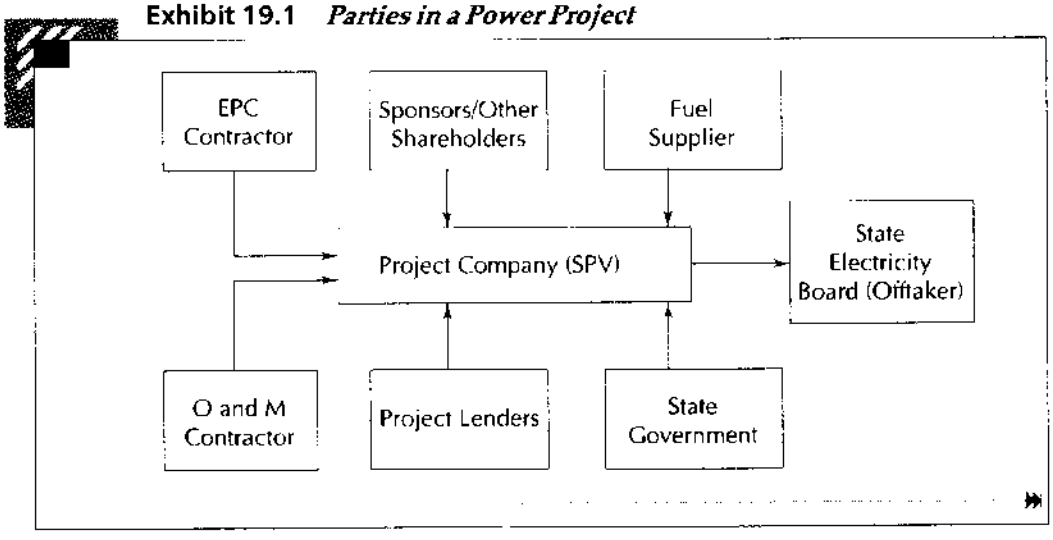
19.5 FINANCING A POWER PROJECT

An electricity generation project is an example of an infrastructure project. In such a project the SPV owns the generation assets and enters into a Power Purchase Agreement (PPA)

with the SEB. Since the SEB purchases all the power generated by the SPV, the PPA , which establishes the conditions under which electrical energy would be sold by the SPV and purchased by the SEB and conditions by which payments would be secured, is amongst the most important contracts that needs to be negotiated and executed. By means of a contract, the state government guarantees the payment obligations of the SEB.

A typical structure of such a project is shown in Exhibit 19.1.

Exhibit 19.1 ***Parties in a Power Project***



Features of a Power Purchase Agreement

In such a project as above, as mentioned earlier, in addition to the shareholders agreement, EPC contract, O&M contract, and the Project Loan agreements, the PPA is a critical contract. The salient characteristics of the PPA are as under:

- The PPA establishes the conditions under which the SPV would sell power to the SEB and the SEB would buy power from the SPV
- Under the PPA, the SEB guarantees a minimum offtake from the SPV or, if it fails to do so, a minimum payment. Typically the minimum payment would cover all the fixed charges incurred by the project including depreciation, interest on term loans, fixed O&M expenses, and return on equity
- A payment mechanism and a security mechanism that ensures availability of payments on time is established. In India, several large power projects have been financed on the basis of a 3 tier security mechanism depicted in Exhibit 19.2. At the first level, the SEB's open and continue to keep open a letter of credits (LC) from an acceptable bank in favour of the SPV. The LC typically covers about 30-45 days of average billing. The second tier comprises an escrow account where the receivables of the SEB itself are escrowed in favour of the SPV. In the event the SPV has invoiced for energy sold and the SEB has not made payment and the LC has also become

inoperable, collections that are captured in the escrow are first released to the SPV and thereafter the remaining escrow balances can be released to the SEB. In the event both the LC and the escrow are inoperable, the third tier of the security mechanism, viz. an irrevocable guarantee of the state government that owns the SEB, can be enforced[3].

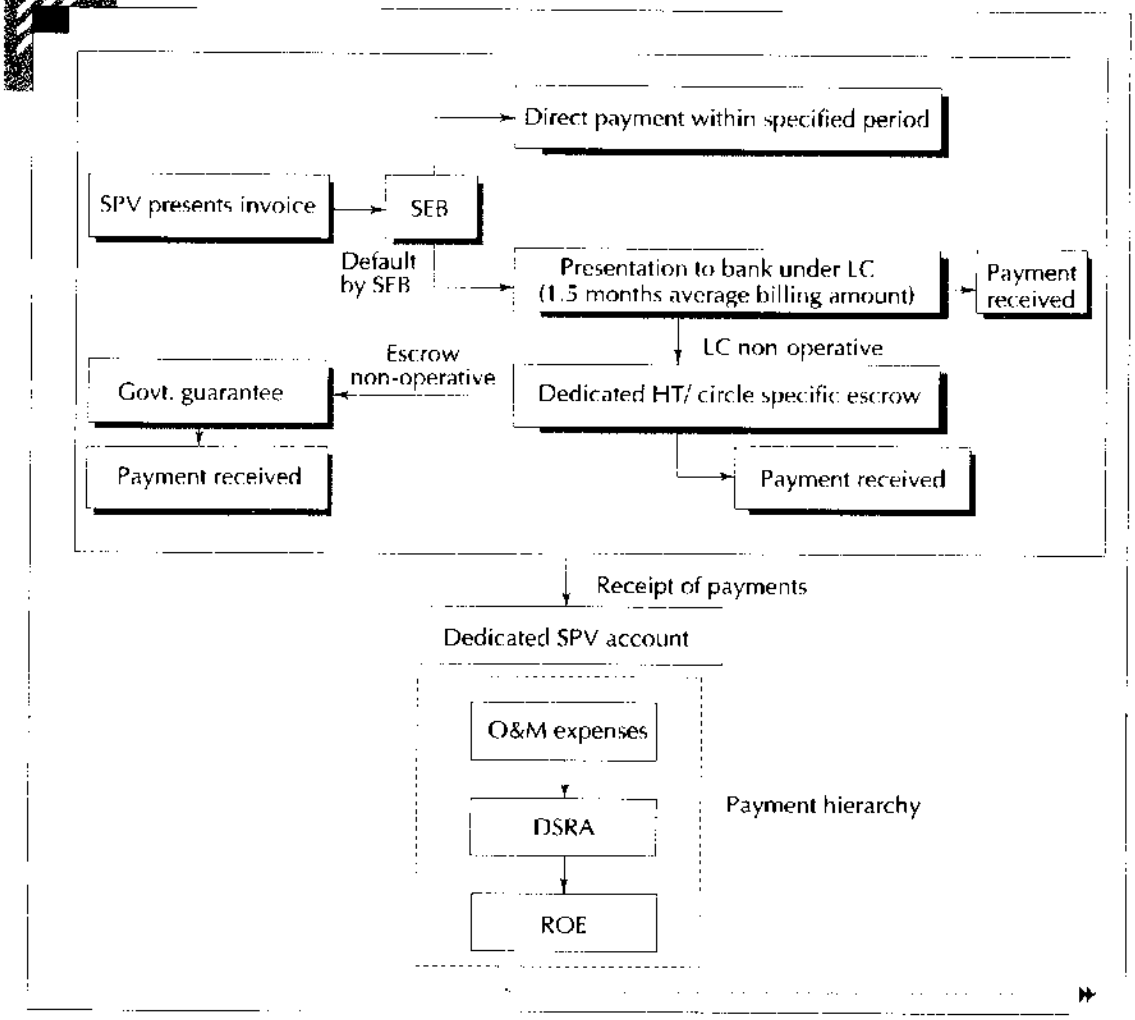
- The PPA also lays down the formula for computing tariffs, which in addition to the fixed charges, also includes variable costs such as fuel cost and also an incentive for performance.
- Responsibilities of the SEB include construction of interconnection facilities to ensure that the energy generated by the SPV can be sold through the state electricity grid. If the cost of interconnection facilities is high and its construction is likely to be time consuming, it may be viewed as a serious risk by project lenders, especially given the precarious financial condition of most Indian SEBs. If the interconnection facilities are not ready on time, the project, even though it is ready to generate power, will not be in a position to sell power.
- The PPA also envisages termination under conditions of sustained default by either the SPV or the SEB in performing their respective obligations or under conditions of Force Majeure. The PPA also allows an exit to the project's shareholders and lenders in the event it is terminated by providing for an SEB buyout of the facilities and laying down different buyout prices that would be payable by the SEB under different termination conditions. It also ensures that appropriate remedy periods are available prior to effecting a termination.

When financing a power project, lenders consider the PPA as an important project document and evaluate the sufficiency of negotiated tariffs, especially if the "fixed charges" element is pre-determined and not "cost based". Lenders also evaluate the requirement of interconnection facilities and take a view on the ability of the SEB to complete the same prior to Commercial Operations Date ("CoD") of the project. Amongst the key provisions of the PPA is the security and credit enhancement mechanisms and lenders also need to be satisfied with the same. Project lenders also ensure that under different events of termina-

3. The 3 tier security structure has not worked in the practical environment as LCs may not always be opened by the SEB's bank if the SEB continues to be default grade; the escrow account may not be meaningful in the event there are multiple projects feeding the same SEB and the SEB is run on non-commercial lines such that the cost of power from the SPVs is higher than the revenues earned by the SEB and finally, in most cases, the state government guarantees may not be bankable given the large continuing commitments of the SEBs and the not so good financial positions of the states themselves. Lenders are therefore proposing to assist projects in states which have agreed to reform the SEBs and the commercial principles under which power would be metered, sold and tariffs recovered from consumers. Such reforms linked financing is also likely to be linked to milestones with lenders disbursing debt on being satisfied with the state's progress in reforming the SEB along commercial lines.

tion and consequent SEB buyout, the committed buyout price includes outstanding debt and interest.

Exhibit 19.2 *3 Tier Payment and Security Mechanism*



In addition to the risks mitigated through the PPA, the project is also exposed to certain construction and additional operating risks. Operating risks cover (a) the inability of the O&M operator to run the plant to ensure the required level of availability for reasons attributable to material defects in the plant–for which the EPC contractor can be held liable during the Defects Liability Period and (b) the inability of the fuel supplier to supply adequate quality/quantity of fuel leading to lower plant availability. A Fuel Supply Agree-

ment (FSA) (between the fuel supplier and the SPV) that is structured properly ensures that risks associated with inadequate quality/quantity of fuel are passed on to the fuel supplier and the fuel supplier compensates the SPV for any alternate fuels that may need to be purchased by it or pays "Consequential Damages" to the SPV–which are essentially all the losses suffered by the SPV under the PPA and other project documents on account of a default by the fuel supplier under the FSA. As before, the guiding objective in such contracting is to ensure that the risks are substantially mitigated for the SPV by allocation to parties that are in the best position to manage these risks. It is entirely feasible that an O&M contractor or a fuel supplier or an EPC contractor may agree to bear only a part of the Consequential Damages resulting on account of their non-performance and the SPV is therefore exposed to certain residual risks under certain events of non-performance. Under such situations, lenders need to carefully evaluate these residual risks, the qualifications of the project parties whose non-performance may expose the SPV to such risks and thus arrive at the probability of such risks actually materialising. If lenders are not completely satisfied, they may seek some form of back-stopping by sponsors and therefore change the flavour of the financing from non-recourse to "limited recourse".

Risk Mitigation Mechanisms

In a way, mitigation of the project's construction and operating risks are fundamental to the process of financing. The key risks and how they are mitigated are shown below.

Key Risks	Mitigation Mechanisms	Project Parties Expected to Bear the Risk
Project Cost Overrun	• Fixed Price, Date Certain EPC Contract • Project cost to include sufficient contingency provisions to cover physical contingencies, cost escalations on account of adverse exchange rate fluctuations, cost escalations on account of change orders/design modifications during implementation etc. • Careful evaluation of EPC contractor's qualifications. • Cost comparison with similar projects. • Loan disbursements allowed only after all statutory approvals for construction have been received by SPV	• EPC Contractor/Project Sponsors

	• Undertaking from Sponsors to fund cost overruns (may be capped)	
Shortfall in Financing	• Draw down allowed only on financial closure • Undertaking from Sponsors to finance shortfalls, if any	• Sponsors
Commercial Risks	• Careful evaluation of the electricity demand supply scenario in the state • A view on the ability of the SEB to meet committed offtake targets	• SEB, State Government and Lenders[4]

Once the lenders are satisfied with the risk allocation mechanism, a project cost and a financing structure is finalised. The lenders then approve the debt facilities to the project, which become drawable at the time of "financial close", which is defined as a time when the SPV has met all the CPs associated with the approved loans. Some typical CPs in power project financing are as under:

- Completion of acquisition of land for the project
- Complete tie-up of the project equity, identification of project sponsors, and execution of a satisfactory Shareholders Agreement
- Completion of Front End Engineering Design by reputed engineering consultants and finalisation of a technical configuration for the project
- Execution of a bankable EPC contract
- Completion of Environmental Impact Assessment studies and receipt of clearances from the Ministry of Environment and Forests and from the State Pollution Control Board
- Execution of a bankable PPA
- Execution of a bankable O&M agreement
- Execution of a bankable FSA
- Equity subscription by sponsors to the extent of 20-30% of their final estimated contribution[5]
- Tie up of all debt, execution of loan documentation with all project lenders
- Creation of security (mortgage of land/hypothecation of assets)

4. Under certain conditions of limited recourse financing, lenders may require Sponsors to provide cash deficit supports or other forms of credit enhancements.
5. Negotiable, typically about 50%; in certain cases lenders have also sought entire sponsors' contribution to come in upfront, prior to any loan disbursements.

- Assignment of all project contracts to lenders
- Execution of all documents by the SEB to facilitate the credit enhancement process

The CPs form part of Term Sheet that is issued by the lenders to the SPV. In addition to the CPs, the Term Sheet also contains applicable commercial terms and security and credit enhancement requirements, if any. A typical credit enhancement that most power projects (and infrastructure projects) provide to lenders is creation of a 6 month forward Debt Service Reserve Account (DSRA), which is a special account administered by a lender's representative and funded directly from the payments made by the SEB in such a manner so as to ensure that the account always contains funds sufficient to service the following 6 months debt service obligations. In addition, project lenders would also want all the project contracts, including, *inter-alia*, the PPA, O&M, EPC and Insurance Agreements to be assigned to the Lenders. In limited recourse financing, lenders may insist that Sponsors pledge their shareholding in the SPV to project lenders, provide certain cash deficit support undertakings to lenders, provide certain funding in the event there are cost overruns and also undertake not to exit the project/or even reduce their initial shareholding unless all loans are fully repaid. In most such financing, lenders also reserve the right to nominate a Director on the Board of the SPV.

19.6 FINANCING TELECOMMUNICATION PROJECTS

Telecommunication projects are characterised by large project costs, a virtually continuous project implementation (or roll-out), long gestation periods, and a dispersed customer base that exposes the project to commercial risks and requires significant marketing and selling budgets. In telecom projects, in practice there can be no single CoD – companies typically commercialise certain areas where the equipment is installed and as the company's reach expands with time, each geographical territory can be commercialised.

In telecom, gestation periods are significant and could range from 3 to 5 years. As the project adds subscribers over a period of time, revenue increases and the project turns profitable. This is unlike a power project, which, on CoD, can ramp up to maximum utilisation. Unlike a power project which generates reasonably flat revenues and profitability over its life, telecom projects, by virtue of their continued implementation and increase in subscriber base demonstrate increases in profitability over a period of time.

In general, telecom projects incur cash losses in its initial years and these need to be funded. In determining a telecom project's cost, lenders follow the concept of "Peak Negative Cash Flow Period", which determines the maximum period over which the project requires external cash injection and the total external financing requirements during such a period. During this period, the project cost would typically include equipment cost, land and buildings cost, entry fees, preoperative expenses, interest during construction, contin-

gencies, working capital margin, and net cash losses and it would be financed by debt, connection charges and customer deposits, and equity. Given the long gestation periods and the commercial risks, project lenders in India have funded telecom projects on a lower debt-equity ratio (DER) such as around 1:1. Since telecom projects incur losses in the initial years, while determining a DER, project lenders also consider a ratio called debt-to-funded equity (which refers to the actual net worth subscribed by the different shareholders without reference to any write-offs) and may agree to a funding pattern that is within a debt-to-funded equity ratio of 1.5:1.

Private telecom projects operate under a license from the Department of Telecom and the project's framework is determined by the conditions of the licence. Projects pay a one-time entry fee and a revenue share as licence fees. In addition, the licence imposes certain obligations in terms of rural/village telephony and coverage of the territory, the cost of which needs to be factored into the project cost. Licenses are fairly standard for different operators, except to the extent demanded by the differences in territories.

Apart from the licence itself, project financiers in telecom projects evaluate the following:

- *The equipment supply contract(s)* Such contract(s) is judged for pricing competitiveness, flexibility to re-negotiate (primarily because global telecom equipment prices have tended to fall significantly over a period of time) prices, upgrade-ability of equipment being supplied and the terms and conditions of payment.
- *The financial strength of the project sponsors* On account of unforeseen circumstances, business plans could go awry leading to higher than envisaged losses and, hence, greater than anticipated equity financing requirements.
- *The business plan assumptions* As the telecom markets become more de-regulated and competitive, telecom services are anticipated to cost lesser over a period of time. Also, as different segments of the telecom market are opened up to private participation, tariff rebalancing to reduce/eliminate current subsidies is expected to become reality. Project financiers need to be aware of the experience in other countries that have deregulated telecom markets and test the project's assumptions against (a) empirical evidence available from these markets and (b) direction of home country regulations.
- *The competitive environment* Several de-regulated telecom markets, unless constrained by availability of spectrum, allow unlimited number of participants. In the fixed line access business in India, as well as in Domestic and International Long Distance the government has allowed/proposes to allow unlimited private participation with restrictions being imposed only on the number of participants in the cellular business in any telecom circle. In such a scenario early movers almost always find project financing easier to secure while subsequent entrants may either not be able to secure financing at all or may have to agree to limited/full recourse financing. In a competitive environment lenders need to have clarity on projects that they would consider for financing.

- *Telecom regulations* Lenders need to take a view on and be comfortable with emerging telecom regulations which may change from time to time. As a market gets deregulated and private sector commences roll out, there is likely to be pressure on regulators to frame policies which may favour either incumbents or new entrants. As such, while lenders and investors seek a certain level of stability in the regulatory framework, it is likely that more often than not, regulations and the regulatory framework would undergo continued shifts and project lenders would be required to take an educated view on how regulations would evolve, rather than expect complete stability. To this extent, the work of the project financier becomes more difficult.

SUMMARY

- Infrastructure projects, which typically provide essential services, have one or more of the characteristics mentioned below: (a) They are highly capital-intensive. (b) They involve sunk costs. (c) They have a long operating life.
- While traditionally infrastructure projects in India were owned and managed by the government undertaking, there is now a broad consensus that private sector participation in this activity must be encouraged.
- The key features of project finance which appears to be the principal arrangement for private sector participation in infrastructure projects are as follows : (i) The project is set up as a separate company which is granted a concession by the government. (ii) The sponsor company which promotes the project usually takes a substantial stake in the equity of the project and enjoys the overall responsibility for running the project. (iii) The project company enters into comprehensive contractual arrangements with various parties like contractors, suppliers, and customers. (iv) The project company employs a high debt-equity ratio, with lenders having no recourse or limited recourse to the sponsor company or to the government in the event of default.
- The key differentiating feature of project finance is the manner in which project risks are allocated to various parties involved in the project. Through a comprehensive web of contracts, every major risk inherent in the project is allocated to the party/parties that is best able to assess and manage that risk.

Questions

1. Briefly describe each of the project parties and their responsibilities.
2. What are the important contents and objectives of the Shareholders Agreement.
3. What are the important contents and objectives of the EPC Contract?
4. What are the important contents and objectives of the Project Loan Agreement?
5. What are the important contents and objectives of the O&M Contract?
6. Show diagrammatically the parties in a power project.
7. What are the salient features of a Power Purchase Agreement (PPA)?
8. What are the features of a telecom project ?
9. Describe briefly the things that project financiers in telecom projects consider.

CHAPTER

20

Venture Capital[1]

A young private company that is not yet ready or willing to tap the public financial markets may seek venture capital (VC, hereafter). Such capital is provided by VC funds, which are prepared to finance risky projects that appear to have promising prospects.

While the concept of VC is perhaps as old as the human race the practice of VC remained somewhat fragmented and individualised throughout the long history. Only in the last six decades or so, the field of VC has acquired a certain degree of coalescence, maturity and sophisitication, particularly in the US. VC is a relatively new phenomenon on the Indian scene and has emerged as one of the much talked about financing alternatives in India in the nineties.

This chapter discusses various aspects of VC. Throughout the discussion the VC investor is referred to as the "investor", the company that receives VC funding as the "investee" or, simply, the "company", the management of the company as "management" or " management-team" and the portfolio of investments of the VC investor as the "portfolio".

The chapter is organised into seven sections as follows:

- VC investors
- What is a VC investment?
- The VC investment appraisal process
- Indian VC industry
- Tax and regulatory aspects of VC
- Current concerns of the Indian VC industry
- How to approach a VC

1. This chapter has been contributed by Professor G. Sabarinathan of IIM, Bangalore.

20.1 VC INVESTORS

A variety of financial institutions, corporations and individuals participate in the VC industry as investors. The most significant among these are VC funds. The VC investors represented in this note are VC funds. (Yet another related term in industry circles is "private equity". While there are some fine distinctions between VC and private equity, there is considerable practical overlap between the two variants of VC. Most of the discussion here would apply to private equity as well.)

VC funds may be described as pools of capital constituted for investing in relatively high-risk opportunities in anticipation of potentially high risk adjusted rates of return. These funds are usually committed for extended periods of time, ranging from seven to twelve years. At the end of the period the investments are liquidated and the capital is returned to the investor, with any capital appreciation thereon. Investors in these funds are usually interested in long term capital appreciation and not short-term gains or periodic yields by way of dividend or interest. Most VC funds are not listed on any exchange or do not have an alternate secondary market mechanism worth mentioning. Investments in these funds are therefore usually illiquid in the initial years. Investors in VC funds are institutional investors and high net worth individuals who have the ability and the preparedness to accept the illiquidity. VC funds are usually *independent* in the sense that they do not represent or subserve the strategic interests of any of the investors in these funds. Their primary objective is to produce a financial return for the investors in the fund. This last criterion is important as it helps companies who raise capital from VC funds to be sure that they can function independently, without the fear of being "controlled" by another business interest group.

Managers of VC funds charge investors in the fund a fixed annual fee, usually 2.50% of the capital under management. As a performance incentive fund managers also retain 20% of the capital gain realised from the investments. The share of the capital gain provides an incentive to the fund manager to maximise the value of the portfolio and aligns the interests of the fund manager with that of the investors in the fund.

The constitution of VC funds and the unique compensation mechanism for managers of these funds, as outlined above, considerably influence the investment strategy of VC funds as will be seen in the discussion that follows.

20.2 WHAT IS A VC INVESTMENT

The popular impression is that VC is synonymous with the financing of technology-centric businesses or innovative and hitherto untried business ideas. In reality VC is a broader and much more flexible form of financing business enterprises. A better understanding of the broad scope of VC could be conveyed by the following examples of some typical VC investments that have been made in the past.

- A national or regional chain of stores across India, based on a new retailing concept such as retailing of office supplies.
- A software development company in Israel that has developed a state of the art telecommunication switch.
- A Chinese manufacturer of hand tools who competes in the international market on the basis of operational efficiencies and low cost, without compromising on quality.
- An African exporter of processed horticultural produce.

Common to these examples above are exceptional growth prospects, a sustainable competitive advantage that helps maintain growth in sales and profitability, which could potentially result in superior returns to the investor.

A survey of the literature on VC including practitioner accounts, industry association definitions, and academic publications indicates that VC investments will usually involve

- Businesses with high growth potential in terms of sales and profitability
- Medium to long term investment horizons or holding periods ranging from two to ten years
- Risk levels which are higher than that inherent in debt financing transactions or investment in equities of well-established firms with a history of profitable operations.
- Equity or quasi-equity financing instruments which enable the investor to participate in the risk and the financial upside of the enterprise
- Active investor involvement in the investee after the funding.

Over the past two decades, VC has emerged as a financing alternative in many countries—at last count in over seventy countries, both developed as well as developing. In many economies, which do not have well-developed capital markets, VC funds have emerged as the source of essential risk capital such as equity financing.

20.3 WHAT MAKES A VC INVESTMENT DIFFERENT

A VC investment is different from a traditional loan transaction or investing in the equity of a well-established firm, listed on a stock exchange, in many respects. In this section we examine some of the more important distinguishing features.

High Uncertainty Levels

VC investors usually fund firms that are exposed to higher degrees of uncertainty. Resolving the uncertainty affecting these firms is rendered more complex by the absence of historical information that can provide the basis for assessing the likelihood of various future outcomes.

The sources of risk and uncertainty in a venture investment are many more in number and complexity than in most other investment opportunities. These risks include:

1. *Technology risks:* The risk that a product, process or service based on a hitherto untried technology may fail to perform as expected or run into related problems or have undesirable or unforeseen side effects.
2. *Product market risk :* The risk that sales volume or price realisation of a product may be lower than expected due to poor customer acceptance of the product or unanticipated competitive conditions.
3. *Management risk: :* The risk that the management team may not have the capability to deliver the results projected in the business plan. Historically, from practitioner accounts, management failure appears to have been the single most important reason for failure of VC backed enterprises. In turn, the failure of the management could be due to a host of reasons ranging from just lack of competence to more serious issues such as the inability of the team members to stick together in running the business or even lack of integrity.
4. *Liquidity risk:* : The risk that the VC investor may not be able to encash his investment. VC funds mostly invest in unlisted companies. Unless the shares of these companies are successfully listed and traded on a stock exchange, or the companies are acquired, the investment in these companies could turn out to be illiquid. (In this note, it is being assumed that buy back of shares by the issuing firm is not a practically feasible alternative, circumscribed as it is by various regulatory requirements.) Illiquidity risk emanates from weak conditions in the capital market, or, due to lack of interest in the company or the industry sector among investors or due to the lacklustre performance of the company.

Information Disclosure

Unlike in the case of public companies, unlisted companies which VC investors fund are not mandatorily required to disclose information. The investor has to ensure that he gets all the information that is required for making an informed decision. Often, being a company that is in the early stages of evolution, the prospective investee may not have the organisational systems and mechanism to generate the information that a professional investor may seek.

20.4 THE VC INVESTMENT APPRAISAL PROCESS AND MANAGEMENT

We look at some of the key elements of VC investment appraisal and management as a VC transaction evolves through the life cycle of a deal within a VC fund's system.

Assessment of Business and Management

The VC investment process commences with a meeting with the promoters and the key members of the management team of the company. This is followed by a critical evaluation

of the business plan. The business plan document is central to the VC transaction. In terms of its coverage the business plan goes well beyond a detailed project report. The plan articulates the vision of the promoters and top management of the company over the investment horizon. It spells out the firm's strategy in much greater detail. Often the proforma financials presented in the business plan, in part or in whole, are incorporated into the formal contractual agreements between the investor and the management of the company.

The emphasis of evaluation is on the following aspects.

Management Team VC fund managers realise that the key to building a successful company is an effective and top class management team. The VC investor's appraisal process lays considerable emphasis on the evaluation of the management team of the company for its leadership ability, integrity, completeness in terms of skills to manage various functional areas, and their cohesiveness as a team. As the company develops, VC investors prepare themselves to even bring about changes in the management team when the incumbent members of the team fail to deliver. At the same time, experienced investors also recognise that such changes are painful to bring about; as such, it is well worth the effort to ensure that the company has the right management team to start with.

Business Strategy Another area of difference is the emphasis on a thorough strategic analysis of the business. VC investors spend much more time seeking answers to broad strategic questions such as

- What is the value proposition that the company's product or service offers? Can it be understood by the end user in simple terms?
- Is there a felt long term need for the company's product? Is there a sizeable market?
- Does the investee firm have a sustainable competitive advantage? What is the source of the competitive advantage?
- What is the revenue model of the company?
- What are the operating economics of the business?
- Is the investment opportunity consistent with the VC fund's investment philosophy and strategy? Can the partners in the fund add value to the investee company?
- How valuable will the company in question be over the investor's holding period?

It may be observed that the common drift among the questions above is an attempt to assess whether the company, over a three to five year period, will have a sizeable share of a large market, based on an unassailable, competitive position, and consequently produce a super normal growth in profit and shareholder wealth? Will that in turn enthuse other shareholders or corporations to own shares in the company so that the VC investor can exit by selling his investment and realise a return on the same?

Given the levels of uncertainty surrounding a VC backed company and the lack of quality data, VC investors do not place much emphasis on complex quantitative analyses of the

prospective financial position of a VC backed company. The VC investor develops a set of several broad business - and corresponding financial – scenarios such as a base case and one optimistic and pessimistic scenario each. He then applies his judgment to form a view on the most likely financial picture of the company over the expected investment horizon.

Exit Focus Most VC investors manage funds with a limited life, as mentioned earlier. That limits them to look at investments with finite holding periods. Unlike the lender, whose loan is repaid from the borrower's cashflow, or an investor in shares listed on a stock exchange, the VC investor does not have a ready made mechanism to liquidate his investment. The VC investor tends to assess the prospects of and the likely means to liquidate his investment, right at the time of committing the investment. (The common means of disinvestment are discussed later in this note.) Absent a clear path to liquidity, the VC investor is reluctant to commit capital to the company.

Valuation of a VC Transaction

All aspects of the VC transaction process are equal in importance; but it would be fair to argue that valuation is more equal than the others in terms of importance. Valuation is the process by which the investor decides the price he wishes to pay for the equity shares of the investee company. (For the purposes of this discussion we assume that the deal is being structured as subscription to equity shares. In the following section, we will look at alternate structuring mechanisms investors resort to.)

The most commonly used method of valuation used by VC funds involves the following steps:

1. Identify the amount of capital to be invested by the investor.
2. Identify the target rate of return expected by the investor. These rates are usually based on rough-and-ready return estimates taking into account the stage of investment (such as seed, startup, etc.), the expected holding period and the level of risk perceived in the investment by the investor.
3. Estimate the multiple of the original investment that will fetch the required rate of return over the anticipated holding period. For example, a 25% compounded annual rate of return over a four year holding period would translate into a multiple of 2.44 times the original investment.
4. Project the market value of the firm based on performance projected during the proposed (or anticipated) year of exit. This involves multiplication of an appropriate metric such as Earnings Per Share (EPS) or Earnings Before Interest Depreciation, Tax and Amortisation (EBIDTA) by a multiple number that reflects the valuation that investors may be willing to pay (or may have paid) in other recent transactions.
5. Estimate the percentage of the projected value (P) that the investor needs to claim in order to achieve his return objective. This will be the percentage of the company's equity that the investor would need to own at the time of exiting from the investment in order to realise his return objectives.

The following observations are worth noting regarding the valuation approach described above:

1. The approach assumes that the market value of the firm at the time of exit is the same as the value of the equity. In turn, this implicitly assumes that the firm is all equity financed. For most VC backed firms this should be a reasonable assumption.
2. Critical assumptions behind these calculations relate to the estimates of Profit After Tax (PAT), EBIDTA, Price/Earnings (P/E) ratio or the P/EBIDTA ratio, choice of comparable firms, etc. The valuation of the transaction can vary considerably depending on the choice of value for each of these parameters.
3. More often than not, an investor in an earlier round of financing ends up with a lower percentage shareholding than he starts off with as the firm issues new equity in subsequent rounds of financing. This phenomenon is known as dilution. Early stage investors, in particular, will have to provide for such potential dilution. The extent of such dilution is tricky to estimate. It involves estimating the amount of capital the company is likely to raise in future and the price at which these rounds of financing are raised. Experienced investors estimate these using large doses of judgment and their past experience.

The valuation of deals is influenced by the following factors.

Outlook for the Economy Other things being equal, a positive overall outlook for the economy influences investors to pay a higher price for a given investment opportunity. This is because a healthy economy could lead to improved outlook for investee companies as well as to higher exit valuations at the time of exit, encouraging investors to pay a higher price for the transaction.

Capital Market Conditions A buoyant stock market appears to influence investors to pay liberal valuations. This could be due to two related reasons. As the most preferred exit route, buoyant stock markets could suggest prospects for higher exit valuations for the VC investor if and when the company plans an IPO. Equally, in some markets buoyant stock markets could also end up financing companies that would have had to resort to VC financing in more restrained stock market conditions.

Industry Related Factors From time to time investors seem to prefer certain sectors over others. Such preference is reflected in the price that shares of companies in that sector command. This trend has been observed across many VC markets, including the American market. The changes in Indian VC investors' preferences appear to reflect the shifts in investor preference in the secondary (stock) market.

Deal Related Factors The specifics of the investment opportunity in question also influence the valuation of the investment opportunity. Such factors will include the stage of investment, the sources of risk, product or service differentiation and other factors that could affect the company's competitive position.

Demand for and Supply of Capital Excess supply of capital has been observed to result in more liberal valuations. Many analysts and practitioners seem to believe that excessive liquidity can push valuations up to unhealthy levels, resulting in low portfolio returns for VC funds. The exuberance of VC investors in India in 1999 and 2000 could be attributed, among other factors, to a similar situation in supply of capital that prevailed not only in India but in many other parts of the western world as well.

Deal Structuring

Most VC transactions are structured as equity or equity linked instruments presumably because of the elegance of equity shares as an instrument and their risk reward sharing features. However, as mentioned earlier, structuring funding as equity subscription exposes the investor to liquidity risk. Equity investors run the risk of getting locked into investments at a fixed price arrived at on the basis of some anticipated financial performance. In case the company does not deliver the anticipated performance the VC investor will have overpaid for the investment. To avoid such a risk, investors structure their funding as convertible instruments. The price at which these instruments are converted into equity is often linked to the actual performance of the company, measured in terms of appropriate metrics such as EPS or EBIDTA that is agreed upon right in the beginning. The conversion mechanism provides an incentive to the management team to deliver projected, or even better-than-projected performance since higher performance leads to higher price paid by the investor (at the time of conversion) for the company's shares. The advantage for the investor, in the process, is that he gets to subscribe to shares at a price linked to the performance of the company.

While structuring a deal VC investors also build in performance incentives for management. These incentive mechanisms usually have the following features.

- Options to subscribe to additional equity shares in the company at attractive, low valuations.
- The allotment of new shares in recognition of managerial or technological contributions, for consideration other than cash, popularly called 'sweat equity', so that founders and members of the management team may build up a sizeable share ownership even if they do not have significant financial capital to contribute.
- These incentives are tied to pre-identified performance milestones. The milestones are defined unambiguously and contracted between the company, investors and the management team. Examples of such milestones are profit measures, market value of the firm, or measures of operational performance such as successful product or technology development.

This powerful combination of incentive compensation and post financing involvement by the VC investor is considered to be key to the effectiveness of VC investors in building valuable portfolios. (We discuss post-financing involvement later.)

Investor-Investee Relationship

Another point of significant distinction is the relationship between the investor and the investee in a VC transaction. On a commercial plane the investor and investee are bound by the potential for mutual economic benefit: Capital gain for the investor and funding and value addition for the investor. On a legal or contractual plane the investor realises that over time, the interests or motivation of the entrepreneur may diverge from that of the investor or other financial stakeholders. For example, the investor will usually seek a timely exit through an IPO or trade sale. The entrepreneur may be keen to ensure his continued role in the management of the company. In the event of such divergence of interests, the investor may like to ensure that his interests prevail. Lastly, the high degree of uncertainty and riskiness of VC transactions require the investor to respond to many exigencies in the company as they emerge after the funding by the investor. Many of these eventualities cannot be envisaged at or before the commitment of funds despite the most thorough due diligence and appraisal process. The investor has to be equipped with the ability and the authority to be able to respond to these eventualities in the investee company.

The VC investor also recognises that the entrepreneur has an important advantage. As an "insider" he has a deeper insight into the business than the investor. Economists refer to this situation as information asymmetry. Information asymmetry increases the probability of wrong investment decisions by the investor. Unlike in a lending situation, where the loan is most of the time secured by some assets which the lender can dispose of to recover the loan dues in case of a default by the borrower, the VC investor's only option is to ensure that the company stays on track. The VC investor ensures that he has the contractual right to protect his interests in these situations by entering into an appropriate set of agreements with the investee.

Post Financing Relationship

The VC investor spends a great deal of time, engaging with the company after the funding has been disbursed. The VC investor involves himself with the company at two distinct levels. At one level, he contributes to strategic decisions such as constitution of the board, appointment of key managers and strategy formulation. He also plays an active part in planning the Initial Public Offering (IPO) of the company's shares. In many markets, including India, a reputed VC investor's share ownership of a company is viewed as the "certification" of the quality of the issuing company. At another level, he plays a monitoring role by ensuring important decisions relating to expansion or restructuring the capital base of the company (equity as well as debt), declaration of dividend, business expansion and diversification, formation of strategic partnerships, restructuring of the business in terms of hiving off or divesting existing businesses, are not prejudicial to the financial interests of the investor.

The investor participates in these decisions by nominating one or more directors to the Board of the company. In addition, the partner in a VC fund who is responsible for a

company in the portfolio typically spends some time every month meeting with the CEO of the portfolio company and key members of the management team, discussing matters of strategic importance. The investor also reviews periodic financial information from the company. In some instances the partner from the VC fund assumes even executive responsibility as the CEO or Chairman of the Board.

More importantly, though, the VC investor wields considerable influence over the entrepreneur's conduct by controlling the continued availability of funds. If the VC investor threatens to cut off supply of funds, other VC investors would hesitate to invest in the company too, essentially choking the company of any VC funding. At the least, the unwillingness of incumbent investors to commit additional capital makes it so much more difficult for the company to raise capital from other investors that VC investors do not always have to flaunt the agreement to make founders of investee companies to see their view point.

It must however be pointed out that the style and extent of post financing involvement tends to vary across investment situations and funds. Interestingly certain styles appear to be more widely prevalent in particular markets. For example, in the Indian context the investor involvement appears to be largely to protect the interests of the investor. VC investor's nominees do not appear to be involved in strategy formulation or key recruitments, in any significant manner.

Exiting from Investments

'Exiting' from an investment is an important consideration for the investor for reasons mentioned at the beginning of this chapter.

The two most common exit routes for VC investors are disposal of shares on a stock exchange, once the shares are listed; and sale of the portfolio company or its assets to a strategic acquirer (also known as a "trade sale".) In a few instances, the investor sells his shares back to the founders or other incumbent principal shareholders of the company. Sale-back to the promoters however is a less popular option among investors, given the limited prospects it appears to provide for capital appreciation. Further, getting investors to honour buy back obligations is not always an easy or friction-free option.

VC investors ensure at the time of committing the investment that there are one or more potential exit paths from the investment. The investor may even articulate his exit expectations to the entrepreneur in some detail right in the beginning. Further, investors provide for adequate measures in the investment agreements to be able to influence exit related decisions.

20.5 THE INDIAN VC INDUSTRY

The Indian VC industry is of a relatively recent origin. Prior to the formation of VC institutions, Indian development financial institutions provided risk capital to industry in the

form of subscription to equity, seed capital to first generation entrepreneurs and other similar forms of risk capital. They were playing the role of VCs in a way, although they did not follow the rigorous processes that a modern day VC would follow. ICICI Ventures (formerly TDICI Ltd.) was the first VC institution and was promoted as a joint venture of ICICI Ltd. and Unit Trust of India (UTI) in 1988. Several other commercial banks and development financial institutions followed with their own VC subsidiaries. With the deregulation of foreign investment into Indian companies, international investors emerged as more significant players in the Indian VC industry from the mid nineties.

Foreign investors brought with them the lessons they had learned in various other developed as well as emerging markets. They have introduced the western investment philosophy and processes into their transactions with Indian companies. Rigorous due diligence, tight contracting, active post financing involvement, and a sharp focus on timely and profitable exit are among their more important contributions. Since their investible funds were part of a global pool of capital, investment sentiments of foreign VC investors in India became closely tied into international investment and sentiments.

The investment preferences of VC investors in India have constantly evolved over the years. In the early years when the industry comprised mainly of Indian development financial institutions and commercial banks, VC investing appears to have been more or less synonymous with financing of technology and entrepreneurship development. The economic reforms of 1991 appear to have introduced a shift towards financing of innovative and/or growth oriented businesses that could sustain in an economy that was increasingly opening up to international competition. International investors appear to have added the dimension of identifiable, timely exit to the thrust on international competitiveness. These investor concerns seem to have driven the preference for specific sectors that measure well on these criteria. Thus, the current "flavours of the season" appear to be information technology and contemporary services such as new formats of retailing, to name the more visible sectors of interest. Interest in manufacturing businesses, if any, appears to be limited to businesses that are conceived to be internationally competitive in scale and quality.

Similarly, over the years, investor preference appears to have drifted in favour of financing the expansion plans of firms already in operation as opposed to greenfield ventures or startups. The lack of interest in start-ups is presumably due to the higher level of risks inherent in start-ups and the lack of willingness of investment managers to "take on" these risks in return for an attractive valuation, unlike some of their counterparts in the western world. Alongwith the emphasis on international competitiveness, the size of the average deal appears to have increased. Most investors, barring a small handful, appear to prefer investment sizes of US $3mn. (Rs 15 cr. approx. at current exchange rates). That leaves most of the smaller deals out of the sphere of interest of many a VC investor.

20.6 REGULATION OF VC INDUSTRY IN INDIA

In most countries the VC industry is subject to fewer regulations than other areas of the financial services sector. The rationale behind this appears to be that the participants in the VC industry are better informed economic agents who have the capability to obtain and process information that is necessary to arrive at rational investment decisions.

The regulation of VC investment activity in India may be examined under two broad headings : (i) Regulation of VC funds registered in India; and (ii) Regulation of foreign VC funds.

Regulation of VC Funds Registered in India

The regulation of VC funds registered in India comprises the taxation regime for VC funds and the regulation of their business activities by the Securities and Exchange Board Of India (SEBI). To get an update on SEBI regulation visit: www.sebi.com.

SEBI (Venture Capital Funds) Regulations, 1996 Broadly, the SEBI (Venture Capital Funds) Regulations, 1996 (SEBI regulations, hereafter) purport to ensure that:

- VC funds do not access public investors who may not have the capability to assess the risks underlying investment in VC funds or VC situations.
- VC funds invest in unlisted companies that are not in a position to access public financial markets.

The important provisions of the SEBI Regulations are given below.

1. A venture capital fund (VCF) may be established in the form of a trust or a company. Every VCF will have to register with the SEBI and obtain a certificate from the SEBI to engage in the business of making VC investments.
2. In order to ensure that VCFs do not raise capital from the public the SEBI regulations require that:
   - That the Memorandum of Association of the company preclude the VCF from inviting public capital subscriptions from the public.
   - That the minimum subscription per investor is Rs 5 lakh and minimum size of the corpus for a VCF to commence business is Rs 5 crore.
   - The VCF may not list its shares or units on a stock exchange for a period of three years from the date of issue.
3. The regulations seek to ensure that VCFs invest in unlisted companies by stipulating that
   - A Venture Capital Undertaking is a domestic company whose shares are not listed on a recognised stock exchange in India
   - 75% or more of the investible funds are invested in equity shares or "equity linked instruments" of unlisted companies.

4. VCFs are not allowed to invest more than 25% of the corpus in any one company. VCFs are also not allowed to invest in "associated companies". These restrictions are presumably intended to pre-empt business houses from misusing the tax concessions available to a VCF for investing in companies of the group.

Taxation of Income of Indian VC funds Section 10(23FB) of the Indian Income Tax Act, 1961 exempts the income of VCFs by way of dividend and long term capital gains from tax. In order to avail the tax exemption the VC fund will have to register with the SEBI along the lines explained above. As with the SEBI regulations, the tax provision purports to ensure that VCFs invest in unlisted companies which are not in a position to access public financial markets.

Regulation of VC Funds Registered Outside India

The investment activities of funds registered outside India and investing in India are regulated either by the foreign direct investment regime (FDI) in India or regulations governing foreign institutional investors (FIIs) who are registered with SEBI. The FDI regime requires the foreign investor to obtain approval for each individual investment transaction. So also, when investments are liquidated and the proceeds sought to be repatriated, the foreign investor is required to obtain the necessary approvals for each transaction. Foreign investors have also discovered tax efficient means of structuring their investment activity such as registering the investment company in countries that have favourable tax treaties with India such as Mauritius.

The regulatory regime governing foreign investors does not specifically address the needs of the VC investor. There are several complexities that cause delays at the time of entry and exit for the foreign investor. Sometimes these procedures can even restrict the investor from realising the best possible terms as in the case of certain exits. Notwithstanding these issues, foreign investors seem to prefer these alternate regimes to the SEBI regime.

20.7 CURRENT CONCERNS OF THE INDIAN VC INDUSTRY

Considering the potential for the various sectors in an economy that is developing, the Indian industry should provide many attractive investment opportunities for VC investors. However there appear to be numerous issues that could cause concern to potential investors. Some of them are discussed briefly below.

1. The common refrain among VC investors has been the *lack of deal flow* of an acceptable "quality". This could be, *inter alia*, due to a complex interaction of social, cultural and economic issues that could possibly be inhibiting the growth of entrepreneurship.
2. Exit by IPO from VC investments has been a cause for concern due to the *lack of liquidity* for most but the top thirty or forty shares that account for more than 80% of

the trading volumes on the stock exchanges. The impact cost for most of the other companies appears to be too high to enable the VC investors to manage profitable exits.

3. VC funds investing in India do not appear to have realised a competitive *risk adjusted rate of return* on the Indian portfolio, after taking into account emerging market risks and the risks that are typical of the average VC fund. Funds which are targetted at investment opportunities in India appear to have difficulty in persuading international investors to commit capital on the basis of actual performance of Indian VC funds.
4. *Contract enforcement* in India takes far too long and is fraught with too much uncertainty. This, combined with the relatively low levels of awareness of and commitment to sound corporate governance practices, appears to heighten anxiety about protecting the investor's interests in a company.
5. The *regulatory regime* is said to make entry into and exit from investments complex, time consuming and costly for foreign investors. The extant regime that provides for exemption of the profit and capital gains of VC funds from income tax are considered to be too restrictive to permit a healthy development of the business.
6. The industry also faces a *shortage of managers* with the necessary exposure to the practices of the VC industry in the western world.

20.8 HOW TO APPROACH A VC FUND

Most of the discussion above has been from the VC's viewpoint of the business. It would be useful for an entrepreneur, who proposes to raise VC, to keep some of the following considerations in mind.

Select the VCs you want to dialogue with VC funds have distinct investment focus areas in terms of industry sectors, the stage of evolution of the companies in which they would like to invest, the amount of financing and the extent of post financing involvement that the investor wishes to adopt. The entrepreneur would need to choose the VC fund, taking into account the fund's investment focus, before he sets out to have a serious discussion. This information can be acquired from brochures of various funds, their websites or by availing of the services of investment bankers who specialise in private equity fund raising.

Present an exciting and convincing story VC funds managers select a small number of companies to invest in from a large number of investment proposals they receive. In order to catch the investor's attention the entrepreneur must therefore have a business plan package that presents an exciting and convincing business story, laying out the potential size of the market for the product or service, the firm's competitive strategy, the financial return potential, and last but not the least, the competence of the management team to deliver these results.

Choose the right investment partner VC involves a closer relationship between the investor and the investee than between a lender and a borrower. This requires that the entrepreneur ensures that the VC fund

- Can develop a productive and harmonious relationship with the investee firm
- Has the organisation and personnel, with the necessary skills and experience to contribute the post financing value that the entrepreneur believes are important for growing the investee business.
- Has enough capital to meet the subsequent financing needs of the investee firm.

Be prepared for an open relationship The relationship between the investor and the investee is most productive where the entrepreneur and investee approach the relationship with a spirit of transparency and accommodate each other's reasonable business expectations. The entrepreneur has to be clear that he is prepared for such an open relationship with his financing partner when he raises VC.

SUMMARY

- A young private company that is not ready or willing to tap the public financial market may seek VC.
- VC funds are freestanding pools of capital, raised mostly from institutional investors and high networth individuals who have the ability to provide long term capital.
- VC investments involve businesses with potential for high growth in sales and profitability, equity or quasi-equity financing instruments, medium to long term investment horizons, above average investment risks and returns and active post financing involvement between investor and investee.
- Exceptionally high risks in terms of technology, management, product market and achieving liquidity increase the overall uncertainty underlying VC investments. VC investors also face the added problem of having to seek out information that they need, since unlisted firms are not subject to mandatory disclosure obligations unlike their listed counterparts.
- The VC investment process is different from that of appraising a term loan. VC investors place greater emphasis on assessing the capability of the management team, analysing the strategic strengths of the business in question and on whether, how and over what time frame investors will achieve liquidity on the investment.
- The process of assigning a monetary value to the equity shares of the prospective investee is known as valuation. VC investors convert the valuation estimate to arrive at a percentage of the equity that they seek for the amount of capital they propose to invest. The valuation of the firm, dependent as it is on several critical assumptions such as projected financial performance of the investee and choice of P/E or P/EBIDTA multiple, tends to be influenced by factors such as the outlook for the economy and capital market, industry and deal related factors and demand and supply for capital.

- VC investors pay considerable attention to structuring the deal, which comprises choosing the instruments for funding the company and defining the terms of the instrument such as yield, redemption or conversion as the case may be. The choice takes into account the investor's concern about liquidity and the need for influence in the management of the company, post financing.
- The relationship between the investor and the investee is governed through a set of agreements between the investor and the investee. The detailed covenants of these agreements define the rights of the investor and provide the levers of control to the investor in the post financing phase.
- The extent and style of post financing involvement adopted by VC fund managers varies from one fund to another. Through their nominees on the Board Of Directors, VC investors participate in organisation building and ensure key business decisions at the investee firm do not adversely affect the investor's interests.
- VC investors exit from their investments by selling their shares on a stock exchange once the shares are listed or by selling their stake to a strategic investor.
- The Indian VC industry is young by international standards but has evolved rapidly over the past decade. Foreign investors who entered the Indian industry after the de-regulation of foreign investment brought in their international fund management practices. Investment preferences of VC funds in India seem to have evolved in response to changes in the economy and the industrial sector, brought about by the economic reform process.
- The Indian VC industry is regulated by the Securities and Exchange Board Of India (SEBI). Funds which are registered with SEBI and fulfill criteria laid down in the Indian Income Tax Act 1961 enjoy exemption from income and capital gain tax. Foreign investors who invest through investment companies registered outside India, are subject to investment regulations governing foreign direct investments and are not subject to the regulatory oversight of SEBI.
- Several issues of concern surround the VC industry in India. Some of them are the low volumes of quality dealflow, poor liquidity on Indian stock exchanges affecting the VC investors' exit prospects, inability of funds to attract capital for investing into India because of the limited performance (return) record of Indian funds, delays and uncertainties in enforcement of commercial contracts, and regulatory complexities affecting foreign investors in terms of entry into and exit from investments.

  Notwithstanding these points of concern, the potential for industrial growth in the Indian economy should make the Indian VC industry attractive to foreign investors.

Questions

1. Define a venture capital investment.
2. Outline the characteristics of a venture capital investment that distinguish them from investing in the equity of an established firm listed on a stock exchange.
3. Briefly describe the important differences in emphasis between the appraisal of a project as part of a lending decision and the appraisal of a venture capital investment opportunity.
4. How do venture capital investors value their investment in a company? What are some of the factors that could influence this valuation?
5. Discuss the salient aspects of the regulation of the VC industry in India.

PART VI

Implementation

21. Project Management
22. Network Techniques for Project Management

CHAPTER 21

Project Management

The basic building blocks of the traditional form of organisation are a functional division of management and a well-defined hierarchical structure. Typically, a firm is organised into various departments, such as production, purchasing, marketing, finance, personnel, engineering, and research and development. Some of these departments have a line function and the others a staff function. Line managers have the principal responsibility for achieving the goals of the firm and are vested with decision making authority. Staff managers primarily serve in an advisory capacity—of course, within the staff departments they enjoy administrative powers.

The traditional form of organisation is quite appropriate for handling established operations which are characterised by a continuous flow of repetitive work, with each department attending to its specific functions—in such a setting, relatively stable inter departmental and inter-personal relationships emerge. However, the traditional form of organisation is not suitable for project management. Why? There are several reasons: (i) a project is a non-routine, non-repetitive undertaking often plagued with many uncertainties; (ii) the relationships in a project setting are dynamic, temporary, and flexible; and (iii) a project requires a coordination of the efforts of persons drawn from different functional areas and contributions of external agencies. Due to these reasons, project management calls for a different form of organisation, sharper tools of planning and control, and improved means of coping with human problems.

This chapter, concerned with various issues relating to project management, is divided into five sections:

- Forms of project organisation.
- Project planning.
- Project control.
- Human aspects of project management.
- Pre-requisites for successful project implementation

21.1 FORMS OF PROJECT ORGANISATION

The traditional form of organisation is not suitable for project work for the following reasons: (i) it has no means of integrating different departments at levels below the top management, and (ii) it does not facilitate effective communication, coordination, and control when several functional departments, with different professional backgrounds and orientations are involved in the project work under time and cost pressures, which often call for overlap, at least partial, of the development, design, procurement, construction, and commissioning work.

Hence there is a need for entrusting an individual (or group) with the responsibility for integrating the activities and functions of the various departments and external organisations involved in the project work. Such an individual may be called the project manager or project coordinator. Depending on the authority that is given to the person responsible for the project, the project organisation may take one of the following three forms:

- Line and staff organisation.
- Divisional organisation.
- Matrix organisation.

Line and Staff Organisation

In this form of project organisation, a person is appointed with the primary responsibility of coordinating the work of the people in the functional departments. Such a person, referred to commonly as the project coordinator, acts essentially in a staff position to facilitate the coordination of line management in functional departments. The project coordinator does not have authority and direct responsibility of the line management. He serves as a focal point for receiving project-related information and seeks to promote the cause of the project by rendering advice, sharing information, and providing assistance. He may gently coax line executives to strive for the fulfilment of project goals. Deprived of formal organisational authority, he may find it difficult to exert leadership and feel unsure of his role. His influence would depend on his professional competence, closeness to top management, and persuasive abilities. Clearly, this is a weak form of organisation which may be employed mostly for small projects—it is certainly not suitable for large projects.

Divisional Organisation

Under this form of project organisation, a separate division is set up to implement the project. Headed by the project manager, this division has its complement of personnel over whom the project manager has full line authority. In effect, this form of organisation implies the creation of a separate goal-oriented division of the company, with its own

functional departments. While the project manager still has the problem of coordinating the inputs of other organisations involved in the project, he has total formal control over the division he heads.

A very strong form of project organisation, the divisional project organisation facilitates the process of planning and control, brings about better integration of efforts, and strengthens the commitment of project-related personnel to the objectives of the project. It considerably improves the prospect of fulfilling the time and budget targets.

This form of organisation, however, may entail an inefficient use of the resources of the firm. It may result in an unnecessary duplication of specialists in the company, because of the necessity to allocate them in total to each project. Further, it may be difficult to achieve a higher degree of specialisation of expertise because the divisional project organisation may have to manage with, say, one mechanical engineer, rather than two specialists.

Matrix Organisation

The line and functional form of organisation is conducive to an efficient use of resources but is not suitable for an effective realisation of project objectives. The divisional form of organisation, on the other hand, is suitable for an effective realisation of project objectives but is not conducive to an efficient use of resources. The matrix form of organisation, the third form of project organisation, seeks to achieve the twin objectives of efficient use of resources and effective realisation of project objectives—at the cost of greater organisational complexity, of course.

In a matrix organisation, the personnel working on the project have a responsibility to their functional superior as well to the project manager. This means that the authority is shared between the project manager and the functional managers. The authority and influence of the project manager cut across the traditional vertical line of command. Exhibit 19.1 shows the organisation chart for a typical matrix organisation. As is evident from this exhibit, the project manager integrates the contributions of personnel in various functional departments toward the realisation of project objectives. While the personnel maintain their departmental affiliation and are responsible to their functional superiors, they are responsible to the project manager as well.

The matrix form of organisation is incongruent with the traditional organisation theory: there is dual subordination; responsibility and authority are not commensurate; the hierarchical principle is ignored. This clearly implies that the matrix form of organisation involves greater organisational complexity and creates an inherently conflictful situation. Yet it seems to be a better vehicle for the simultaneous pursuit of the twin objectives—efficient utilisation of resources and effective attainment of project objectives—which were discussed earlier.

21.2 PROJECT PLANNING

Projects involving few activities, resources, constraints, and inter-relationships can be visualised easily by the human mind and planned informally. However, when a project crosses a certain threshold level of size and complexity, informal planning has to be substituted by formal planning. The need for formal planning is indeed much greater for project work than for normal operations. Without effective planning, there may be chaos.

Functions of Planning

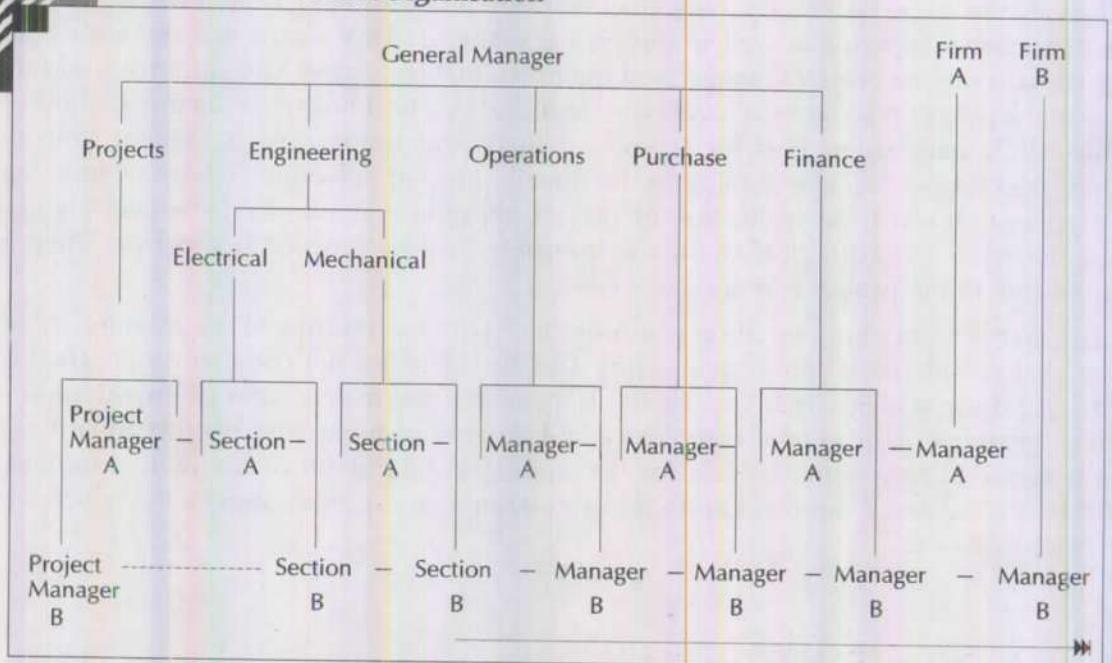
Planning, a vital aspect of management, serves several important functions:

- It provides a basis for organising the work on the project and allocating responsibilities to individuals.
- It is a means of communication and coordination between all those involved in the project.
- It induces people to look ahead.
- It instills a sense of urgency and time consciousness.
- It establishes the basis for monitoring and control.

Areas of Planning

Comprehensive project planning covers the following:

Exhibit 21.1 ***Matrix Organisation***



- *Planning the project work* The activities relating to the project must be spelt out in detail. They should be properly scheduled and sequenced.
- *Planning the manpower and organisation* The manpower required for the project (managers, technologists, operators, and others) must be estimated and the responsibility for carrying out the project work must be allocated.
- *Planning the money* The expenditure of money in a time-phased manner must be budgeted.
- *Planning the information system* The information required for monitoring the project must be defined.

Project Objectives and Policies

Often, the focus of project planning is on questions like who does what and when. Before such operational planning is done, the objectives and policies guiding the project planning exercise must be articulated. The questions to be answered in this context are: What are the technical and performance objectives? What are the time and cost goals? To what extent should the work be given to outside contractors? How many contractors should be employed? What should be the terms of contract?

Well-defined objectives and policies serve as the framework for the decisions to be made by the project manager. Throughout the life of the project, he has to seek a compromise between the conflicting goals of technical performance, cost standard, and time target. A clear articulation of the priorities of management will enable the project manager to take expeditious actions.

Work Breakdown Structure

The work breakdown structure, as its name suggests, represents a systematic and logical breakdown of the project into its component parts. It is constructed by dividing the project into its major parts, with each of these being further divided into sub-parts. This is continued till a breakdown is done in terms of manageable units of work for which responsibility can be defined. Thus the work breakdown structure helps in:

- Effective planning by dividing the work into manageable elements which can be planned, budgeted, and controlled.
- Assignment of responsibility for work elements to project personnel and outside agencies.
- Development of control and information system.

Work Breakdown Structure and Project Organisation The project organisation represents formally how the project personnel and outside agencies are going to work. The work breakdown structure defines the works to be done in a detailed manner. To assign responsibility for the tasks to be done, the work breakdown structure has to be integrated with the project organisation structure. This calls for blending the vertical breakdown of

the work (as arrived in the work breakdown structure) with the project organisation structure. This results in delineation of project tasks which are the specific responsibilities of organisational units/managers. The technical name given to such a project task is *cost account*. A cost account represents a unit of work (i) which is defined in fairly concrete terms, (ii) for which a single person is responsible, and (iii) for which a budget of expenditure and manpower requirement can be prepared meaningfully.

Life Cycle of a Project

The important stages in the life cycle of a project are:

- Project development and preliminary engineering.
- Bidding and contract negotiation.
- Engineering design.
- Purchase and procurement.
- Construction.
- Commissioning.

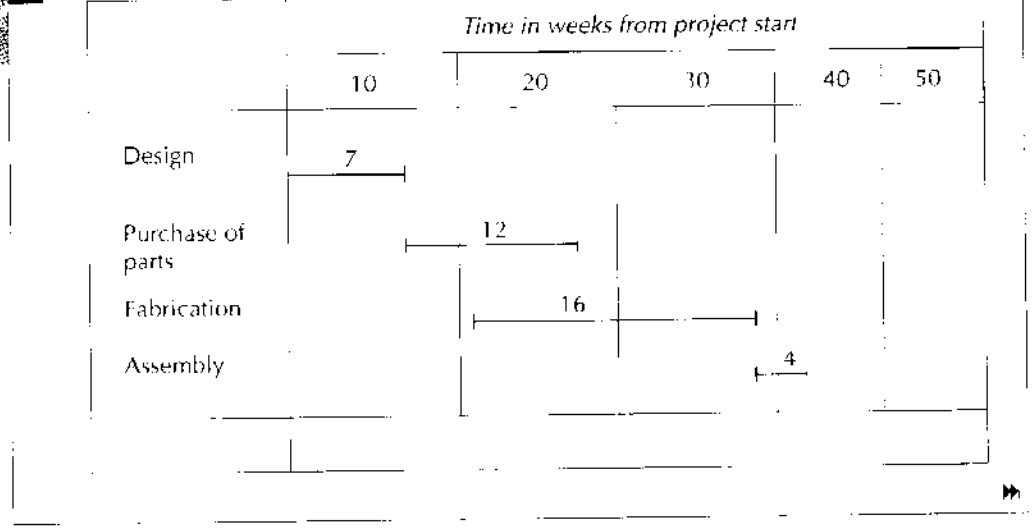
In planning these stages, one has to bear in mind two concepts: the rolling wave concept and the integration concept. According to the rolling wave concept, when detailed planning is done for project development and preliminary engineering, summary planning would be done for the remaining steps. When the actual work on project development and preliminary engineering commences, detailed planning would be done for the next stage which is concerned with bidding and contract negotiation, and so on. According to the integration concept, planning for all stages must be integrated, even though detailed planning would be done in accordance with the rolling wave concept. The need for integrative planning stems from the inter-relationship among various stages of project work. This need is further reinforced when the compulsion to reduce the project duration leads to overlap, at least partial, of various stages of the project.

Tools of Planning

The oldest formal planning tool is the bar chart, also referred to as the Gantt chart or the multiple activity chart. In the last five decades, network techniques have received considerable attention. This section briefly describes the nature of these tools of planning. (Network techniques, which warrant a detailed discussion, are covered at length in the following chapter.)

Bar Chart This is a pictorial device in which the activities are represented by horizontal bars on the time axis. The left-hand end of the bar shows the beginning time, the right-hand end the ending time. The duration of the activity is indicated by the length of the bar. The manpower required for the activity is shown by a number on the bar. An illustrative bar chart is shown in Exhibit 21.2.

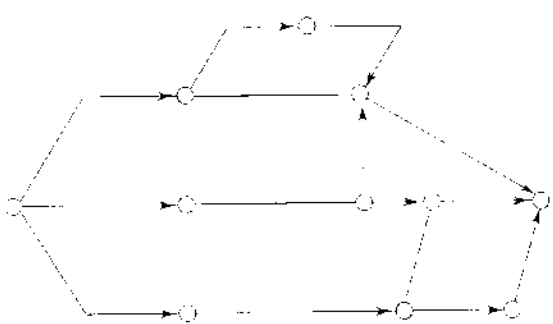
Exhibit 21.2 ***An Illustrative Bar Chart***



The advantages of the bar chart are: (i) it is simple to understand; (ii) it can be used to show progress; and (iii) it can be used for manpower planning. The bar chart, however, suffers from some disadvantages which limit its usefulness: (i) it cannot show interrelationship among activities on large, complex projects; (ii) there may be a physical limit to the size of the bar chart, which may limit the size of the project that can be planned with this technique; and (iii) it cannot easily cope with frequent changes or updating.

Network Techniques These are more sophisticated than the traditional bar chart. In these techniques, the activities, events, and their inter-relationships are represented by a network diagram, also called an arrow diagram. Exhibit 21.3 shows an illustrative network diagram.

Exhibit 21.3 ***An Illustrative Network Diagram***



The advantages of network techniques are: (i) they can effectively handle inter-relationships among project activities; (ii) they identify the activities which are critical to the completion of the project on time and indicate the float (or spare time) for other activities; (iii) they can handle very large and complex projects; and (iv) they can be easily computerised and updated.

While the network techniques are a superior tool for project planning, they suffer from several drawbacks: (i) being more complicated than the traditional bar chart they are not easily understood by the project personnel; and (ii) they do not define an operational schedule which tells who does what and when.

Hierarchy of Plans

A large project may consist of thousands (or even tens of thousands) of activities. A project plan consisting of such a large number of activities cannot be comprehended and visualised by the human mind. Hence, the global plan of so many activities may be held in a computer memory and structured on a hierarchical and modular basis in terms of plans of much smaller size, consisting of, say, 30 to 150 activities. Thus, for a large project a hierarchy of plans, having varying levels of detail, as illustrated by Exhibits 21.4 and 21.5 need to be prepared.

I Level Plan A highly summarised plan, the I level plan shows the broad activities of the project, such as engineering design, contract negotiation, procurement, construction, and commissioning with very elementary breakdown. It may serve as the basis for making rough estimates for overall resources and outlays. It would indicate the major inter-relationships in the project and suggest what could be the critical phases of the project. Such a plan is useful for strategic planning and establishing project objectives and policies. It serves as a tool for top management review.

II Level Plan The activities in the summary plan (at the I level) are shown in greater detail in the II level plan. This permits a more detailed examination of various stages of the project, so that inter-relationships can be properly established. The II level plan is essentially a tool of middle management planning, decision making, and control. It facilitates (i) identification of individuals responsible for various work packages,[1] (ii) aggregative manpower planning, and (iii) broad scheduling of project work.

III Level Plan This is the plan constructed in terms of cost accounts. It is useful for lower levels of management. It helps them in week to week, or even day to day, planning and control. Such a plan is based on a very detailed estimate of resource requirement, funds availability, project inter-relationships, and time targets.

1. A work package represents a higher element than the cost account in the work breakdown structure.

Exhibit 21.4 ***A Hierarchy of Bar Charts***

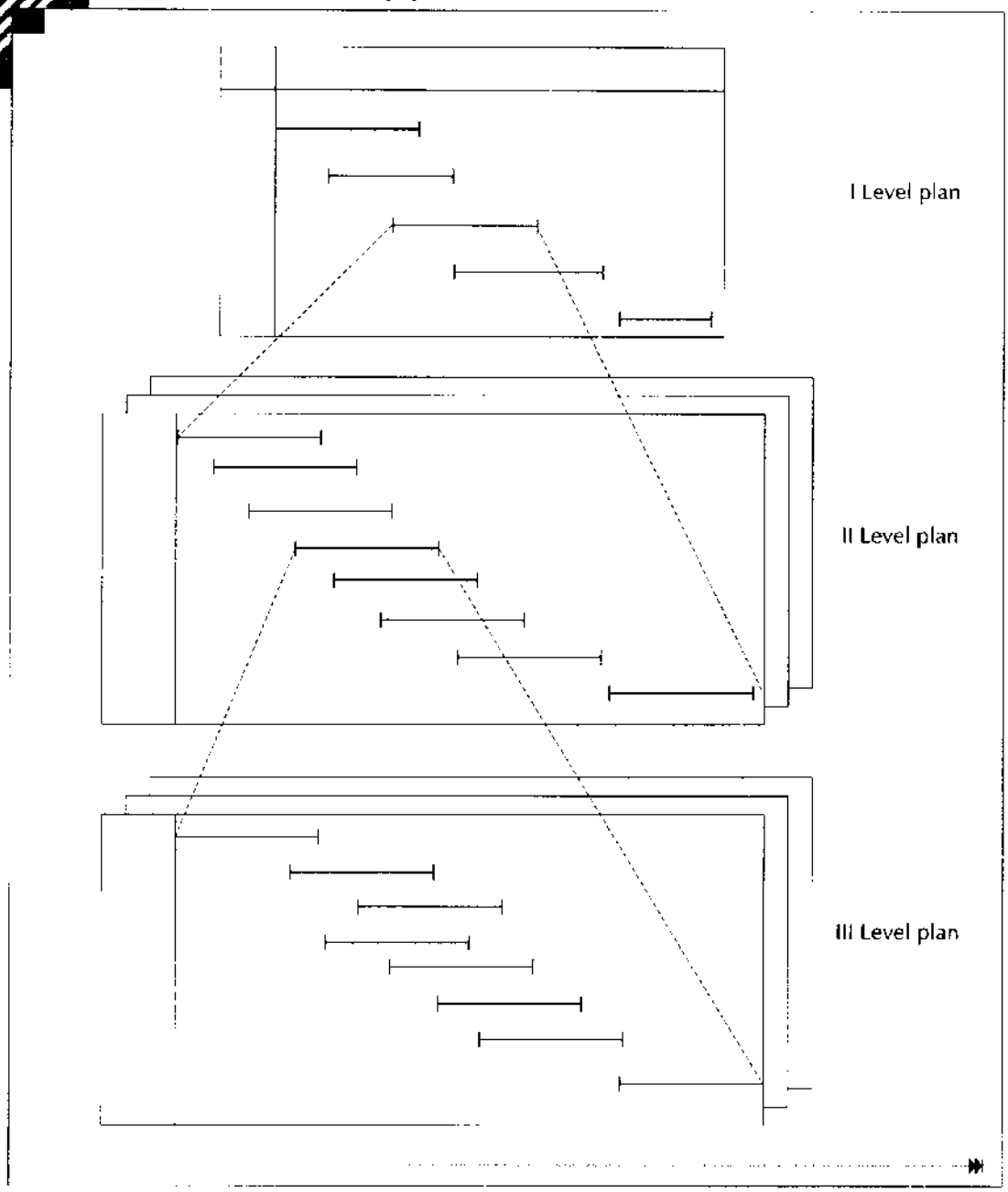
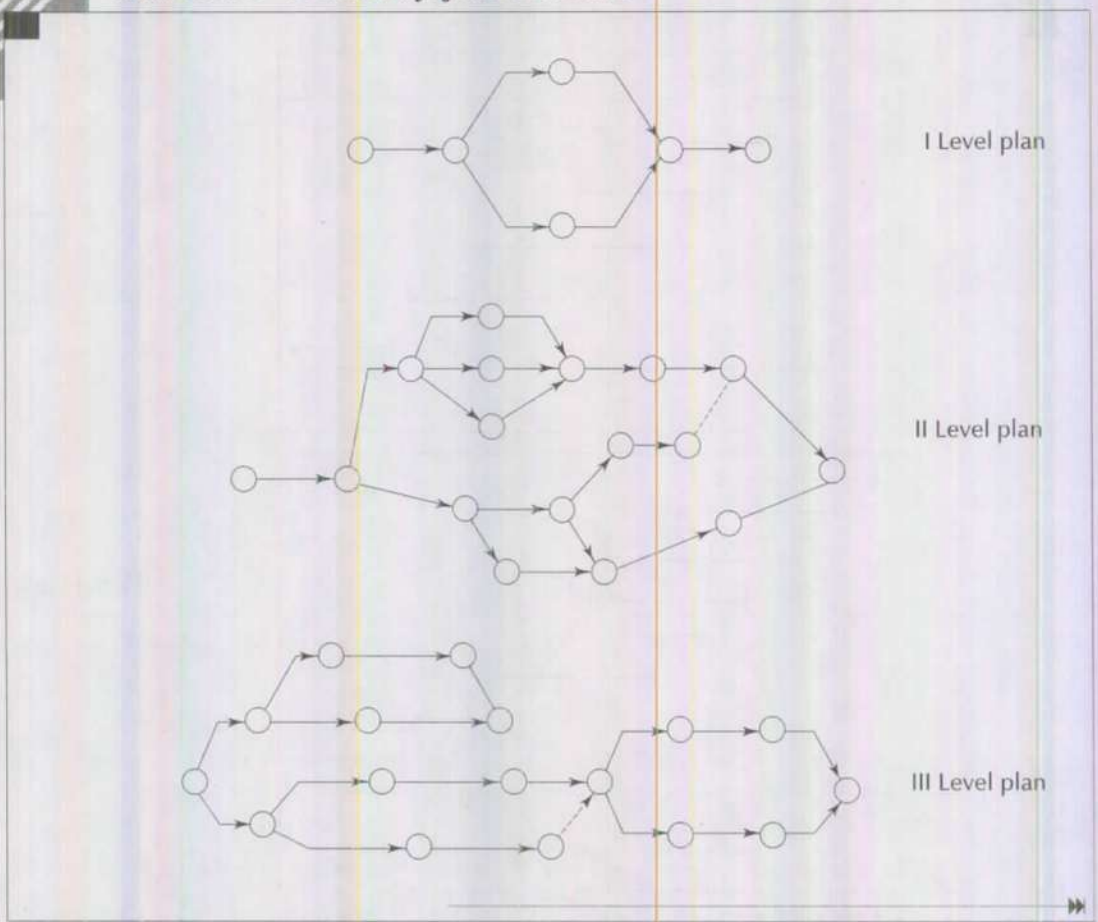


Exhibit 21.5 ***A Hierarchy of Network Plans***



21.3 PROJECT CONTROL

No sooner is the project launched, control becomes the dominant concern of the project manager. Indeed, once the launch phase is over, planning and control become closely intertwined in an integrated managerial process.

Project control involves a regular comparison of performance against targets, a search for the causes of deviation, and a commitment to check adverse variances. It serves two major functions: (i) it ensures regular monitoring of performance, and (ii) it motivates project personnel to strive for achieving project objectives.

Reasons for Ineffective Control

Effective control is critical for the realisation of project objectives. Yet, control of projects in practice tends to be ineffective. Why? There seems to be three reasons for poor control of projects.

Characteristics of the Project Most of the projects are large, complex undertakings involving many organisations and people. This renders the task of control difficult because:

- Keeping track of physical performance and expenditure on hundreds or thousands (or tens of thousands) of activities which are often non-routine is a stupendous task.
- Coordination and communication problems multiply when several organisations are involved in the project.

People Problems To control a non-routine project, a manager requires an ability to monitor a wide range of disparate factors, a sensitivity to symptoms indicative of potential problems, and a faculty for comprehending the combined effect of multiple forces. Naturally, most of the operational managers, used to the steady rhythm of normal operations and routine work lack the experience, training, competence, and inclination to control projects.

Poor Control and Information System One of the factors which inhibits effective control is the poor quality of control and information system. Some of the weaknesses observed in the control and the information system are:

- *Delay in reporting performance* Often there is a delay in the reporting of performance. This prevents effective monitoring of the project and initiation of timely action to check adverse developments.
- *Inappropriate level of detail* Generally cost information for control is collected in terms of cost codes found in the company's cost accounting system, irrespective of the level of detail employed for project planning and budgeting. Consider an extreme example wherein cost and value of work done are reported for the project as a whole. What is the value of such information for identifying where slippages are occurring and who is responsible for them.
- *Unreliable information* One of the major problems in project control is unreliable and inaccurate data and information. Often project managers receive reports which suggest that "everything is okay" or things are "reasonably within control" when the reality is otherwise. Further, for months after the project is completed, costs dribble in to change a favourable variance into an unfavourable one or to aggravate an unfavourable variance.

Variance Analysis Approach

The traditional approach to project control involves a comparison of the actual cost with the budgeted cost to determine the variance. An example of variance analysis follows:

	Activity A	*Activity B*
Budgeted cost in the period	50,000	30,000
Cumulative budget to date	200,000	75,000
Actual cost in the period	55,000	28,000
Cumulative actual cost to date	240,000	80,000
Variance for the period	(5,000)	2,000
Cumulative variance to date	(40,000)	(5,000)

The variance analysis approach is inadequate for project control for the following reasons:

1. *It is backward looking rather than forward looking* It tells only what happened in the past but does not answer the following questions: What will happen in future? Is the rate of work accelerating or decelerating?
2. *It does not use the data effectively to provide integrated control* The traditional variance analysis shows whether in the time period under analysis more or less resources were expended than budgeted. However, it does not indicate the value of work done. This information is vital for purposes of control.

Performance Analysis: Modern Approach to Control

Effective control over a project requires systematic 'performance analysis'. This calls for answering the following questions:

- Is the project as a whole (and its individual parts) on schedule, ahead of schedule, or behind schedule? If there is a variation, where did it occur, why did it occur, who is responsible for it, and what would be its implications?
- Has the cost of the project as a whole (and its individual parts) been as per budget estimates, less than the budget estimates, or more than the budget estimates? If there is a variation, where did it occur, why did it occur, who is responsible for it, and what would be its implications?
- What is the trend of performance? What would be the likely final cost and completion date for the project and its individual parts?

For small and simple projects, the project managers would do performance analysis for the project as a whole, or for its major components. As the project becomes larger and more complex, performance analysis needs to be done for individual segments of the projects which are referred to as 'cost accounts.' As we have seen earlier, a 'cost account' is a logical management centre.

Method of Analysis For analysing the performance at cost account and higher levels of the work breakdown structure, we employ a method of analysis which takes into account the value of work that has been done. In the traditional method of analysis, the project manager measured the actual progress against the predetermined schedule and the actual cost against the budget estimate. This did not enable him to know systematically whether the expenditure incurred was commensurate with progress. He perhaps relied on subjective estimates.

Performance analysis seeks to remove this subjectivity by employing an analytical framework based on the following terms:

- *BCWS* (Budgeted cost for work scheduled): It represents the total of three components: (i) budgets for all work packages, scheduled to be completed, (ii) budgets for the portion of in-process work, scheduled to be accomplished, and (iii) budgets for the overheads for the period.
- *BCWP* (Budgeted cost for work performed): This is equal to the sum of three components: (i) budgets for work packages actually completed, (ii) budgets applicable to the completed in-process work, and (iii) overhead budgets.
- *ACWP* (Actual cost of work performed): This represents the actual cost incurred for accomplishing the work performed during a particular time period.
- *BCTW* (Budgeted cost for total work): This is simply the total budgeted cost for the entire project work.
- *ACC* (Additional cost for completion): This represents the estimate for the additional cost required for completing the project.

Given the above terms, the project may be monitored along the following lines:

Cost variance	:	$BCWP - ACWP$
Schedule variance in cost terms	:	$BCWP - BCWS$
Cost performance index	:	$BCWP/ACWP$
Schedule performance index	:	$BCWP/BCWS$
Estimated cost performance index	:	$BCTW/(ACWP + ACC)$

Performance Analysis: An Illustration

A project was begun on 1st January 20X0 and was expected to be completed by 30th September 20X0. The project is being reviewed on 30th June 20X0 when the following information has been developed.

			Rs
Budgeted cost for work scheduled	(*BCWS*)	:	1,500,000
Budgeted cost for work performed	(*BCWP*)	:	1,400,000
Actual cost of work performed	(*ACWP*)	:	1,600,000
Budgeted cost for total work	(*BCTW*)	:	2,500,000
Additional cost for completion	(*ACC*)	:	1,200,000

Analysis

			Rs
— Cost variance	:	$BCWP - ACWP$	= (1,400,000 – 1,600,000)
			= – 200,000
— Schedule variance in cost terms	:	$BCWP - BCWS$	= (1,400,000 – 1,500,000)
			= – 100,000

— Cost performance index : $BCWP/ACWP = \frac{1,400,000}{1,600,000}$

$= 0.8075$

— Schedule performance index : $BCWP/BCWS = \frac{1,400,000}{1,500,000}$

$= 0.933$

— Estimated cost performance index : $BCTW/(ACWP + ACC) = \frac{2,500,000}{(1,600,000 + 1,200,000)}$

$= 0.893$

21.4 HUMAN ASPECTS OF PROJECT MANAGEMENT

A satisfactory human relations system is essential for the successful execution of a project. Without such a system, the other systems of project management, however sound they may be by themselves, are not likely to work well. While technical problems can often be solved with additional investment of resources, people's problems may not be amenable to a satisfactory solution in the short span of the project life.

To achieve satisfactory human relations in the project setting, the project manager must successfully handle problems and challenges relating to:

- Authority.
- Orientation.
- Motivation.
- Group functioning.

Authority

Except in the divisional organisation, the project manager whose activities cut across functional lines of command, lacks the desired formal authority over project-related personnel. Without the conventional leverage of hierarchical authority, the project manager has to coordinate the efforts of various functional groups (within the organisation) and outside agencies. While he often has formal control emanating from contracts and agreements, as far as outside agencies involved in the project work are concerned, in his own organisation he has to contend with split authority and dual subordination.

Since the project manager works largely with professionals and supervisory personnel, the basis of the authority would be different from that found in simple superior–subordinate relationships. For exercising leadership and influence over professional people, he has

to explain the logic and rationale for the project activities; show receptivity to the suggestions made by others; avoid unilateral imposition of decisions; eschew dogmatic postures; and search for areas of agreement which can be the basis of acceptable solutions.

His effective authority would stem from his ability to develop a rapport with the project personnel, his skill in resolving conflicts among various people working on the project, his professional reputation and stature, his skills in communication and persuasion, and his ability to act as a buffer between the technical, engineering, financial, and commercial people involved in the project.

Orientation

Most of the managers working for a project are usually engineers (or technologists). Typically, an engineer:

- Works with physical laws, characterised by mathematical precision, as his tools.
- Adopts a structured, mechanical approach to his problems.
- Seeks an enduring solution to his problem.
- Attaches a high value on technical perfection.

When an engineer assumes managerial responsibilities, he faces a very different world in which he is supposed to:

- Perform the tasks of planning, organising, directing, and controlling the resources of the firm in a world of uncertainty.
- Adopt a more creative approach to solve non-programmed and unstructured problems.
- Attach greater importance to efficient utilisation of resources and resolution of human relation problems.

Thus the project manager has to strengthen the managerial orientation of project personnel so that the project goals and objectives can be efficiently achieved within the constraints of time and budget. Clearly for achieving this task he must himself be an accomplished engineer–manager.

Motivation

The project manager functions within the boundaries of a socio-technical system. Most of the factors of this system—organisational structure, technical requirements, competencies of project personnel—are more or less 'given' for him. The principal behavioural factor which he can influence is the motivation of the project personnel. In this context, he should bear in mind the following:

- Human beings are motivated by a variety of needs: physiological needs, social needs, recognition needs, and self-actualisation needs. Individuals differ greatly in the importance they attach to various need satisfactions. Further, their attitudes tend to

change with time and circumstances, and are significantly influenced by their peers and superiors.

- The traditional approach to management was based on the assumption that human beings regard work as unpleasant, shirk responsibility, and ordinarily employ inefficient and wasteful methods. Such a conception of human behaviour suggests that a great deal of pressure has to be applied. Behavioural research, however, has shown that while some pressure is beneficial, an excess of it is undesirable. Beyond a certain point, pressure is dysfunctional.
- Motivation tends to be strong when the goal set is challenging, yet attainable. If the goal is too demanding, it results in frustration and conflict; if too lax, it induces complacency.
- Expectation of reward, rather than fear of punishment, has a greater bearing on individual behaviour. Further, the effectiveness of reward or punishment depends on how quickly it is administered.
- In a project setting where hygiene factors (like pay, physical working conditions, etc.) are reasonably taken care of, the principal motivators would be a sense of accomplishment and professional growth. In this setting, the project manager should rely more on participative methods of management.

In order to succeed in motivating project personnel, the project manager must be a perceptive observer of human beings, must have the ability to appreciate the variable needs of human beings, must have skill in several styles of management suitable to different situations, and must be sensitive to the reactions of people so that he can act supportively rather than threateningly.

Understandably, the project manager has a difficult task. In this endeavour, he can, however, count on one blessing: the stimulating and satisfying nature of project work. In established organisations many professional and supervisory personnel find it difficult to see how their efforts redound to the realisation of organisational goals. Separated from top management by several layers of organisational hierarchy, they are unable to relate their work to the missions of the firm (which themselves often may be blurred to them). In addition, the jobs in established organisations are somewhat dull and routine. All this creates a sense of alienation and frustration which dampens motivation. Fortunately, in a project setting, where the superordinate goals are clearly defined and visible to all involved, where there is usually a great emphasis on participative style of management, where the layers in the organisational hierarchy are few, and where the jobs are more challenging, project personnel tend to have greater commitment. Being able to relate their work easily to the goals of the project, their motivation is usually high.

Group Functioning

In a large complex project, many persons drawn from different functions, departments, and organisations are involved. This leads to formation of groups, formal and informal.

According to Rensis Likert, organisations may be considered as systems of interlocking groups. Thus, in a typical project organisation, many interlocking and interdependent groups are formed.

The groups formed in a project setting may be of three types: vertical groups, horizontal groups, and mixed groups. A *vertical group* consists of people drawn from different levels in the same department, or function, or company. A *horizontal group* consists of people drawn from different functions, departments, and companies, but occupying similar hierarchical positions. A *mixed group* consists of people drawn from different levels from various functions, departments, and companies.

A vertical group tends to form most naturally because of departmental/functional/organisational affinities. However, the existence of such groups may lead to a pronounced "we/they" attitude and accentuate conflicts. A horizontal group is a useful instrument in linking the overall project organisation. The members of the horizontal group, occupying key positions in their respective fields, serve as channels of communication. By their influence, they can strengthen the commitment to the project. The mixed group tends to promote greater cohesion of the total project organisation. It is very conducive to creating a 'project' attitude and developing an overriding commitment for the project. Hence the project manager should strive to establish a mixed group as the principal group of the project. However, it is difficult to establish such a group because of the temporary nature of a project—when members of a group know that the group would be dissolved sooner or later, they retain strong links with their parent company or department.

Building Effective Groups An effective group consists of members who are satisfied and committed and who strive for the attainment of project objectives, without dissipating their energies in inter-personal and inter-group conflicts. The manifest signs of an effective group are: *esprit de corps*, pride in the project, supportive behaviour, coordinated endeavour, mutual respect, and resilience during trying periods. An ineffective group, on the other hand, consists of disgruntled members who are more involved in inter-personal and inter-group rivalries and less concerned about project goals. Such a group is characterised by apathy, animosity, mutual bickering, disjointed efforts, cynical attitudes, and low morale.

How can effective groups be established? Studies in group dynamics suggest several stages, which are partially overlapping, in the formation of an effective group:

- Development of mutual trust.
- Diminution of defensive behaviour.
- Openness and candour in communication.
- Cooperation and supportive behaviour.
- Resolution of differences by mutual negotiation.

For building an effective group, the firm must pursue a genuinely participative style of management. With this managerial philosophy, the project manager can facilitate the development of mutual trust and acceptance, open communication, cooperation, and project

attitude. In this task, he needs leadership capabilities, sensitivity to human nature, perceptiveness, concern for welfare of others, maturity, and impartial approach. Clearly this is a difficult and challenging task.

21.5 PRE-REQUISITES FOR SUCCESSFUL PROJECT IMPLEMENTATION

Time and cost over-runs of projects are very common in India, particularly in the public sector. The Annual Report of the Ministry of Programme Implementation for a recent year provides some alarming information about 184 central projects monitored by the Ministry of Programme Implementation:

- 119 projects (about 65 percent of the total) have suffered time over-runs, which have gone as high as about 200 percent—the average delay in commissioning these projects was about 3 years.
- 125 projects (about 68 percent of the total) have suffered cost over-runs, which have been as high as 75 percent.
- Projects for which no time and cost over-runs have been indicated have mostly been taken up recently and it is likely that many of them will also suffer from time and cost over-runs.

A similar analysis of state projects would perhaps reveal an even more dismal picture. Due to such time and cost over-runs, projects tend to become uneconomical, resources are not available to support other projects, and economic development is adversely affected.

What can be done to minimise time and cost over-runs and thereby improve the prospects of the successful completion of projects? While a lot of things can be done to achieve this goal, the more important ones appear to be as follows:

- Adequate formulation.
- Sound project organisation.
- Proper implementation planning.
- Advance action.
- Timely availability of funds.
- Judicious equipment tendering and procurement.
- Better contract management.
- Effective monitoring.

Adequate Formulation

Often project formulation is deficient because of one or more of the following shortcomings:

- Superficial field investigation.
- Cursory assessment of input requirements.
- Slip-shod methods used for estimating costs and benefits.

- Omission of project linkages.
- Flawed judgments because of lack of experience and expertise.
- Undue hurry to get started.
- Deliberate over-estimation of benefits and under-estimation of costs.

Care must be taken to avoid the above deficiencies so that the appraisal and formulation of the project is thorough, adequate, and meaningful.

Sound Project Organisation

A sound organisation for implementing the project is critical to its success. The characteristics of such an organisation are:

- It is led by a competent leader who is accountable for the project performance.
- The authority of the project leader and his team is commensurate with their responsibility.
- Adequate attention is paid to the human side of the project.
- Systems and methods are clearly defined.
- Rewards and penalties to individuals are related to performance.

Proper Implementation Planning

Once the investment decision is taken—and often even while the formulation and appraisal are being done—it is necessary to do detailed implementation planning before commencing the actual implementation. Such planning should, *inter alia*, seek to:

- Develop a comprehensive time plan for various activities like land acquisition, tender evaluation, recruitment of personnel, construction of buildings, erection of plant, arrangement for utilities, trial production run, etc.
- Estimate meticulously the resource requirements (manpower, materials, money, etc.) for each period to realise the time plan.
- Define properly the inter-linkages between various activities of the project.
- Specify cost standards.

Advance Action

When the project appears *prima facie* to be viable and desirable, advance action on the following activities may be initiated: (i) acquisition of land, (ii) securing essential clearances, (iii) identifying technical collaborators/consultants, (iv) arranging for infrastructure facilities, (v) preliminary design and engineering, and (vi) calling of tenders.

To initiate advance action with respect to the above activities, some investment is required. Clearly, if the project is not finally approved, this investment would represent an infructuous outlay. However, the substantial savings (in time and cost) that are expected

to occur, should the project be approved (a very likely event, given the *prima facie* desirability of the project) often amply justify the incurrence of such costs.

Timely Availability of Funds

Once a project is approved, adequate funds must be made available to meet its requirements as per the plan of implementation—it would be highly desirable if funds are provided even before the final approval to initiate advance action. Piecemeal, ad-hoc, and niggardly allocation, with undue rigidities, can impair the manoeuvrability of the project team. It is a common observation that firms which have a comfortable liquidity position are, in general, able to implement projects expeditiously and economically. Such firms can initiate advance actions vigorously, negotiate with suppliers and contractors aggressively, organise input supplies quickly, take advantages of opportunities to effect economies, support suppliers in resolving their problems so that they can in turn redound to the successful completion of projects, and sustain the morale of project-related personnel at a high level.

Judicious Equipment Tendering and Procurement

To minimise time over-runs, it may appear that a turnkey contract has obvious advantages. Since these contracts are likely to be bagged by foreign suppliers, when global tenders are floated, a very important question arises. How much should we rely on foreign suppliers and how much should we depend on indigenous suppliers? Over-dependence on foreign suppliers, even though seemingly advantageous from the point of view of time and cost, may mean considerable outflow of foreign exchange and inadequate incentive for the development of indigenous technology and capability. Over-reliance on indigenous suppliers may mean delays and higher uncertainty about the technical performance of the project. A judicious balance must be sought which moderates the outflow of foreign exchange and provides reasonable fillip to the development of indigenous technology. In any case, the number of contract packages should be kept to a minimum in order to ensure effective coordination.

Better Contract Management

Since a substantial portion of a project is typically executed through contracts, the proper management of contracts is critical to the successful implementation of the project. In this context, the following should be done:

- The competence and capability of all the contractors must be ensured—one weak link can jeopardise the timely performance of the contract.
- Proper discipline must be inculcated among contractors and suppliers by insisting that they should develop realistic and detailed resource and time plans which are congruent with the project plan.

- Penalties—which may be graduated—must be imposed for failure to meet contractual obligations. Likewise, incentives may be offered for good performance.
- Help should be extended to contractors and suppliers when they have genuine problems—they should be regarded as partners in a common pursuit.
- Project authorities must retain latitude to off-load contracts (partially or wholly) to other parties well in time where delays are anticipated.

Effective Monitoring

In order to keep a tab on the progress of the project, a system of monitoring must be established. This helps in:

- Anticipating deviations from the implementation plan.
- Analysing emerging problems.
- Taking corrective action.

In developing a system of monitoring, the following points must be borne in mind:

- It should focus sharply on the critical aspects of project implementation.
- It must lay more emphasis on physical milestones and not on financial targets.
- It must be kept relatively simple. If made over-complicated, it may lead to redundant paper work and diversion of resources. Even worse, monitoring may be viewed as an end in itself rather than as a means to implement the project successfully.

SUMMARY

- The traditional form of organisation is not very suitable for project work because it has no means of integrating different departments at levels below the top management and it does not facilitate effective communication, coordination, and control.
- Project organisation may take one of the following three forms: line and staff organisation, divisional organisation, and matrix organisation.
- In the line and staff form of project organisation, a person is appointed with the primary responsibility of coordinating the work of the people in the functional departments. Under the divisional form of project organisation, a separate division headed by the project manager is set up to implement the project. In a matrix organisation, the personnel working on the project have a responsibility to their functional superior as well as to the project manager.
- The line and functional form of organisation is conducive to an efficient use of resources but is not suitable for an effective realisation of project objectives. The divisional form of organisation, on the other hand, is suitable for an effective realisation of project objectives but not conducive to an efficient use of resources. The matrix form of organisation seeks to achieve the twin objectives of efficient use of resources and effective realisation of project objectives, at the cost of greater organisational complexity, of course.

- Comprehensive project planning covers the following areas: project work, manpower and organisation, money, and information systems.
- The important stages in the life cycle of a project are: project development and preliminary engineering, bidding and contract negotiation, engineering design, purchase and procurement, construction, and commissioning.
- The two important tools of planning are the bar chart and the network techniques. The bar chart is a pictorial device in which the activities are represented by horizontal bars on the time axis. In network techniques, the activities, events, and their inter-relationships are represented by a network diagram.
- For large projects, a hierarchy of plans showing various levels of detail may be prepared.
- The traditional approach to project control, involving a comparison of the actual cost with the budgeted cost, is referred to as variance analysis. This approach is inadequate for project control for the following reasons: (i) it is backward-looking rather than forward-looking, and (ii) it does not use the data effectively to provide integrated control.
- The modern approach to project control, referred to as performance analysis, involves monitoring the project along the following lines:

Cost variance	: Budgeted cost of work performed—Actual cost of work performed.
Schedule variance in cost terms	: Budgeted cost of work performed—Budgeted cost of work scheduled.
Cost performance index	: Budgeted cost of work performed/Actual cost of work scheduled.
Schedule performance index	: Budgeted cost of work performed/Budgeted cost of work scheduled.
Estimated cost performance index	: Budgeted cost for total work/(Actual cost of work performed + Additional cost for completion).

- To achieve satisfactory human relations in the project setting, the project manager must successfully handle problems and challenges relating to (i) authority, (ii) orientation, (iii) motivation, and (iv) group functioning.
- Often, the project manager has to coordinate the efforts of various functional groups (within the organisation) and outside agencies without the leverage of hierarchical authority. His effective authority depends largely on his professional stature and inter-personal skills.
- The project manager has to strengthen the managerial orientation of project personnel, particularly technical and engineering personnel.
- In order to succeed in motivating personnel, the project manager must be a perceptive observer of human beings, must have the ability to appreciate the variable needs of human beings, must have skills in several styles of management suitable to different situations, and must be sensitive to the reactions of people so that he can act supportively rather than threateningly.

- There are several stages, partially overlapping, in the formation of an effective group: development of mutual trust, diminution of defensive behaviour, openness and candour in communication, cooperation and supportive behaviour, and resolution of differences by mutual negotiation.
- Time and cost over-runs of projects are very common in India, particularly in the public sector. Hence, projects tend to become uneconomical and economic development is adversely affected.
- The important pre-requisites for successful completion of projects are: (i) adequate formulation, (ii) sound project organisation, (iii) proper implementation planning, (iv) advance action, (v) timely availability of funds, (vi) judicious equipment tendering and procurement, (vii) better contract management, and (viii) effective monitoring.

Questions

1. "The traditional form of organisation is not suitable for the management of projects." Comment.
2. Describe and evaluate the various forms of project organisation.
3. What is a bar chart? What are its advantages and limitations?
4. Discuss the notion of hierarchy of plans.
5. Why does the control of projects in practice tend to be ineffective?
6. Discuss and evaluate the variance analysis approach to project control.
7. What is 'performance analysis'? What are the dimensions along which monitoring is done in 'performance analysis'?
8. Discuss the authority and orientation problems in a project setting.
9. What considerations should the project manager bear in mind with respect to motivation of the project personnel?
10. What types of groups may be formed in a project setting?
11. What is an effective group? What are the stages in the formation of an effective group?
12. Discuss the pre-requisites for successful project implementation.

Problems

1. A project has begun on 1st April 200x and was expected to be completed by 31st December 200x. The project is being reviewed on 30th September 200x when the following information has been developed:
   - Budgeted cost for work scheduled (BCWS) : Rs 6,000,000
   - Budgeted cost for work performed (BCWP) : Rs 5,500,000
   - Actual cost of work performed (ACWP) : Rs 5,800,000
   - Budgeted cost for total work (BCTW) : Rs 10,000,000
   - Additional cost for completion (ACC) : Rs 5,000,000

   Determine the following: (i) cost variance, (ii) schedule variance in cost terms, (iii) cost performance index, (iv) schedule performance index, and (v) estimated cost performance index.

CHAPTER

22

Network Techniques for Project Management

Once a project is selected, the focus shifts to its implementation. This involves the completion of numerous activities (project components) by employing various resources—men, materials, machine, money, and time—so that a project on paper is translated into concrete reality.

The activities of a project have inter-relationships arising from physical, technical, and other considerations. For proper planning, scheduling, and control of the activities of a project, given their inter-relationships and constraints on the availability of resources, network techniques have been found quite useful. It may be noted that financial institutions and the Government of India insist that a network plan should accompany feasibility reports.

There are two basic network techniques: PERT and CPM. PERT, an acronym for *Program Evaluation Review Technique,* was originally developed to facilitate the planning and scheduling of the Polaris Fleet Ballistic Missile Project of the US government. Designed to handle risk and uncertainty, PERT is eminently suitable for research and development programmes, aerospace projects, and other projects involving new technology. In such projects the time required for completing various jobs or activities can be highly variable. Hence the orientation of PERT is 'probabilistic'.

CPM, an acronym for *Critical Path Method,* is akin to PERT It was developed independently in 1956-57 by the Du Pont Company in the US to solve scheduling problems in industrial settings. CPM is primarily concerned with the trade-off between cost and time. It has been applied mostly to projects that employ a fairly stable technology and are relatively risk free. Hence its orientation is 'deterministic'.

Widely diverse projects are amenable to analysis by PERT and CPM. Here is an illustrative list:

- Launching a spaceship.
- Research and development programme.
- Construction of a plant.
- Building a river valley project.
- Overhaul of an organisation.
- Training of manpower.
- Starting a new venture.
- Adult literacy programme.

The common characteristics of the above projects which make them amenable to analysis by PERT or CPM are:

1. The project can be broken down into a well-defined set of jobs or activities.
2. The activities must be performed in a certain sequence which is technologically ordered.
3. Within a defined sequence, the activities may be started and stopped in an independent manner.

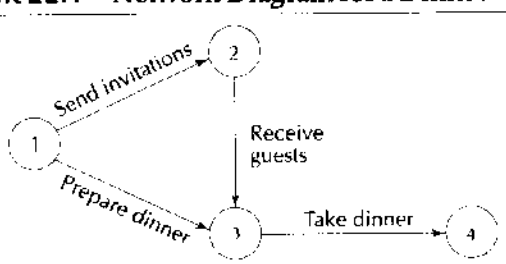
This chapter discusses the basics of PERT, CPM and network cost system. It is organised into seven sections.

- Development of project network.
- Time estimation.
- Determination of critical path.
- Scheduling when resources are limited.
- PERT model.
- CPM model.
- Network cost system.

22.1 DEVELOPMENT OF PROJECT NETWORK

Basic to PERT as well as CPM is the network diagram. The network diagram, also referred to as the project graph, shows the activities and events of the project and their logical relationships. A simplified network diagram for a dinner project is shown in Exhibit 22.1.

Exhibit 22.1 ***Network Diagram for a Dinner Project***



The network diagram is constructed in terms of activities and events. An activity is a definite task, job, or function to be performed in a project. For example, 'prepare dinner' (see Exhibit 22.1) is an activity. An activity is represented by an arrow. The head of the arrow marks the completion of the activity and the tail of the arrow marks its beginning. (The length and 'compass' direction of the arrow have no significance.) An event is a specific point in time indicating the beginning or end of one or more activities. It represents a milestone and does not consume time or resources. For example, event 2 in Exhibit 22.1 marks completion of the activity 'send invitation'.

Since activities are the basic building blocks of a network diagram, it is necessary to enumerate all the activities of the project. For this purpose, it is helpful to break the project into several steps. The number of steps, of course, would depend on the magnitude and complexity of the project. For industrial projects generally a two-step procedure could suffice. In the first step, the major parts of the project are identified and in the second step the activities of each major part are delineated. Activities should be so defined that they are distinct, reasonably homogeneous tasks for which time and resource requirement can be estimated.

Once the activities are enumerated it is necessary to define for each activity, the activities which precede it, the activities which follow it, and the activities which can take place concurrently. Given this information, the network diagram, showing the logical relationship between activities and events may be developed following either the forward method or the backward method.

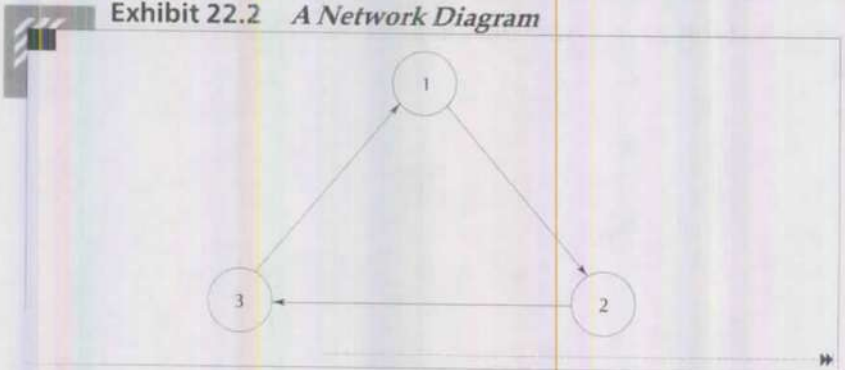
The forward method begins with the initial event, marking the beginning of the project, and proceeds forward till the end event is reached. The backward method begins with the end event and works backwards till the beginning event is reached.

Rules for Network Construction

The rules to be observed in constructing the network diagram are discussed below:

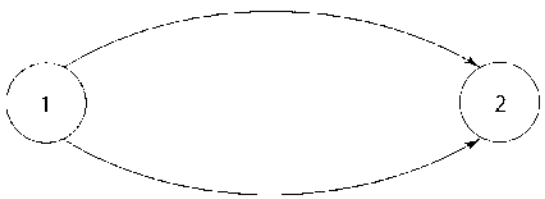
1. Each activity must have a preceding and a succeeding event. An activity is numerically denoted by the pair of preceding and succeeding events. In the dinner project, for example, the activity 'send invitations' is designated as (1–2).
2. Each event should have a distinct number. The number given to an event can be chosen in any way, provided this condition is satisfied. In practice, however, events are so numbered that the number at the head of the arrow is greater than that at its tail.

Exhibit 22.2 *A Network Diagram*



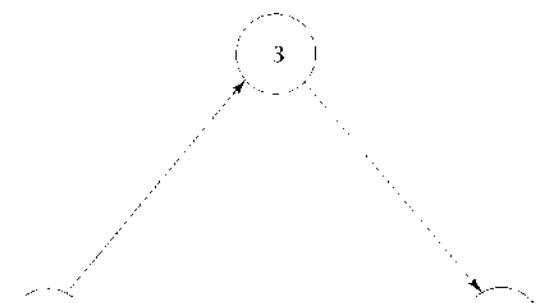
3. There should be no loops in the project network. A situation like the one shown in Exhibit 22.2 is not permissible.
4. Not more than one activity can have the same preceding and succeeding events. This means that each activity is represented by a uniquely numbered arrow and a situation like the one shown in Exhibit 22.3 is not permissible.

Exhibit 22.3 *A Loop*



To ensure that each activity is uniquely numbered it may be necessary sometimes to introduce dummy activities. A dummy activity is an imaginary activity which can be accomplished in zero time and which does not consume resources. It is represented by a dashed arrow. Exhibit 22.4 shows a variant of Exhibit 22.3 with a dummy activity (3–2) introduced to conform to the rules of network construction.

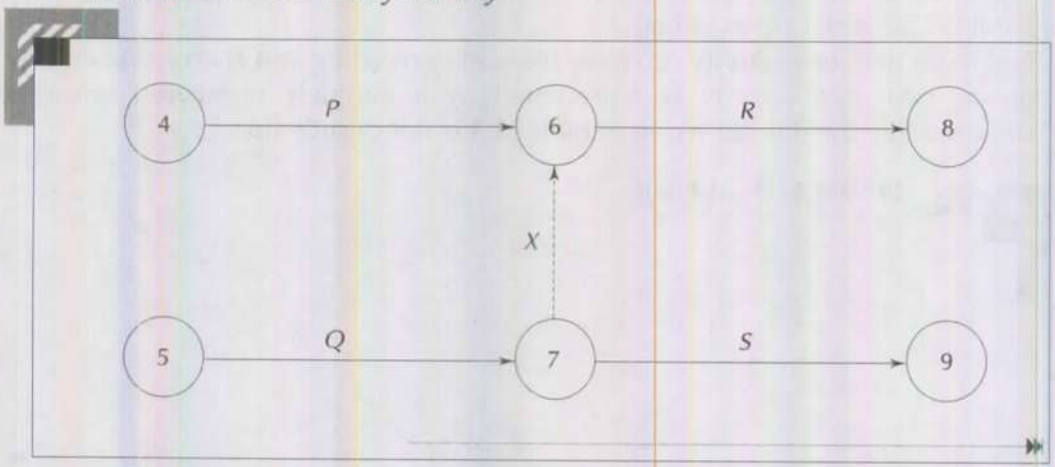
Exhibit 22.4 *A Dummy Activity*



A dummy activity may also be used to represent a constraint, necessary to show the proper relationship between activities. Exhibit 22.5 shows part of a network diagram having a dummy activity.

In Exhibit 22.5, *X*, represented as (7–6), is a dummy activity showing a certain logical relationship. According to this figure, activities *P*(4–6) and *Q*(5–7) must be completed before activity *R* (6–8) can start.

Exhibit 22.5 ***A Dummy Activity***



Illustration

A building project consists of the following activities:

A = Lay foundation
B = Erect framework
C = Install millwork
D = Install wiring
E = Install plumbing
F = Plaster walls
G = Install siding
H = Decorate the interior
I = Finish the exterior

The interrelationship among these activities is as follows:

1. A should precede B.
2. B should precede C, D, E, F, and G.
3. C, D, E, and F should precede H.
4. G should precede I.

Given the above interrelationship the network diagram for the project is developed, in several steps, using the forward method, as shown in Exhibit 22.6.

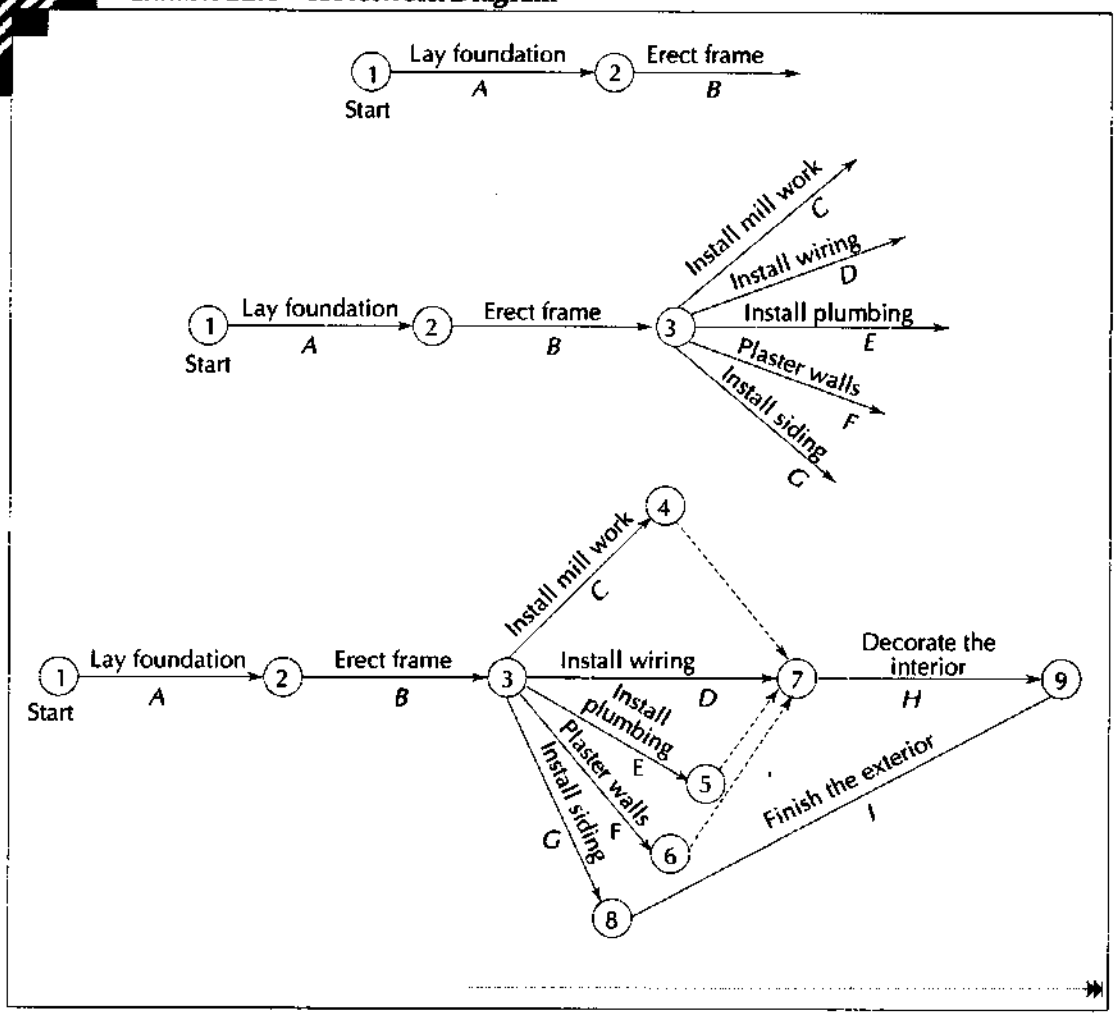
22.2 TIME ESTIMATION

Once the logic and detail of the network have been established, time estimates must be assigned to each activity. Generally, three time values are obtained for each activity:

1. Optimistic time (t_o)
2. Most likely time (t_m)
3. Pessimistic time (t_p)

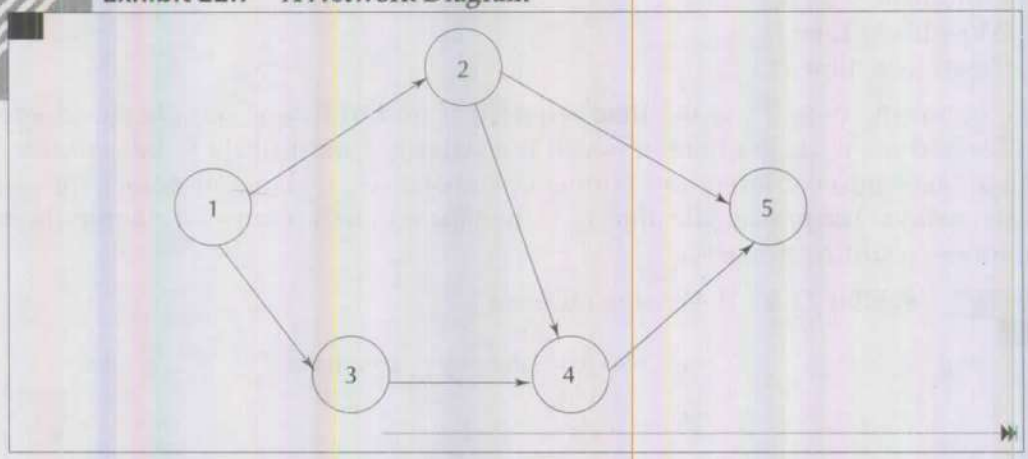
The optimistic time, t_o, is the time required if no hurdles or complications arise. The most likely time, t_m, is the time in which the activity is most likely to be completed. This estimate takes into consideration normal circumstances, making allowance for some unforeseen delays. The pessimistic time, t_p, is the time required if unusual complications and/or unforeseen difficulties arise.

Exhibit 22.6 ***A Network Diagram***



For discussing other aspects of PERT analysis a simple project shown in Exhibit 22.7 shall be used.

Exhibit 22.7 *A Network Diagram*



Obtaining Time Estimates

Time estimates should be obtained by the PERT planner from persons who are responsible for estimation. The following points should be borne in mind while obtaining time estimates:

1. Time estimates should be obtained by skipping around the network rather than by following a specific path. If estimates are obtained by following one path, there is a tendency for the person providing the estimates to add them mentally and compare them with a previously conceived notion of the time of the total path.
2. The estimates of t_o, t_m, and t_p should be defined independently of each other.
3. The time available for completing the project should not influence the estimates of t_o, t_m, and t_p.
4. It should be made known that t_o, t_m, and t_p are estimates and not schedule commitments.
5. The estimates of t_o, t_m, and t_p should include allowances for occurrences which are generally considered as random variables (weather conditions, administrative delays, etc.) but not for occurrences that are normally not considered as random variables (flood, wars, etc.)

Average Time

Once the three time estimates for each activity are obtained, the expected value of activity durations is calculated. The expected value, t_e, is usually obtained by the formula:

$$t_e = \frac{t_o + t_m + t_p}{6} \qquad (22.1)$$

where t_e = weighted arithmetic average time

t_o = optimistic time

t_m = most likely time

t_p = pessimistic time

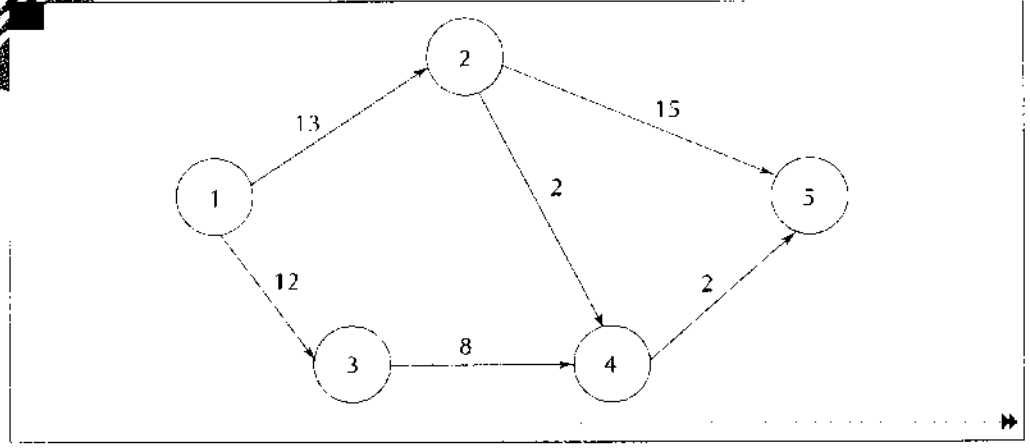
The time estimates for various activities in our illustrative project are shown in Exhibit 22.8.

Exhibit 22.8 ***Time Estimates***

Activity	*Time Estimate*	*Optimistic* t_o	*Most Likely* t_m	*Pessimistic* t_p	*Average* $t_e = \frac{t_o + 4t_m + t_p}{6}$
Numerical Description					
a	1–2	9	12	21	13
b	1–3	6	12	18	12
c	2–4	1	1.5	5	2
d	3–4	4	8.5	10	8
e	2–5	10	14	24	15
f	4 5	1	2	3	2

The network diagram with average time estimates is shown in Exhibit 22.9.

Exhibit 22.9 ***A Network Diagram***



22.3 DETERMINATION OF THE CRITICAL PATH

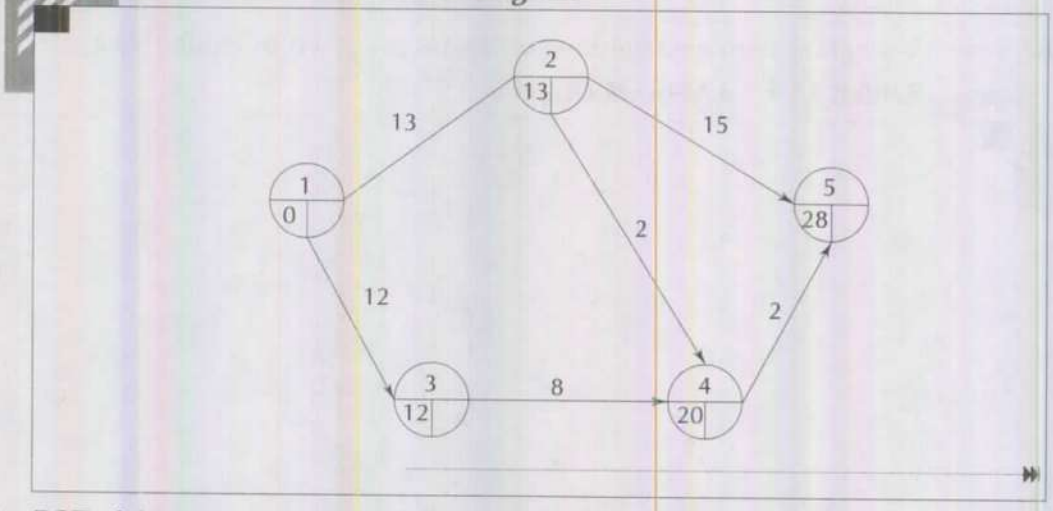
Once the network diagram with single time estimates has been developed, the following computational procedure may be employed for determining the critical path/s, event slacks, and activity floats.

1. Calculate the Earliest Occurrence Time (EOT) for Each Event An event occurs when all activities leading to the event have been completed. In the network diagram shown in

Exhibit 22.9, for example, event 4 occurs when activities (2–4) and (3–4) are completed. Obviously activity (2–4) cannot begin unless event 2 occurs, which in turn requires the completion of activity (1–2). Likewise, activity (3–4) cannot begin unless event 3 occurs which in turn requires the completion of activity (1–3). Thus we find that event 4 occurs when activities (1–2), (2–4), (1–3), and (3–4) are completed. In other words, event 4 occurs when paths (1–2–4) and (1–3–4) are completed.

The *EOT* of an event refers to the time when the event can be completed at the earliest. Looking at event 4 we find that since the paths leading to it, viz., (1–2–4) and (1–3–4) take 15 weeks and 20 weeks, respectively, the *EOT* of event 4 is 20 weeks. In general terms, the *EOT* of an event is the duration of the longest path (from the beginning event whose *EOT* is set at 0) leading to that event. The *EOT*s of various events in our illustrative project are shown in Exhibit 22.10. It may be noted that in Exhibit 22.10 and subsequent figures an event is represented by a circle. The upper half of the circle denotes the event number, the left quarter in the lower half denotes the *EOT*, and the right quarter in the lower half denotes the latest occurrence time, a term described later.

Exhibit 22.10 ***A Network Diagram***



The *EOT* of the end event obviously represents the minimum time required for completing the project. To obtain the *EOT* of various events we start from the beginning event and move forward towards the end event. This computational procedure is referred to as the forward pass. In this computation we assume that each activity starts immediately on the occurrence of the event preceding it. Hence the starting and finishing time for various activities obtained from this computation are the earliest starting time (*EST*) and the earliest finishing time (*EFT*).

The general formula for *EOT* is:

$$EOT\ (i) = \text{Max}\ [EOT\ (k) + d(k, i)] \qquad (22.2)$$

where $EOT\ (i)$ = earliest occurrence time of event i

$EOT\ (k)$ = earliest occurrence time of event k (k precedes i and there may be several k's)

$d\ (k, i)$ = duration of activity (k, i).

The maximisation shown is done considering all activities (k, i) leading to event node i.

The formulae for EST and EFT are:

$$EST\ (i, j) = EOT\ (i) \tag{22.3}$$

$$EFT\ (i, j) = EOT\ (i) + d(i, j) \tag{22.4}$$

where $EST\ (i, j)$ = earliest starting time for activity (i, j)

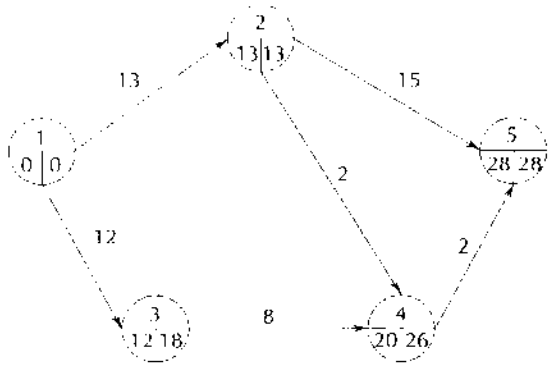
$EOT\ (i)$ = earliest occurrence time of event (i)

$EFT\ (i, j)$ = earliest finishing time for activity (i, j)

$d(i, j)$ = duration of activity (i, j)

2. Calculate the Latest Occurrence Time (LOT) for Each Event The *LOT* for an event represents the latest allowable time by which the event can occur, given the time that is allowed for the completion of the project (occurrence of end event). Normally, the time allowed for the completion of the project is set equal to the *EOT* of the end event. (In other words, the project is supposed to be completed at the earliest possible time.) This means that for the end event the *LOT* and *EOT* are set equal. The *LOT* for various events is obtained by working backward from the end event. This procedure is known as the backward pass. The *LOT* for event 4 in our illustrative project, for example, is equal to the *LOT* for event 5, the end event, minus the duration of the activity (4–5) which connects event 4 with 5. Since the *LOT* for event 5 is 28 weeks and the duration of activity (4–5) is 2 weeks the *LOT* for event 4 is 26 weeks (28–2). This represents the latest time by which event 4 should occur to enable the project to be completed in 28 weeks. Likewise, the *LOT* for other events can be calculated by moving backward. The *LOT* for various events is shown (in the right quarter of the lower half of event nodes) in Exhibit 22.11.

Exhibit 22.11 ***A Network Diagram***



The general formula for *LOT* is:

$$LOT\ (i) = \text{Min}\ [LOT\ (j) - d(i, j)] \tag{22.5}$$

where $LOT\ (i)$ = latest occurrence time for i
$LOT\ (j)$ = latest occurrence time for j
(j follows i and there may be several j's)
$d(i, j)$ = duration of activity (i, j)
The minimisation shown here is done with respect to all activities (i, j) starting from i.

Given the *LOT* for various events we can calculate the latest finishing time (*LFT*) and latest starting time (*LST*) for various activities using the formulae:

$$LFT\ (i, j) = LOT\ (j) \tag{22.6}$$

$$LST\ (i, j) = LFT\ (i, j) - d(i, j) \tag{22.7}$$

where $LFT\ (i, j)$ = latest finishing time for activity (i, j)
$LOT\ (j)$ = latest occurrence time for event j
$LST\ (i, j)$ = latest starting time for activity (i, j)
$d(i, j)$ = duration of activity (i, j)

3. Calculate the Slack for Each Event The slack for an event is the difference between its *LOT* and *EOT*. The slacks for various events of our illustrative project are shown in Exhibit 22.12.

Exhibit 22.12 ***Event Slack***

Event	*LOT*	*EOT*	*(in weeks) Slack = LOT − EOT*
5	28	28	0
4	26	20	6
3	18	12	6
2	13	13	0
1	0	0	0

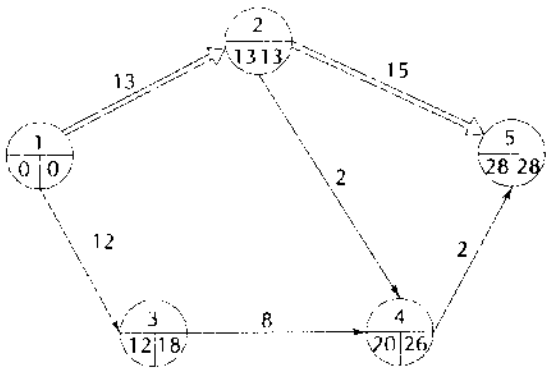
4. Obtain the Critical and Slack Paths The critical path starts with the beginning event, terminates with the end event, and is marked by events which have a zero slack. This is obviously the path on which there is no slack, no cushion. Other paths are slack paths with some cushion. The critical path for our illustrative project is (1–2–5). It is indicated by doubled arrows in Exhibit 22.13.

The critical path is the longest path from the beginning event to the end event. Since the end can be reached, i.e., project completed, only when this longest path is traversed, the minimum time required for completing the project is the duration on the critical path. The

duration on the critical path of our project is 28 weeks; this is the minimum time required for completing the project. (It is already indicated by the *EOT* of event 5, the end event.)

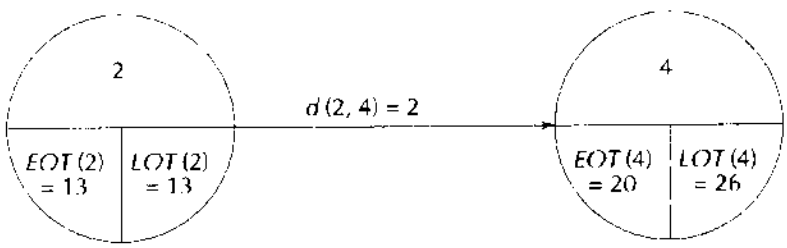
5. Compute the Activity Floats Given the estimates of activity time and event slacks, activity floats can be calculated. There are three measures of float: (i) total float; (ii) free float; and (iii) independent float. For illustrating these measures let us consider activity (2–4) of our illustrative project. Activity (2–4) is shown in Exhibit 22.14.

Exhibit 22.13 ***A Network Diagram***



In Exhibit 22.14 *EOT*, *LOT*, and *d* represent respectively, earliest occurrence time, latest occurrence time, and duration.

Exhibit 22.14 ***EOT and LOT***



The *total float* of an activity is the extra time available to complete the activity if it is started as early as possible, without delaying the completion of the project. The total float for activity (2–4) is equal to:

Latest occurrence time for event 4	– Earliest occurrence time for event 2	– Duration of activity (2–4)
= 26 weeks	– 13 weeks	– 2 weeks
= 11 weeks		

The *total float* represents the float under the most favourable conditions. This is so because the activity can be started at the earliest (the *EOT* of the preceding event) and completed at the latest (the *LOT* of its succeeding event). Obviously, activities which do not have a float even under these conditions, the most favourable ones, are critical to the project and hence lie on the critical path.

The *free float* of an activity is the extra time available to complete the activity when the activity is started at the *LOT* of its preceding event and completed by the *EOT* of its succeeding event. The independent float for activity (2–4) is:

Earliest occurrence time for event 4	– Latest occurrence time for event 2	– Duration of activity (2–4)
= 20 weeks	– 13 weeks	– 2 weeks
= 5 weeks		

The *independent float* of an activity is the extra time available to complete the activity when the activity is started at the *LOT* of its preceding event and completed by the *EOT* of its succeeding event. The independent float for activity (2–4) is:

Earliest occurrence time for event 4	– Latest occurrence time for event 2	– Duration of activity (2–4)
= 20 weeks	– 13 weeks	– 2 weeks
= 5 weeks		

The independent float represents the float under the most adverse conditions. Hence when an activity has a positive independent float it means that the activity has a cushion (equal to its independent float) irrespective of what happens elsewhere. (It may be noted that the independent float of an activity may be negative but the total float and free float cannot be negative.)

More generally, floats may be represented by the following equations:

$$TF\ (i, j) = LOT\ (j) - EOT\ (i) - d\ (i, j) \quad (22.8)$$

$$FF\ (i, j) = EOT\ (j) - EOT\ (i) - d\ (i, j) \quad (22.9)$$

$$IF\ (i, j) = EOT\ (j) - LOT\ (i) - d\ (i, j) \quad (22.10)$$

where $TF\ (i, j)$ = total float of activity (i, j)

$LOT\ (j)$ = latest occurrence time for event j

$EOT\ (i)$ = earliest occurrence time of event i

$d\ (i, j)$ = duration of activity (i, j)

$FF\ (i, j)$ = free float of activity (i, j)

$EOT\ (j)$ = earliest occurrence time of event j

$IF\ (i, j)$ = independent float of activity (i, j)

$LOT\ (j)$ = latest occurrence time of event i

The floats for various activities of our illustrative project are shown in Exhibit 22.15.

22.4 SCHEDULING WHEN RESOURCES ARE LIMITED

From Exhibit 22.15, we find that critical activities (1–2) and (2–5) have no float associated with them. This means that there is no flexibility whatsoever in scheduling these activities—the earliest starting time is the same as the latest starting time and the earliest finishing time is the same as the latest finishing time. For non-critical activities, however, some float is available and this provides flexibility in scheduling them. The choice available in this respect is bounded by two schedules: the early start schedule and the late start schedule.

Exhibit 22.15 ***Activity Floats***

Activity (i, j)	*Duration*	*Earliest Start Time (i, j) = EST (i)*	*Earliest Finish Time (i, j) = EFT (j)*	*Latest Start Time (i, j) = LST (i)*	*Latest Finish Time (i, j) = LFT (j)*	*Total Float*	*Free Float*	*(in weeks) Independent Float*
a (1–2)	13	0	13	0	13	0	0	0
b (1–3)	12	0	12	6	18	6	0	0
c (2–4)	2	13	15	24	26	11	5	5
d (3–4)	8	12	20	18	26	6	0	(6)
e (2–5)	15	13	28	13	28	0	0	0
f (4–5)	2	20	22	26	28	6	6	0

The Bounding Schedules: Early Start Schedule and Late Start Schedule

The early start schedule refers to the schedule in which all activities start as early as possible. In this schedule (i) all events occur at their earliest because all activities start at their earliest starting time and finish at their earliest finishing time, (ii) there may be time lags between the completion of certain activities and the occurrence of events which these activities lead to; and (iii) all activities emanating from an event begin at the same time.

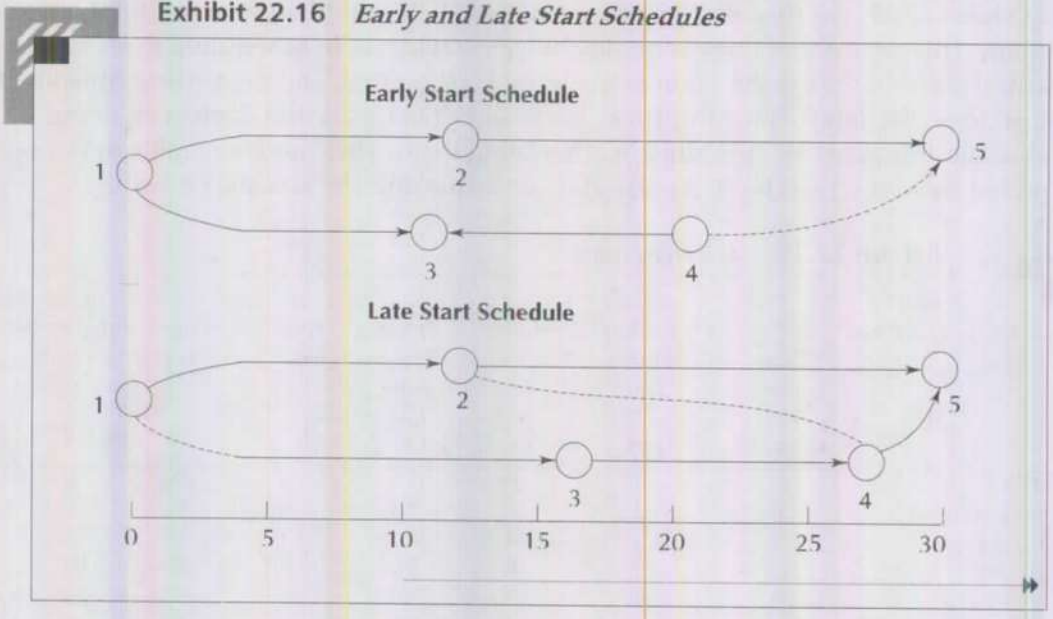
The early start schedule suggests a cautious attitude towards the project and a desire to minimise the possibility of delay. It provides a greater measure of protection against uncertainties and adverse circumstances. Such a schedule, however, calls for an earlier application of resources.

The late start schedule refers to the schedule arrived at when all activities are started as late as possible. In this schedule (i) all events occur at their latest because all activities start at their latest finishing time; (ii) some activities may start after a time lag subsequent to the occurrence of the preceding events; and (iii) all activities leading to an event are completed at the same time.

The late start schedule reflects a desire to commit resources late—as late as possible. However, such a schedule provides no elbow room in the wake of adverse developments. Any unanticipated delay results in increased project duration.

The early start schedule and the late start schedule for our illustrative project are shown in Exhibit 22.16. Here the project schedules are shown as graphs with a horizontal time scale.

Exhibit 22.16 ***Early and Late Start Schedules***



Choice of a Schedule in View of Resource Constraints

In our discussion so far we have assumed that any schedule which is technologically feasible—which does not violate the logical relationship among activities as shown in the network diagram—can be adopted. For generating various schedules, the early start schedule, the late start schedule, or any other schedule lying between these two bounds, information was required regarding only network logic and activity durations.

This approach to scheduling implicitly assumes that adequate resources are available so that each activity can be scheduled anywhere between its earliest starting time and latest starting time. In real life situations, however, there may be restrictions on the availability of resources. For example, manpower supply may be limited or funds made available periodwise may be rigidly budgeted. When restrictions exist, various schedules may have to be considered to find out which one is the most appropriate in the light of these restrictions. We shall discuss two examples to indicate the broad approach to scheduling in the face of resource constraints.

Example 1: Scheduling to Match Availability of Manpower

Let us consider a small project for which the network diagram is shown in Exhibit 22.17.

In Exhibit 22.17 activity duration is shown above the activity arrow and manpower requirement is shown below the activity arrow. Only 12 men are available for the project

(a manpower resource constraint). The early start schedule of this project is shown as a graph on the horizontal time scale in Exhibit 22.18.

Looking at the manpower requirement for the early start schedule we find that it is 20 for the first day, 14 for the second day, 15 for the third day, 5 for the fourth day, and 5 for the fifth day. Obviously, this schedule is unacceptable in view of the manpower constraint. So, we explore the possibility of shifting activities. Our efforts at shifting activities, keeping the project duration at five days, soon reveals that no schedule is feasible with only 12 men. So we extend the duration of the project by one day and try various schedules to see whether we can find a feasible schedule. A little juggling of activities shows that a schedule like the one shown in Exhibit 22.19 is feasible—this is the best we can do.

Exhibit 22.17 ***Activity Durations and Manpower Requirements***

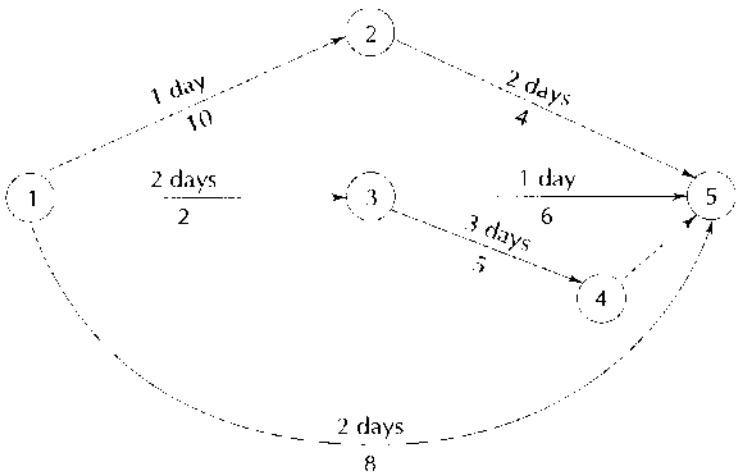


Exhibit 22.18 ***Early Start Schedule***

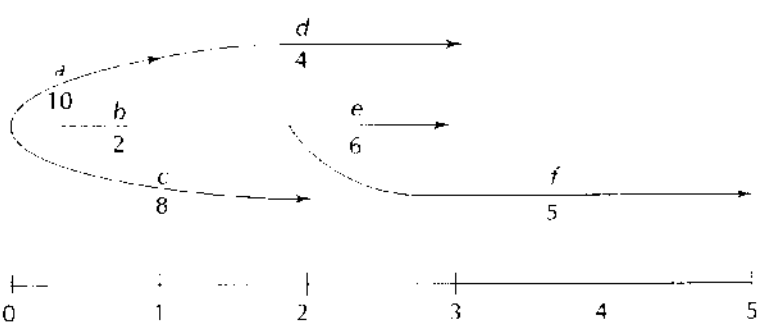
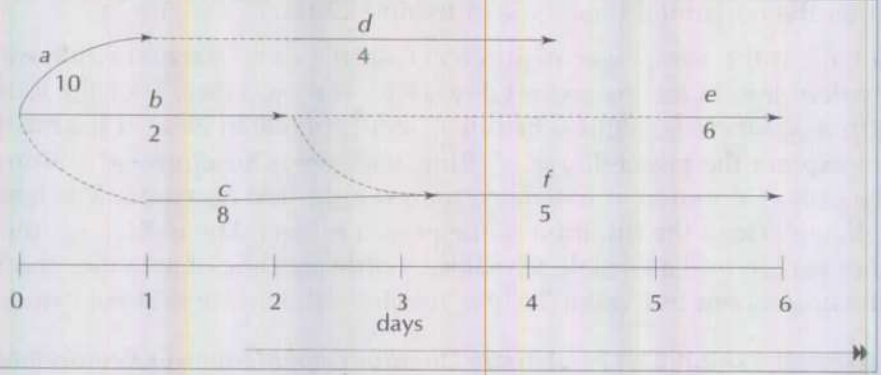


Exhibit 22.19 ***A Feasible Schedule***



Example 2: Scheduling to Match the Release of Funds

The cost estimates for various activities of our illustrative project (*see* Exhibit 22.8) are given in Exhibit 22.20. For our discussion here, *weeks* have been changed to *months*.

Exhibit 22.20 ***Cost Estimates***

Activity	*Duration in Months*	*Cost per Months*	*Cost*
		Rs	Rs
(1–2)	13	200,000	2,600,000
(1–3)	12	500,000	6,000,000
(2–4)	2	1,000,000	2,000,000
(3–4)	8	250,000	2,000,000
(2–5)	15	100,000	1,500,000
(4–5)	2	750,000	1,500,000
		Total =	15,600,000

The government has decided to release Rs 15,600,000, required for the project, in the following manner:

Rs 6,900,000 in the first year; Rs 6,800,000 in the second year; and Rs 1,900,000 in the third year. It has also stipulated that the unspent amount would lapse and hence cannot be carried forward.

Before we develop the project schedule, a preliminary question may be asked: Is it possible *prima facie* to schedule this project without extending its duration beyond 28 months, which is the minimum time required given the network logic and activity durations? To answer this question let us look at the funds requirement for the early start schedule and late start schedule. This is shown in Exhibit 22.21.

In this exhibit activities are represented by bars. The length of the bar corresponds to activity duration. The monthly fund requirement for each activity is shown above its bar. (Here it is assumed that expenditure on an activity is uniformly spread over its duration.)

The project requirements, month-wise and cumulative, are shown along the time axis. The cumulative project requirements for the early start schedule and the late start schedule are also shown in the form of cost curves in Exhibit 22.22.

From Exhibits 22.21 and 22.22 we find that:

1. The rate of expenditure is relatively higher for the earlier stages in the early start schedule and is relatively higher for the later stages in the late start schedule.
2. A rate of spending greater than that of the early start schedule is not possible. (This is so because in the early start schedule all activities start as early as possible.) Any release of funds above the early start schedule requirement curve is beyond the capacity of the project to spend.
3. The rate of spending corresponding to the late start schedule is the absolute minimum necessary to complete the project on time. If the rate of spending is less than that corresponding to the late start schedule the project duration will have to be necessarily extended.
4. A pattern of funds release lying between the two bounds, early start schedule requirement and late start schedule requirement, *prima facie* suggests that a schedule can be worked out without extending project duration.

Let us now look at the cumulative funds release pattern for our illustrative project. This lies between the early start schedule requirement and the late start schedule requirement. So *prima facie* it suggests that a feasible schedule without extending the project duration can be developed. Let us proceed further and consider scheduling year by year. The activities that begin in year 1 according to the early start schedule are (1–2) and (1–3). If both these activities are commenced as early as possible, the fund requirement for year 1 would be Rs 8.4 million. Since this amount exceeds Rs 6.9 million, the amount to be released in year 1, the expenditure in year 1 has to be reduced by Rs 1.5 million. For this we consider the possibility of shifting activities to subsequent periods. Looking at activities (1–2) and (1–3) we find that (1–2) is on the critical path, so there is no flexibility available with respect to it. Activity (1–3), however, can be shifted as it is not on the critical path. Since activity (1–3) requires Rs 0.5 million per month it has to be shifted by three months so that the amount spent in year 1 is equal to the amount released in year 1. Since there is a free float of six months for activity (1–3), we shift it by three months.

We now go to year 2. The effects of shifting activity (1–3) by three months are as follows: (i) The funds requirement for year 2 on account of activity (1–3) increases by Rs 1.5 million over and above what it is for the early start schedule. (ii) The earliest starting time for activity (3–4) moves to 15 months from 12 months and the earliest finishing time moves to 23 months from 20 months. Since this shift occurs within year 2, there is no change in funds requirement on account of activity (3–4). (iii) The earliest starting time for activity (4–5) moves to 23 months from 20 months and the earliest finishing time for activity (4–5) moves to 25 months from 23 months. This decreases the funds requirement for year 2 by Rs 0.75 million. The net effect, therefore, is to increase funds requirement by

Rs 0.75 million over and above what it is for the earliest starting schedule. Hence the total requirement becomes Rs 6.8 million + Rs 0.75 million = Rs 7.55 million. However, the funds budgeted for year 2 are only Rs 6.8 million. So we consider the possibility of shifting some activities to year 3. We find that by shifting activity (4–5) to year 3 the expenditure in year 2 can be reduced to Rs 6.8 million, the budget of that year. As a result of this shifting, the expenditure for year 3 (first four months of it) equals the budgeted funds release for year 3. The schedule arrived at finally is shown in Exhibit 22.23.

Exhibit 22.21 ***Funds Requirements for Different Schedules***

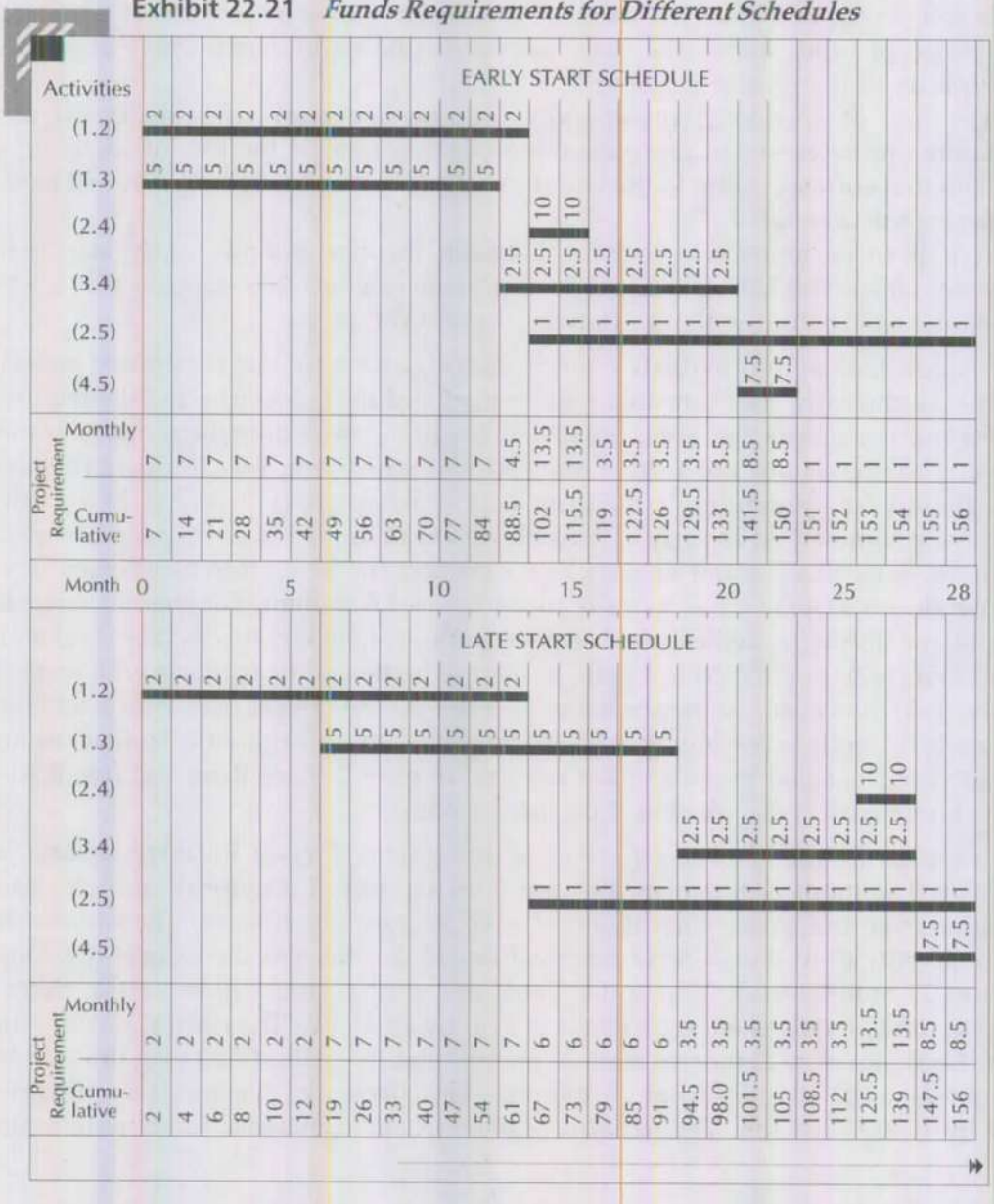
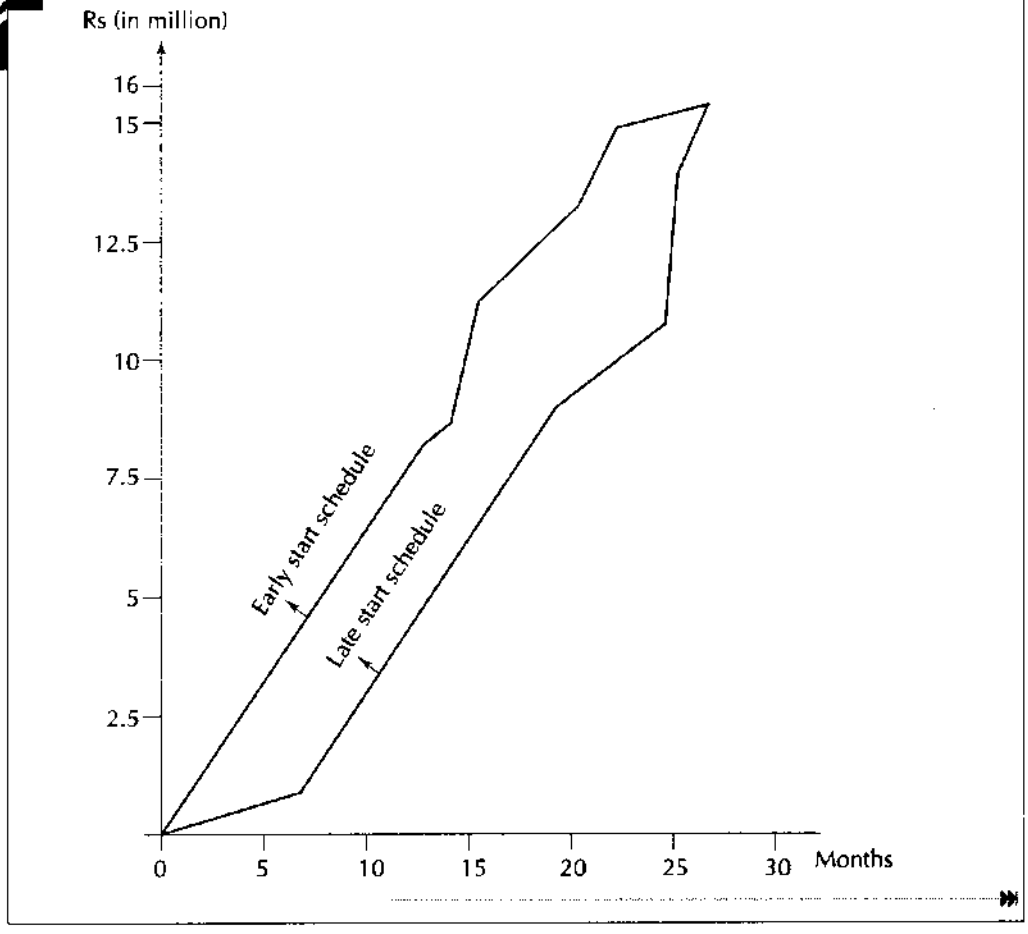


Exhibit 22.22 ***Cost Curves***

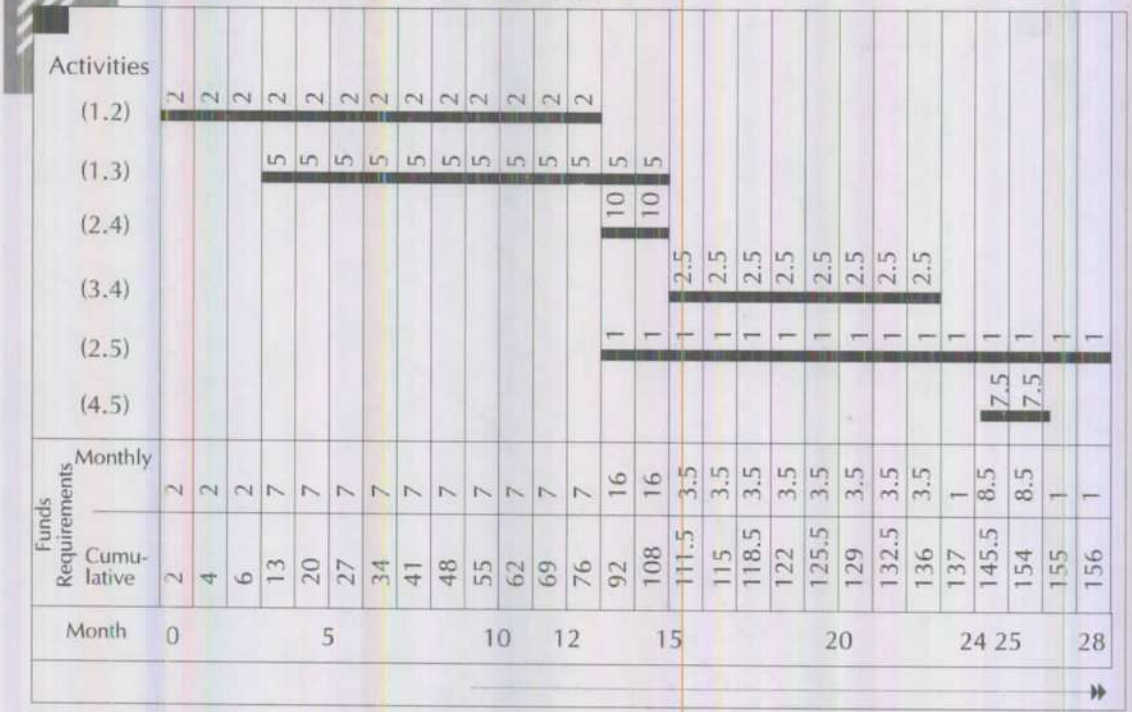


Problems in Scheduling Real Life Projects

In the above discussion we have considered simple examples comprising few activities and one constraint, to indicate the broad approach. In real life projects the activities run into hundreds and there may be several constraints. The problem of scheduling in such cases tends to become very complex. For solving such problems the technique of linear programming can be used. However, when a problem has numerous activities, say, more than 100, the technique of linear programming becomes computationally unwieldy and inordinately expensive, even with the aid of the fastest computers available.

In view of the practical difficulties in using linear programming for solving large-scale scheduling problems, heuristic programs have been developed.

Exhibit 22.23 ***The Selected Schedule***



A heuristic is a rule of thumb like 'schedule critical activities first' or 'schedule the activity which has the largest independent float in the end'. A heuristic program consists of a collection of such heuristics. In recent years, many heuristic programs have been developed—they are formulated usually as computer programs. These programs may be broadly divided into two types: resource levelling programs and resource allocation programs. A resource levelling program seeks to level resource requirements, given a constraint on project duration. A resource allocation program tries to find the shortest project schedule, given fixed resource availabilities.

22.5 PERT MODEL

So far, the analysis was focused on the determination of the critical path, event slacks, and activity floats. For this purpose we used single time estimates of activity duration though initially three-time estimates were developed for each activity. Now we consider the variability of project duration.

Measures of Variability

Variability in PERT analysis is measured by variance or its square root, standard deviation. Variance of a set of numbers is the average squared difference of the numbers in the set from their arithmetic average. A simple example may be given to illustrate the calculation of variance. Let a series consist of numbers 4, 6, and 8. The average of this series is 6. The differences of various numbers in the series from this average are—2, 0, and 2. Squaring them we get 4, 0 and 4. Hence variance[1], the average of squared difference, is 8/3 and standard deviation is $\sqrt{8/3}$.

The steps involved in calculating the standard deviation of the duration of critical path are as follows:

1. Determine the standard deviation of the duration of each activity on the critical path.
2. Determine the standard deviation of the total duration of the critical path on the basis of information obtained in step 1.

For determining the standard deviation of the duration of an activity we require the entire probability distribution of the activity distribution. We, however, have only three values from this distribution: t_p, t_m, and t_o. In PERT analysis, a simplification is used in calculating the standard deviation. It is estimated by the formula[2].

$$\sigma = \frac{t_p - t_o}{6} \tag{22.11}$$

where σ = standard deviation

t_p = pessimistic time

t_o = optimistic time

Variance is obtained by squaring σ.

The standard deviation and variance of the activities on the critical path of our illustrative project are shown in Exhibit 22.24.

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1. In this example we assumed that the three values 4, 6 and 8 had the same probability of occurrence (1/3) and hence we did not consider probabilities explicitly. Where the values have different probabilities associated with them, probabilities are considered explicitly. Variance is calculated by the formula $\Sigma\, pi(X_i - \overline{X})^2$ · X_i is a possible value, p_i is the probability associated with it, and $\overline{X}$ is the weighted arithmetic average of X's. This means $\overline{X} = \Sigma\, p_i X_i$.

2. In this formula σ is one-sixth of the difference between the two extreme time estimates, t_p and t_o. It is based on the fact that nearly all the distribution of a single-peaked distribution falls within three standard deviations of the mean. For a normal distribution, more than 99.5 percent of the distribution lies within this interval and for no single-peaked distribution is it less than 89 percent according to Tchebycheff's inequality. This means that t_o and t_p are not necessarily the end points of the range of possible values but points beyond which the probability of occurrence is very small.

Assuming that the probability distribution of various activities on the critical path are independent, the variance of the critical path duration is obtained by adding variance of activities on the critical path[3].

Exhibit 22.24 ***Standard Deviation and Variance of Activity Duration on Critical Path***

Activity	t_p	t_o	$\sigma = t_p - t_o/6$	*Variance* $= \sigma^2$
(1–2)	21	9	2	4.00
(2–5)	24	10	2.33	5.44

Variance (critical path duration) = Sum of variances of activity durations on the critical path

This means

$$\text{Standard deviation (critical path duration)} = \begin{pmatrix}\text{Sum of variances of}\\ \text{activity durations on}\\ \text{the critical path}\end{pmatrix}^{1/2}$$

The standard deviation of the critical path duration for our illustrative project is

$$(4 + 5.44)^{1/2} = 3.07$$

Now we know that the mean[4] and standard deviation of the critical path duration for our project are 28 weeks and 3.07 weeks, respectively.

For real life projects which have a large number of activities on the critical path we can reasonably assume that the critical path duration is approximately normally distributed[5], with mean and standard deviation obtained by the method described above.

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3. This is based on an elementary theorem in statistics which says that when $X_1, X_2, X_3, \cdots, X_n$ are independent variables the following holds true:

$$\text{Variance}(X_1 + X_2 \cdots + X_n) = \text{Variance}(X_1) + \text{Variance}(X_2) \vdots + \text{Variance}(X_n)$$

4. The mean length of the critical path is simply the sum of the mean values of activity durations on the critical path. This is based on an elementary theorem in statistics which says:

$E(X_1 + X_2 \cdots + X_n) = E(X_1) + E(X_2) \cdots E(X_n)$

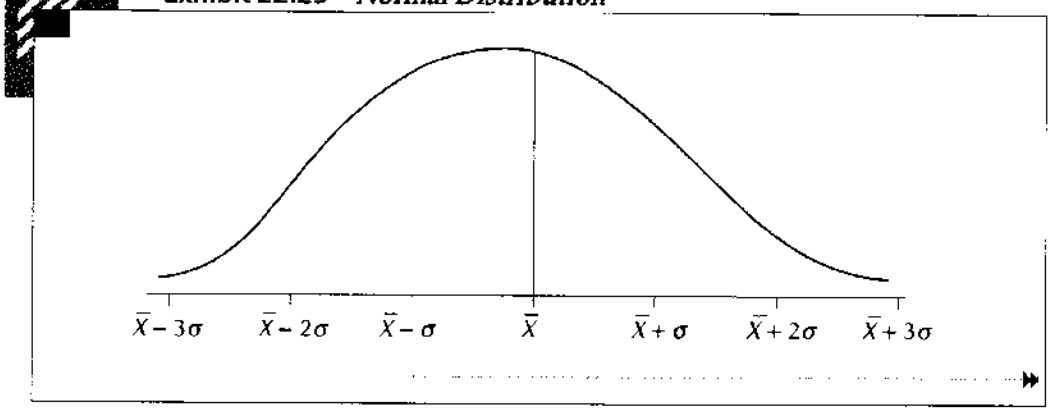
E stands for expected value or the mean value.

5. This assumption is based on the central limit theorem, a fundamental theorem in statistics, which says that the sum of a large number of independent random variables is approximately normally distributed, irrespective of how the individual random variables are distributed.

A normal distribution looks like a bell-shaped curve as shown in Exhibit 22.25. It is symmetric and single peaked and is fully described by its mean and standard deviation. The probability of values lying within certain ranges is as follows:

Range	*Probability*
Mean ± One standard deviation	0.682
Mean ± Two standard deviations	0.954
Mean ± Three standard deviations	0.998

Exhibit 22.25 ***Normal Distribution***



Probability of Completion by a Specified Date

Armed with information about mean (T) and standard deviation (σ) for critical path duration, which is normally distributed, we can compute the probability of completion by a specified date (D) as follows:

1. Find $Z = \dfrac{D-T}{\sigma}$
2. Obtain cumulative probability up to Z[6] by looking at the probability distribution of the standard normal variate.

6. Z represents the number of standard deviations by which D, the specified date, exceeds T, the mean critical path duration. Determining Z is equivalent to converting our specific normal distribution (with mean T and standard deviation σ) into standard normal distribution. The mean and standard deviation of standard normal distribution are 0 and 1 respectively.

This is shown in Exhibit 22.26.

Exhibit 22.26 ***Cumulative Probability up to Z for Standard Normal Distribution***

Z	*Cumulative probability*
−3.0	0.001
−2.8	0.003
−2.6	0.005
−2.4	0.008
−2.2	0.014
−2.0	0.023
−1.8	0.036
−1.6	0.055
−1.4	0.081
−1.2	0.115
−1.0	0.159
−0.8	0.212
−0.6	0.274
−0.4	0.345
−0.2	0.421
0.0	0.500
0.2	0.579
0.4	0.655
0.6	0.726
0.8	0.788
1.0	0.841
1.2	0.885
1.4	0.919
1.6	0.945
1.8	0.964
2.0	0.977
2.2	0.986
2.4	0.992
2.6	0.995
2.8	0.997
3.0	0.999

The above procedure may be illustrated for our project[7], which has $T = 28$ and $\sigma = 3.07$. The probability of completing this project by certain specified dates is shown in Exhibit 22.27.

7. It may be noted that in our illustrative project there are only two activities on the critical path and hence the assumption that the project duration is approximately normally distributed may not be realistic. However, as real life projects have a large number of activities on their critical paths, the procedure illustrated here is useful for them.

Exhibit 22.27 ***Probability of Completion by the Specified Date***

Specified date (D)		*Z*		*Probability of completion by D*
20	$\frac{20-28}{3.07}$	$\cong$	-2.6	0.005
25	$\frac{25-28}{3.07}$	$\cong$	-1.0	0.159
30	$\frac{30-28}{3.07}$	$\cong$	0.6	0.726

22.6 CPM MODEL

The PERT model was developed for projects characterised by uncertainty and the CPM model was developed for projects which are relatively risk-free. While both the approaches begin with the development of the network and a focus on the critical path, the PERT approach is 'probabilistic' and the CPM approach is 'deterministic'. This does not, however, mean that in CPM analysis we work with single time estimates. In fact, the principal focus of CPM analysis is on variations in activity times as a result of changes in resource assignments. These variations are planned and related to resource assignments and are not caused by random factors beyond the control of management as in the case of PERT analysis. The main thrust of CPM analysis is on time–cost relationships and it seeks to determine the project schedule which minimises total cost.

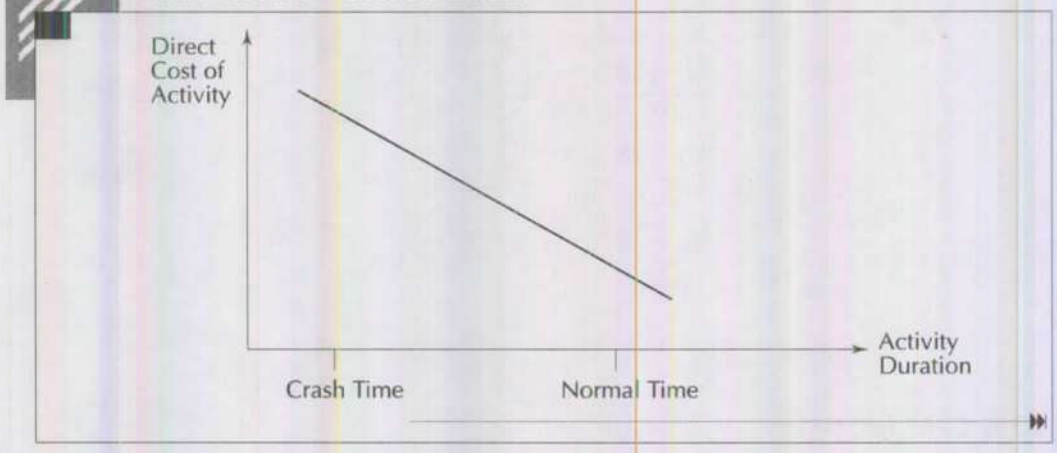
Assumptions

The usual assumptions underlying CPM analysis are:

1. The costs associated with a project can be divided into two components: direct costs and indirect costs. Direct costs are incurred on direct material and direct labour. Indirect costs consist of overhead items like indirect supplies, rent, insurance, managerial services, etc.
2. Activities of the project can be expedited by crashing which involves employing more resources.
3. Crashing reduces time but enhances direct costs because of factors like overtime payments, extra payments, and wastage. The relationship between time and direct activity cost can be reasonably approximated by a downward sloping straight line.

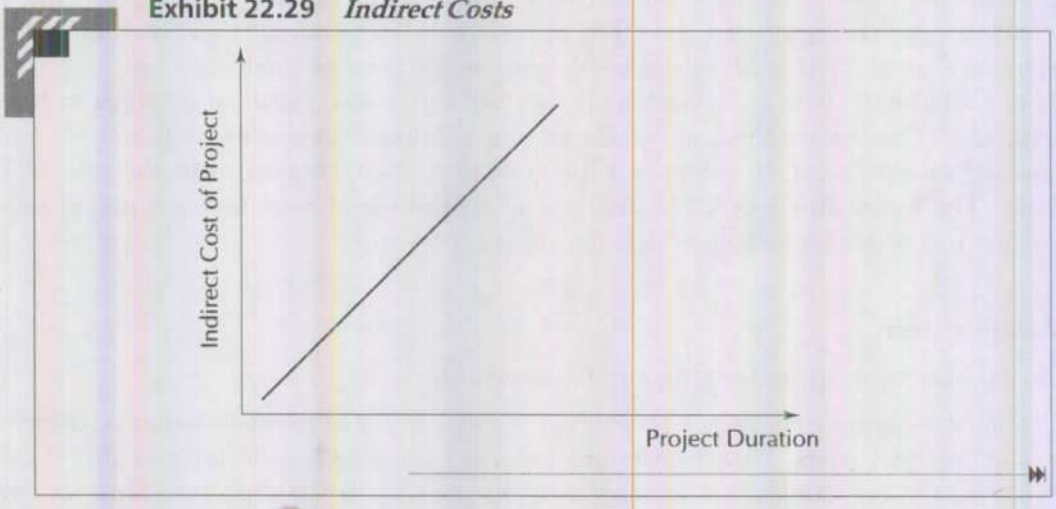
A typical cost-time line is shown in Exhibit 22.28.

Exhibit 22.28 ***Cost-Time Line***



4. Indirect costs associated with the project increase linearly with project duration. A typical line for indirect costs is shown in Exhibit 22.29.

Exhibit 22.29 ***Indirect Costs***



Procedure

Given the above assumptions, CPM analysis seeks to examine the consequences of crashing on total cost (direct cost plus indirect cost). Since the behaviour of indirect project cost is well defined, the bulk of CPM analysis is concerned with the relationship between total direct cost and project duration. The procedure used in this respect is generally as follows:

1. Obtain the critical path in the normal network. Determine the project duration and direct cost.

2. Examine the cost–time slope of activities on the critical path obtained and crash the activity which has the least slope.[8]
3. Construct the new critical path after crashing as per step 2. Determine project duration and cost.
4. Repeat steps 2 and 3 till activities on the critical path (which may change every time) are crashed.

Illustration

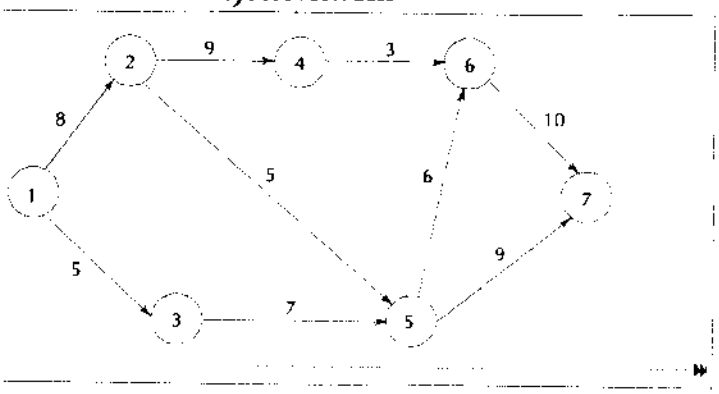
The above procedure may be illustrated with an example. The activities, durations, and direct activity costs of a project are shown in Exhibit 22.30. The indirect cost is Rs 2,000 per week.

Exhibit 22.30 ***Normal and Crash Time and Cost***

Activity	Time in Weeks		Cost		Cost to Expedite Per Week
	Normal	Crash	Normal	Crash	
			Rs	Rs	Rs
1–2	8	4	3,000	6,000	750
1–3	5	3	4,000	8,000	2,000
2–4	9	6	4,000	5,500	500
3–5	7	5	2,000	3,200	600
2–5	5	1	8,000	12,000	1,000
4–6	3	2½	10,000	11,200	2,400
5–6	6	2	4,000	6,800	700
6–7	10	7	6,000	8,700	900
5–7	9	5	4,200	9,000	1,200
			45,200	70,400	

The project network with normal duration is shown in Exhibit 22.31.

Exhibit 22.31 ***Project Network***

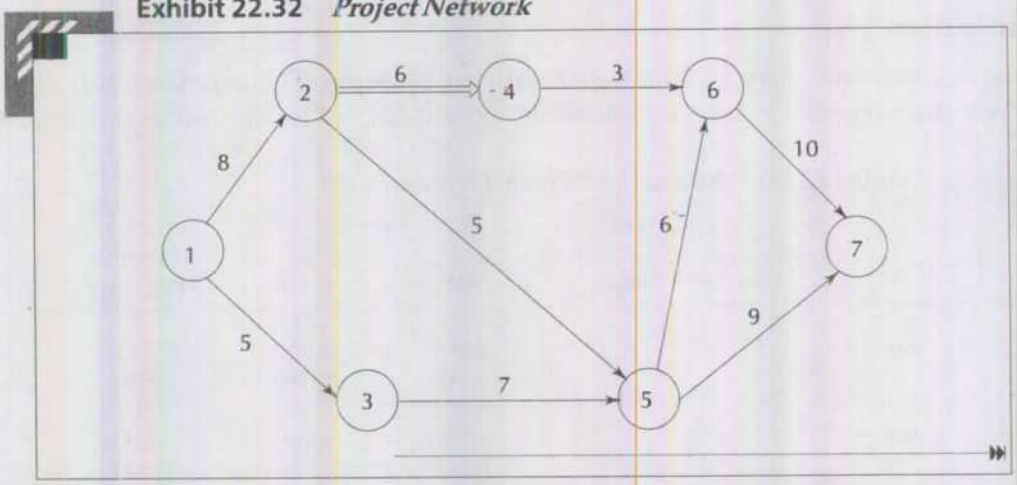


8. If there is more than one critical path, one activity on each of the critical paths should be crashed. The activity crashed on each critical path, of course, will have the lowest cost–time slope on that path.

The critical path in the all-normal network is (1–2–4–6–7). The project duration is 30 weeks and the total direct cost is Rs 45,200.

Examining the time–cost slope of activities on the critical path we find that activity (2–4) has the lowest slope; in other words, the cost to expedite per week is the lowest for activity (2–4). Hence activity (2–4) is crashed. The project network after such a crashing is shown in Exhibit 22.32.

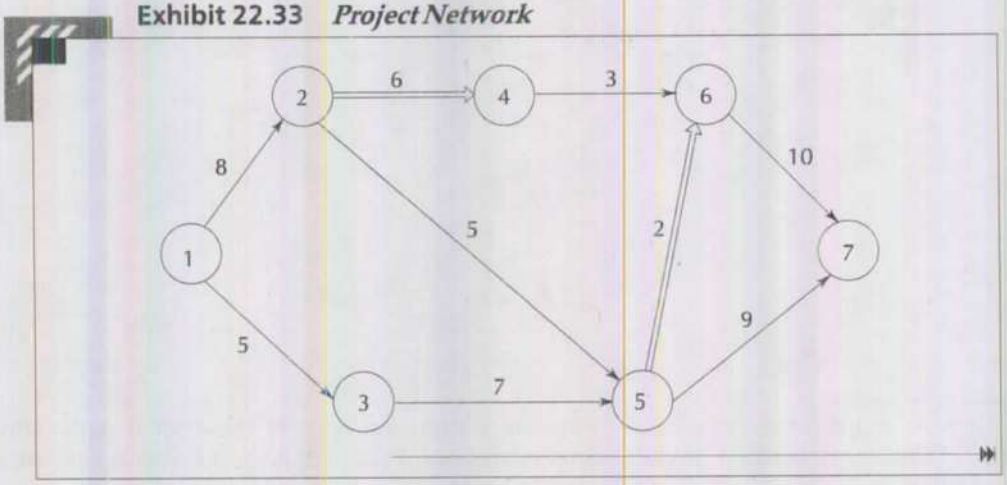
Exhibit 22.32 *Project Network*



As per Exhibit 22.32 the critical path is (1–2–5–6–7), with a length of 29 weeks, and the total direct cost is Rs 46,700.

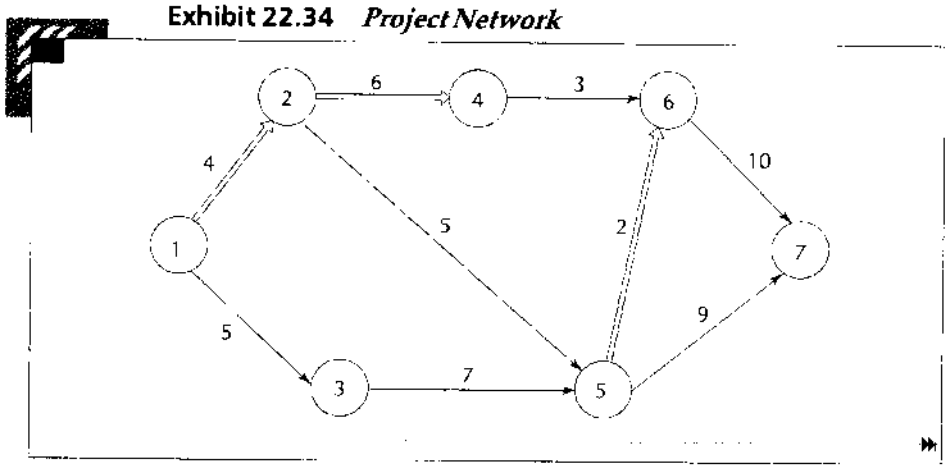
Looking at the time–cost slope of the activities on the new critical path (1–2–5–6–7), we find that the activity (5–6) has the lowest slope. Hence this activity is crashed. The project network after such crashing is shown in Exhibit 22.33. As per this figure, the critical path is (1–2–4–6–7) with a length of 27 weeks and the total direct cost is Rs 49,500.

Exhibit 22.33 *Project Network*



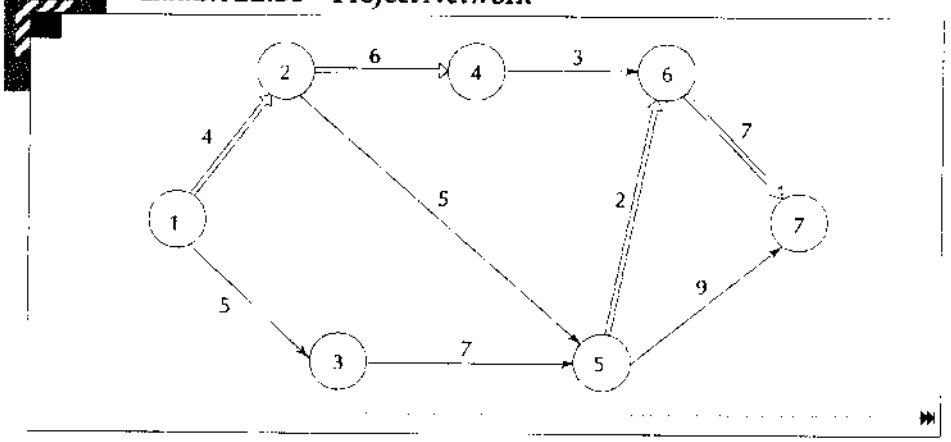
Comparing the time-cost slope of the non-crashed activities on the new critical path (1–2–4–6–7), we find that the activity which costs the least to crash is (1–2). Hence this is crashed. The project network after such a crashing is shown in Exhibit 22.34. As per this figure the critical path is (1–3–5–6–7) with a length of 24 weeks and the total direct cost is Rs 52,500.

Exhibit 22.34 *Project Network*



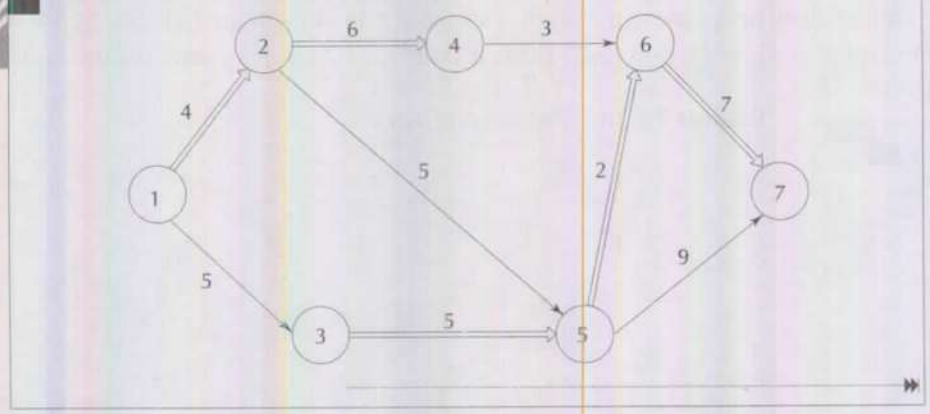
Looking at the time–cost slope of the non-crashed activities on the new critical path (1–3–5–6–7), we find that activity (6–7) has the lowest slope. Hence it is crashed. The project network after such a crashing is shown in Exhibit 22.35. As per this figure there are two critical paths (1–3–5–6–7) and (1–3–5–7), both with a length of 21 weeks, and the total direct cost is Rs 55,200.

Exhibit 22.35 *Project Network*



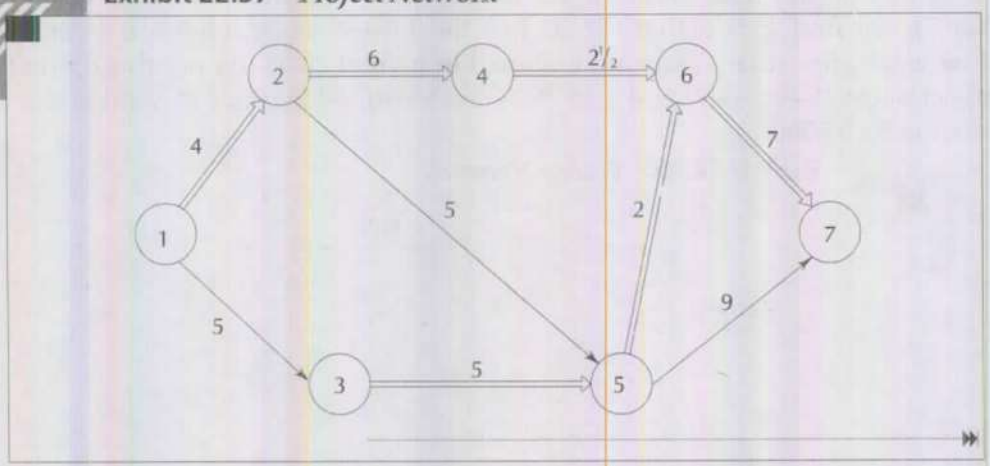
Considering the time-cost slope of non-crashed activities on critical paths (1–3–5–6–7) and (1–3–5–7), we find that activity (3–5) which is common to both the critical paths is the least costly to crash. Hence, it is crashed. The project network after this crashing is shown in Exhibit 22.36. As per this figure, the critical path is (1–2–4–6–7) with a duration of 20 weeks and the total direct cost is Rs 56,400.

Exhibit 22.36 *Project Network*



Looking at the new critical path (1–2–4–6–7) we find that the only non-crashed activity is (4–6). Crashing this gives us the project network shown in Exhibit 22.37. As per this figure, the critical path again is (1–2–4–6–7) with a duration of 19½ weeks and the total direct cost is Rs 57,600.

Exhibit 22.37 *Project Network*



Since all the activities on the critical path (1–2–4–6–7) are crashed, there is no possibility of further time reduction. Hence let us now look at the time-cost relationship. Exhibit 22.38 shows this[9].

9. At this stage, we look at the crashed activities on the non-critical paths to find out whether they can be de-crashed without increasing the project duration as indicated by the critical path (1–2–4–6–7). If this is possible, we begin with the activity which has the highest time–cost slope and proceed in the order of the decreasing time-cost slope. In our project, however, there is no scope for de-crashing on the non-critical path because it is not possible to do so without increasing the project duration.

From Exhibit 22.38, we find that the total cost is minimised for the project schedule represented by Exhibit 22.37 in which the activities crashed are (1–2), (2–4), (3–5), (5–6), and (6–7). The information provided in Exhibit 22.38 is useful for decision making.

Exhibit 22.38 ***Project Duration and Total Cost***

Exhibit	*Activities Crashed*	*Project Duration in Weeks*	*Total Direct Cost*	*Total Indirect Cost*	*Total Cost*
			Rs	Rs	Rs
22.31	None	30	45,200	60,000	105,200
22.32	(2–4)	29	46,700	58,000	104,700
22.33	(2–4) and (5–6)	27	49,500	54,000	103,500
20.34	(1–2), (2–4) and (5–6)	24	52,500	48,000	100,500
22.35	(1–2), (2–4), (5–6) and (6–7)	21	55,200	42,000	97,200
22.36	(1–2), (2–4), (3–5), (5–6) and (6–7)	20	56,400	40,000	96,400
22.37	(1–2), (2–4), (3–5), (5–6), (4–6) and (6–7)	19½	57,600	39,000	96,600

If the objective is to minimise the total cost of the project, the pattern of crashing suggested by Exhibit 22.36 is optimal. If the objective is to minimise the project duration then the pattern of crashing suggested by Exhibit 22.37 is optimal. In real life situations, however, both the factors may be important. In addition, factors like strain on resources and degree of manageability are also important. The final decision would involve a careful weighing and balancing of these diverse factors, some quantitative, some qualitative. In any case, information along the lines provided in Exhibit 22.38 provides useful input for decision making.

22.7 NETWORK COST SYSTEM

The techniques of PERT and CPM discussed above are essentially time-oriented. They seek to answer questions like:

- What is the most desirable time schedule of activities?
- How much time would it take, on an average, to complete the project?
- What is the probability of completing the project in a specified time? (It may be noted that in CPM analysis, the primary objective is to develop a time schedule in view of time–cost tradeoff and not to develop a detailed budget of costs, activity-wise and time-wise. Similarly, when scheduling is done under funds constraint, the primary objective is to establish a time schedule consistent with funds constraint and not to develop a system for cost planning and control.)

Such analysis largely overlooks the cost aspect which is usually as important as the time aspect and sometimes even more. To provide a vehicle for cost planning and control of projects, the network cost system was developed. This represents a very useful supplement to the traditional time-oriented network analysis. Let us look at cost projection and cost analysis and control under the network cost system.

Cost Projection

The basic principle of the network cost system is fairly simple: costs are planned, measured, analysed, and controlled in terms of project activities. Though simple, this principle represents a departure from the conventional cost accounting system where costs are generally planned, measured, analysed, and controlled in terms of functions or organisational divisions.

Once costs are estimated in terms of activities, cost projections can be made for any chosen schedule. For cost projection it is usually assumed that the expenditure for any activity is incurred evenly over the duration of the activity. Where this assumption does not appear valid, the activity should be divided into two or more sequential components, such that for each of the components the expenditure occurs uniformly over its duration. The projected cost curve for a given schedule and activity-wise cost estimates can be readily obtained.

Analysis and Control of Costs

As the project progresses the following may be measured/estimated periodically for purposes of monitoring and control.

1. *Costs incurred to date* In a network cost system costs are recorded activity-wise. Costs incurred to date can be obtained by summing up costs for various activities.
2. *Budgeted costs to date* Budgeted costs to date can be readily obtained from the cost projections made at the beginning.
3. *Value of work done to date* When costs are measured, an estimate should also be made of the extent of work accomplished. The value of work done can then be obtained as follows: budgeted costs × percentage work accomplished. This may be illustrated by an example. A certain activity has a budgeted cost of Rs 80,000 and at the time of the periodic progress review it is estimated that 60 percent of the work has been accomplished. So the value of work done is put at Rs 80,000 × 60 percent = Rs 48,000.
4. *Cost over-run (under-run) to date* There is cost over-run when the cost incurred is more than the value of work done. Similarly, there is cost under-run when the cost incurred is less than the value of work done. Cost over-run (under-run) is usually expressed in percentage terms. It is defined as follows:

$$\frac{\text{Actual cost} - \text{Value of work completed}}{\text{Value of work completed}} \times 100$$

5. *Time over-run (under-run) to date.* There is time over-run if the project is behind schedule. Likewise, there is time under-run if the project is ahead of schedule. Time over-run (under-run) is usually defined in terms of months behind or months ahead.

Graphic Display

The above information may be displayed graphically as shown in Exhibit 22.39.

Exhibit 22.39 ***Time and Cost, Budget and Actual***

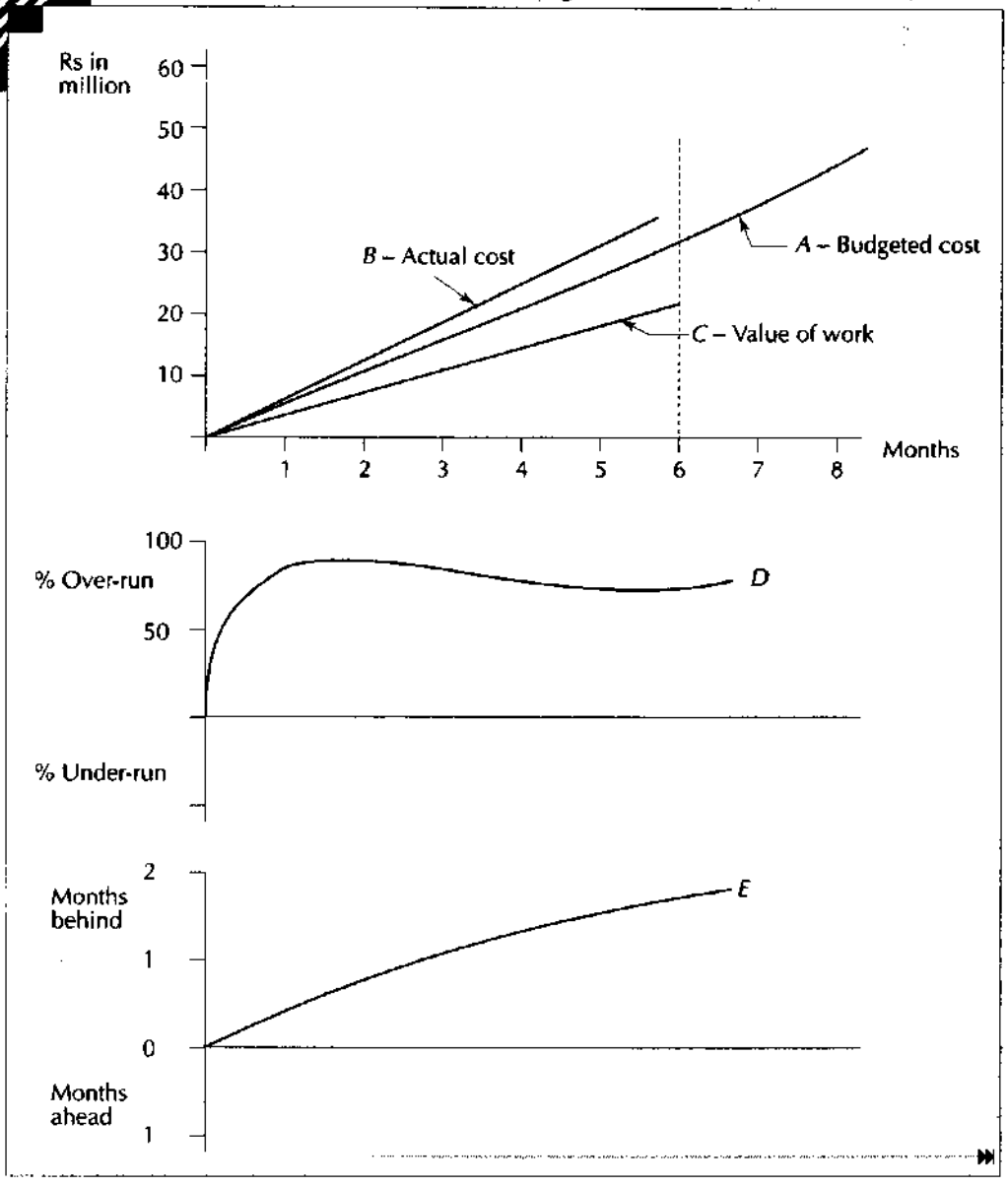


Exhibit 22.39 has three graphs. The first graph shows budgeted costs (curve *A*), actual costs (curve *B*), and value of work (curve *C*). The second graph shows percentage cost over-run or under-run (curve *D*). It may be noted that curve *D* is derived from curves *B*

and *C*. The vertical distance between curves *B* and *C* is divided by the height of curve *C* and multiplied by 100 to get curve *D*. The third graph shows the number of months by which the project is behind or ahead of the schedule (curve *E*). Curve *E* is derived from curves *A* and *C*. The months behind/ahead at any particular point of time is simply the horizontal distance (measured in months) of curve *C* at that point of time and curve *A*. Exhibit 22.39 provides information about time and cost, budget and actual, at one place and is a very useful device for monitoring and control.

SUMMARY

- For proper planning, scheduling, and control of the activities of a project, given their interrelationships and constraints on the availability of resources, network techniques have been found quite useful.
- There are two basic network techniques: PERT and CPM. PERT is applied mostly to projects characterised by uncertainty; its orientation is probabilistic. CPM is applied to projects which are relatively risk-free; its orientation is deterministic. Widely diverse projects are amenable to analysis by PERT and CPM.
- The steps involved in PERT analysis are: (i) development of project network, (ii) time estimation, (iii) determination of critical path, event slacks, and activity floats, (iv) development of project schedule, and (v) calculation of the variability of project duration and the probability of completion in a given time.
- The network diagram is constructed in terms of activities and events. An activity is a definite task, job or function to be performed in a project. An event is a specific point of time indicating the beginning or end of one or more activities.
- The rules to be observed in constructing the network diagram are: (i) Each activity must have a preceding and succeeding event. (ii) Each event should have a distinct number. (iii) There should be no loops in the project network. (iv) Not more than one activity can have the same preceding and succeeding events.
- To ensure that each activity is uniquely numbered it may be necessary to introduce dummy activities. A dummy activity is an imaginary activity which can be accomplished in zero time and which does not consume resources. A dummy activity may also be used to represent a constraint necessary to show the proper relationship between activities.
- Once the logic and detail of the network have been established, time estimates may be assigned to each activity. Generally, three time values are obtained for each activity: optimistic time (t_o), most likely time (t_m), and pessimistic time (t_p). The average time (t_e) is obtained by the formula:

$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

- Once the network diagram with single time estimates has been developed, the following computational procedure may be employed for determining the critical path/s, event slacks, and activity floats: (i) Calculate the earliest occurrence time for each event.

(ii) Calculate the latest occurrence time for each event. (iii) Calculate the slack of each event. (iv) Obtain the critical and slack paths. (v) Compute the activity floats.

- The early start schedule refers to the schedule in which all activities start as early as possible. The late start schedule reflects a desire to commit resources late—as late as possible.
- In real life situations there may be restrictions on the availability of resources. In the face of these, various schedules may have to be considered to find out which one is most appropriate in the light of these restrictions.
- Variability in PERT analysis is measured by variance or its square root, standard deviation.
- The steps involved in calculating the standard deviation of the duration of the critical path are as follows: (i) Determine the standard deviation of the duration of each activity on the critical path. (ii) Determine the standard deviation of the total duration of the critical path on the basis of information obtained in step (i).
- Armed with information about the mean and standard deviation of critical path duration, we can compute the probability of completion by a specified date.
- The usual assumptions underlying CPM analysis are: (i) The costs associated with a project can be divided into two components: direct costs and indirect costs. (ii) Activities of the project can be expedited by crashing which involves employing more resources. (iii) Crashing reduces time but enhances direct costs. (iv) Indirect costs associated with the project increase linearly with project duration.
- Given the above assumptions, CPM analysis seeks to examine the consequences of crashing on total cost (direct cost plus indirect cost). The procedure used in this respect is generally as follows: (i) Obtain the critical path in normal network. Determine the project duration and direct cost. (ii) Examine the cost-time slope of activities on the critical path obtained and crash the activity which has the least slope. (iii) Construct the new critical path after crashing as per step (ii). Determine project duration and cost. (iv) Repeat steps (ii) and (iii) till all activities on the critical path (which may change every time) are crashed.
- To provide a vehicle for cost planning and control of projects, the network cost system was developed. This represents a very useful supplement to the traditional time-oriented network analysis.
- The basic principle of network cost system is fairly simple: costs are planned, measured, analysed, and controlled in terms of project activities.
- As the project progresses, the following may be measured/estimated periodically for purposes of monitoring and control: (i) costs incurred to-date, (ii) budgeted costs to-date, (iii) value of work done to-date, (iv) cost over-run (under-run) to-date, and (v) time over-run (under-run) to-date. ■

Questions

1. What is the basic difference between PERT and CPM?
2. What steps are involved in PERT analysis?
3. Discuss the rules for network construction.
4. What considerations should be borne in mind in time estimation?
5. What is the procedure for determining the critical path?
6. What are *EOT* and *LOT*?
7. Discuss the difference between total float, free float, and independent float.
8. What is an early start schedule and a late start schedule?
9. Illustrate the problem of scheduling in view of resource constraints with the help of an example.
10. How would you calculate the variability of project duration and probability of completion at a specified time? Illustrate with an example.
11. What are the usual assumptions underlying CPM analysis?
12. Discuss the procedure of CPM analysis with the help of a simple example.
13. Discuss the basic principle of network cost system.
14. What kind of periodic monitoring is done in a network cost system?

Problems

1. Draw the network diagram for an industrial project with which you are familiar.
2. A project consists of the following activities represented in terms of preceding and succeeding events. Draw its network diagram.

Activity	*Mean time (weeks)*
(1, 2)	4
(1, 3)	2
(1, 4)	3
(2, 4)	5
(3, 4)	6
(4, 5)	2
(5, 7)	3
(2, 5)	1
(4, 7)	5

3. A project consists of 12 activities and their time estimates are shown below:

Activity	*Time (in weeks)*		
	t_o	t_m	t_p
(1–2)	4	6	10
(1–3)	3	7	12
(1–4)	5	6	9
(1–7)	2	4	6

(2–4)	6	10	20
(2–6)	3	4	7
(2–7)	5	9	15
(3–4)	3	7	12
(4–5)	2	4	5
(5–6)	1	3	6
(3–7)	2	5	8
(6–7)	1	2	6

(a) Draw the network diagram.
(b) Determine the critical path.
(c) Calculate event slacks and activity floats.
(d) Find the standard deviation of the critical path duration.
(e) Compute the probability of completing the project in 30 weeks.

4. The normal and crash times and direct costs for the activities of a project are shown below:

Activity	*Time*		*Cost*	
	Normal	*Crash*	*Normal*	*Crash*
(1–2)	5	2	6000	9000
(2–4)	6	3	7000	10,000
(1–3)	4	2	1000	2000
(3–4)	7	4	4000	8000
(4–7)	9	5	6000	9200
(3–5)	12	3	16,000	19,600
(4–6)	10	6	15,000	18,000
(6–7)	7	4	4000	4900
(7–9)	6	4	3000	4200
(5–9)	12	7	4000	8500

(a) Draw the network diagram.
(b) Determine all normal and critical path.
(c) Find the minimum cost project schedule if the indirect costs are Rs 1000 per week.

PART VII

Review

23. Project Review and Administrative Aspects

CHAPTER

23

Project Review and Administrative Aspects

The last phase of capital budgeting is concerned with the review of the projects undertaken. A project is monitored during the implementation phase so that time and cost over-runs are minimised. Further, after a project is commissioned its performance is periodically reviewed to see whether its performance has been in line with expectations. If things turn sour, the question of abandonment may also have to be examined.

The focus of this book has been mainly on the techniques of project analysis and selection and the supporting theoretical constructs. Capital budgeting, however, does not occur in a vacuum. Rather, it takes place in a real organisation with its attendant complexities such as compartmentalised thinking, multi-layered decision making, uneven knowledge of finance, bureaucratic red tape, and agency problems. To cope with these problems, firms develop suitable administrative procedures and try to mitigate agency problems through a combination of monitoring and incentives.

This chapter examines various facets of project review. It also discusses administrative aspects of capital budgeting and the devices for mitigating agency problems. It is divided into six sections:

- Control of in-progress projects.
- Post-completion audits.
- Abandonment analysis.
- Administrative aspects of capital budgeting.
- Agency problem.
- How sound is the capital budgeting system.

23.1 CONTROL OF IN-PROGRESS PROJECTS

Though a lot of effort is expended in selecting capital projects, things often go wrong in the implementation phase. This is evident from the frequent cost and time over-runs

witnessed in practice. Hence it is necessary to exercise strict control on in-progress capital projects. There are two aspects of controlling in-progress capital projects.

Establishment of Internal Control Procedures For every in-progress capital project, proper control accounts are set-up. These are charged with all relevant expenditures, which are further classified into capital and revenue items. These accounts reflect out-of-pocket payments as well as allocated expenses. The project-by-project segregation of costs ensures that proper attention can be directed to projects as they approach various milestones.

Use of Regular Progress Reports Periodic progress reports compare actual expenditures against estimates. They offer several benefits: (a) They provide timely information so that corrective action can be initiated to tackle potential problems. (b) They generate inputs for cash budgeting and fund raising. (c) They serve as the basis for calculating variances and explaining variances.

23.2 POST-COMPLETION AUDITS

An audit of a project after it has been commissioned is referred to as a post-audit or a post-completion audit. Most firms do a post-audit for projects above some threshold level.

Regular post-completion audits of capital projects: (i) provide a documented log of experience that may be valuable in improving future decision making, (ii) enable the firm in identifying individuals with superior abilities in planning and forecasting, (iii) help in discovering systematic biases in judgment, (iv) induce healthy caution among project sponsors, and (v) serve as a useful training ground for promising executives who need broader business experience and exposure.

It is a common practice to use book ROI defined as

$$\frac{\text{Net income}}{\text{Book value of assets}}$$

for evaluating existing businesses and projects on a continuing basis. Though widely used, the book ROI has two serious flaws:

- Even though a project may earn a constant economic rate of return, its book ROI displays wide variation across time.
- There is an upward bias in the book ROI of a business which has substantial investment in intangible assets.

Constant Economic Rate of Return but Variable Book ROI

Performance evaluation may be done in terms of economic rate of return or book return on investment

$$\text{Economic rate of return for a given year} = \frac{\text{Cash flow + Change in present value}}{\text{Present value at the beginning of the year}}$$

$$\text{Book return on investment for a given year} = \frac{\text{Cash flow + Change in book value}}{\text{Book value at the beginning of the year}}$$

The calculation of these measures may be illustrated with an example. Modern Enterprises Limited is considering an investment of Rs 100 million in a new electronics unit which has an economic life of 7 years. The projected cash flows are as follows:

Year	1	2	3	4	5	6	7
Cash flow	14	16	17	29	29	29	29

(Rs in million)

If the opportunity cost of capital is 12 percent, the *NPV* of the project turns out to be zero.

$$NPV = -100 + \frac{14}{(1.12)} + \frac{16}{(1.12)^2} + \frac{17}{(1.12)^3} + \frac{29}{(1.12)^4} + \frac{29}{(1.12)^5} + \frac{29}{(1.12)^6} + \frac{29}{(1.12)^7} = 0$$

The economic rate of return and the book return on investment (assuming a straight line depreciation over the 7-year life) for the electronics project are shown in Exhibits 23.1 and 23.2 respectively.

Exhibit 23.1 ***Calculation of Economic Rate of Return***

(Rs in million)

Year	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1. Cash flow	14	16	17	29	29	29	29
2. Present value at the beginning of the year, 12 percent discount rate	100	98	93.8	88.1	69.7	49.0	25.9
3. Present value at the end of the year, 12 percent discount rate	98	93.8	88.1	69.7	49.0	25.9	0
4. Change in value during the year (3–2)	−2	−4.2	−5.7	−18.4	−20.7	−23.1	−25.9
5. Economic income (1+4)	12	11.8	11.3	10.6	8.3	5.9	3.1
6. Economic rate of return (5/2)	.12	.12	.12	.12	.12	.12	.12
7. Economic depreciation	2	4.2	5.7	18.4	20.7	23.1	25.9

Exhibit 23.2 *Calculation of Book Return on Investment*

(Rs in million)

Year	1	2	3	4	5	6	7
1. Cash flow	14	16	17	29	29	29	29
2. Book value at the beginning of the year, straight line depreciation	100	85.7	71.4	57.1	42.9	28.6	14.3
3. Book value at the end of the year, straight line depreciation	85.7	71.4	57.1	42.9	28.6	14.3	0
4. Change in book value during the year (3–2)	–14.3	–14.3	–14.3	–14.3	–14.3	–14.3	–14.3
5. Book income (1+4)	–0.3	1.7	2.7	14.7	14.7	14.7	14.7
6. Book return on investment (5/2)	–0.003	0.020	0.038	0.257	0.343	0.514	1.028
7. Book depreciation	14.3	14.3	14.3	14.3	14.3	14.3	14.3

The economic rate of return shown in line 6 of Exhibit 23.1 remains constant at 12 percent throughout the life of the asset. This is a true measure of the project's profitability. The book ROI shown in line 6 of Exhibit 23.2 is very low in the initial years and rises rapidly from year 4 onwards. It becomes as high as 1.028 or 102.8 percent for year 7. Thus we find that the book ROI typically misrepresents true profitability, understating it in the earlier years and overstating it in the later years.

The popularity of book ROI, a flawed measure, seems to impair the quality of capital budgeting decisions. If managers are evaluated on the basis of book ROI they are likely to pay lip service to net present value. They may salute net present value but walk in the direction of book ROI. As the American Accounting Association Committee on Managerial Decision Models observed:

"The use of traditional accrual accounting methods for evaluating performance is a critical roadblock to implementation of present value models. Clearly, there is an inconsistency between citing present value models as being superior for capital budgeting decisions and then using entirely different concepts for tallying performance. As long as such practices persist, managers will often be tempted to make decisions which may be non-optimal under the present value criterion but optimal, at least over short or intermediate spans of time, under conventional accounting methods of evaluating operating performance."

Bias in Book ROI

Book ROIs are biased upwards for businesses that make substantial intangible investments in R&D, brand building, and so on, simply because these outlays are not reflected on the balance sheet.

To illustrate this point let us compare two companies, a pharmaceutical company and a steel company. The pharmaceutical company invests mostly in R&D whereas the steel company invests mostly in plant and equipment. For the sake of simplicity, assume that

both are mature firms which are not growing. However, they require investments to maintain the present level of business.

Exhibit 23.3 ***Financial Profiles of the Pharmaceutical and Steel Companies***

Rs in million

	Pharmaceutical	*Steel*
1. Revenues	2,000	2,000
2. Operating costs, excluding depreciation	1,000	1,000
3. Operating cash flow (1–2)	1,000	1,000
4. Investment in plant and equipment	200	600
5. Investment in R&D	600	200
6. Annual cash flow (3–4–5)	200	200

Exhibit 23.3 shows the financial profiles of the two companies. In order to maintain its existing business each company must invest Rs 800 million annually. The only difference is that the pharmaceutical company invests mostly in R&D whereas the steel company invests mostly in plant and equipment.

The fixed assets of both the companies have an economic life of 5 years and are depreciated at a rate of 20 percent per annum as per the straight line method. Exhibit 23.4 shows the book asset values and annual depreciation for the two companies. Note that the sum of R&D and depreciation is the same for the two companies.

Exhibit 23.4 ***Book Asset Values and Annual Depreciation and R&D Outlays***

Rs in million

Age (years)	*Pharmaceutical*		*Steel*	
	Original investment	*Net book value*	*Original investment*	*Net book value*
0 (New)	200	200	600	600
1	200	160	600	480
2	200	120	600	360
3	200	80	600	240
4	200	40	600	120
Net Book Value		600		1800

	Pharmaceutical	*Steel*
Annual depreciation	200	600
R&D outlay	600	200
Total	800	800

The book ROIs for the two companies are calculated in Exhibit 23.5. Although the two companies have identical cash flows, profitability, and present values, the pharmaceutical company's book ROI is three times the steel company's. The difference arises because the value of the pharmaceutical company's assets are understated relative to the steel company's assets.

The point of this story is that a business with a high book ROI need not necessarily be performing better. It may simply have more hidden assets which are not reflected on the balance sheet.

Exhibit 23.5 ***Book ROI***

Rs in million

	Pharmaceutical	*Steel*
1. Revenues	2,000	2,000
2. Operating costs, excluding depreciation	1,000	1,000
3. R&D expense	600	200
4. Depreciation	200	600
5. Net income	200	200
6. Net book value	600	1800
7. Book ROI (5/6)	33.3%	11.1%

A Possible Way Out

The problem with book ROI stems from using book depreciation rather than economic depreciation. Why not then switch to economic depreciation? This is difficult because it calls for reestimating each asset's present value each year. No wonder accountants set up a depreciation schedule right in the beginning, however arbitrary it may be, and adhere to it.

One solution may be to use a depreciation schedule that conforms to the *expected* economic depreciation which is known right in the beginning. This way you do not have to restate each asset's present value every year. Despite forecasting inaccuracies this may be better than the accounting depreciation.

23.3 ABANDONMENT ANALYSIS

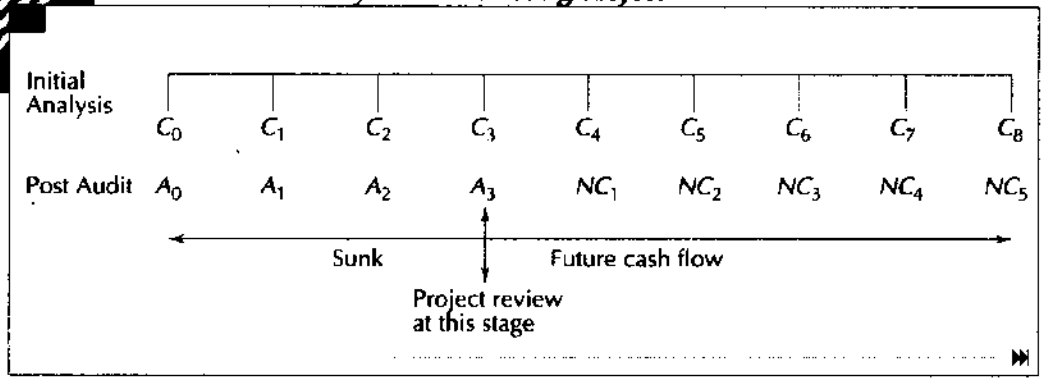
Capital expenditure management is a dynamic process. A capital investment cannot be regarded as a commitment till the end of the project life. As time rolls on, changes occur which can alter the attractiveness of projects or even entire divisions. Hence capital investments must be reappraised periodically to determine whether they should be continued or terminated or divested.

The techniques used to analyse a new project can also be used to analyse whether an existing project should be continued or terminated. However, there are some differences between an existing project and a new project:

- Most of the investment in a new project is still to be made and hence is a relevant cash outflow. By contrast, much of the investment in an existing project represents a sunk cost, which is not relevant for project analysis.
- In the case of a new project, the estimates of cash flows are likely to be more uncertain. On the other hand, thanks to the experience that the firm has with an existing project, the estimates of its future cash flows are likely to be more precise.
- The discount rate to be used for reappraising an existing project is likely to be different from that used to analyse the same project when it was initiated.

Once you estimate the incremental cash flows on an existing project and establish an appropriate discount rate, you can decide whether the project should be continued, terminated, or divested. To illustrate, assume that you are analysing an 8-year project three years into its life. The cash flows are as shown in Exhibit 23.6.

Exhibit 23.6 ***Analysis of an Existing Project***



C_t = forecast of cash flow for period t in the initial analysis ($t = 0...8$)

A_t = actual cash flow in period t ($t = 0...3$)

NC_n = new forecast of cash flow in period n assessed at the end of year 3 ($n = 1...5$)

To decide whether the project should be continued or terminated or divested, the following information is required:

- *Present value of the expected cash flows (PVCF)* This is defined as:

$$PVCF = \sum_{n=1}^{m} \frac{NC_n}{(1+r)^n}$$

where m is the balance life of the project at the time of review and r is the appropriate discount rate.

- *Salvage value (SV)* This is the value expected to be realised from terminating the project and selling its assets.
- *Divestiture value (DV)* This is the price offered by a third party to buy the project.

Given the values of *PVCF*, *SV*, and *DV*, the following are the decision rules:

If	*Action*
$PVCF < SV < DV$	Divest
$PVCF < DV < SV$	Terminate
$SV < DV < PVCF$	Continue
$SV < PVCF < DV$	Divest
$DV < SV < PVCF$	Continue
$DV < PVCF < SV$	Terminate

Illustration

Suppose you are analysing a call centre opened by Global Enterprises three years ago, which has a remaining life of five years. Exhibit 23.7 presents the initial forecast of cash flows, the actual cash flow upto the end of the third year, and the revised forecast for the balance five years.

The present value of expected cash flow (*PVCF*) at the end of year 3 works out to Rs 253.1 million.

Exhibit 23.7 ***Analysis of an Existing Call Centre of Global Enterprises***

Initial Analysis			*Analysis in Year 3*			
Year	*Initial forecast of cash flow*	*Present value at 12%*	*Year*	*Actual cash flow*	*Forecast in year 3*	*Present value of cash flow at 11%*
0	(250)	(250)		(230)		
1	30	26.8		20		
2	50	39.9		30		
3	80	60.0		65		
4	100	63.6	1		80	72.1
5	100	56.7	2		90	73.1
6	80	40.6	3		70	51.2
7	60	27.1	4		50	33.0
8	50	20.2	5		40	23.7
	Initial *NPV* = 84.9		*NPV* at the end of year 3 =			253.1

The salvage value (*SV*) at the end of year 3 is Rs 175 million. A third party has offered to buy the call centre for Rs 260 million.

What should Global Enterprises do? Since *DV* (260) > *PVCF* (253.1) > *SV* (175), the recommended course of action is to divest the call centre.

Behavioural Issues in Project Abandonment

A basic rule of capital budgeting says that investment decisions should be guided by the net present value criterion. Applied to a project 'continuation versus abandonment'

decision, this rule says the project must be abandoned if the net present value associated with abandonment is greater than the net present value associated with continuation. By the same logic, the project should be continued if the present value associated with continuation is greater than the net present value associated with abandonment.

Do managers follow the logic of net present value calculations in evaluating continuation versus abandonment decisions? It appears that they often overlook this logic. They have a tendency to get entrapped into losing projects and, in their attempts to rescue them, throw good money after bad. Why does this happen? While there can be several reasons, it happens mainly because sunk costs, which are irrelevant for economic accounting are often not ignored in mental accounting.

To illustrate the difference between economic accounting and mental accounting, consider the example of a person who having already lost Rs 20,000 in a business venture is confronted with a choice between two alternatives, *A* and *B*. Alternative *A* would yield a certain gain of Rs 10,000 whereas alternative *B*, akin to a gamble, has two equiprobable payoffs, 0 and Rs 20,000. If he employs the rules of economic accounting, he will form two accounts. The first contains a loss of Rs 20,000 and it is closed. The second involves a choice between *A* and *B* in which he would obviously choose *A* (as the expected value of *A* is same as that of *B* without the dispersion characterising the latter). Put differently, a person who employs economic accounting will ignore sunk costs.

If he is guided by "mental accounting" he sees only one account that is open with an existing loss of Rs 20,000. Put in other words, he does not ignore sunk costs. Hence he views alternatives *A* and *B* as follows:

A. Closing the account with a loss of Rs 10,000. (The previous loss of Rs 20,000 less the gain of Rs 10000.)

B. Closing the account with a loss of Rs 20,000 (if the pay-off of the gamble is zero) or a loss of nil (if the payoff of the gamble is Rs 20,000).

Kahneman and Tversky argue that people, confronted with a choice between a sure loss and a gamble which offers some prospect of reducing their loss to zero or so, tend to display risk-seeking behaviour.

A person who uses "mental accounting" does not adapt his asset position to losses and hence is likely to be entrapped in continuing the project. He distinguishes between unrealised 'paper losses' and realised 'losses' and adapts his asset position only after the losses are realised. Since realisation of losses induces regret, he is reluctant to realise them and resorts to procrastination as a way to defer the attendant pain. Of course, he may even deepen his commitment to the project further in the hope of finally emerging as a 'winner' and avoiding the ignominy of failure. In this context, note that commitment has a positive side as well as a negative side. On the positive side, it helps people to work harder, surmount obstacles, and scale great heights. On the negative side, it entraps people into negative *NPV* projects, induces them to throw good money after bad, and impairs their judgment.

Overcoming Resistance Since the *NPV* prescription is clear, there is no intellectual difficulty in distinguishing projects where commitment is worthwhile from projects where it is not. The difficulty seems to arise because of a 'self control' problem. While the rational internal "principal" may understand the benefits of terminating a losing project, it may find it difficult to persuade the internal "agent" to take the desired action because termination means that a mental account has to be closed and the accompanying loss realised. To overcome this tendency the following measures may be used.

Follow Certain Rules Rules are useful in exercising self-control. Two rules that may be considered in the present context are:

- Evaluate the projects in conformity with the principles of economic accounting.
- Review all projects periodically to determine whether they should be terminated or continued in accordance with the *NPV* rule.

Develop Proper Rewards and Penalties If there are high rewards for success and high penalties for failure, project managers (or sponsors) may have a tendency to deepen their commitment (which may lead to entrapment) and also delay disclosure of bad news about the project. To counter such tendencies, the performance evaluation system of the company should (a) reward project managers who disclose bad news early and penalise project managers who withhold bad news, and (b) convey a message to project managers that some failure is normal in business and early steps should be initiated to cut losses.

Institute Relatively Independent Reviews Companies can develop formal structures whereby projects are periodically reviewed by people who are not members of the project team to determine whether they should be continued or terminated in accordance with the principles of economic accounting. Such reviews are likely to be more objective and unbiased.

Managing Divestments

Since divestments are becoming commonplace, corporates should approach them systematically and rationally. Here are some basic guidelines for managing divestments:

Regard Divestments as a Normal Part of Business Life Divestments are motivated *inter alia* by the following features of business life: (a) A company's disposition towards a given activity may change over its life cycle. What may appear as highly desirable and appealing at one stage may strike as unattractive and unappealing at another stage. (b) Decisions are based on judgments which are sometimes right and sometimes wrong—this is a fact of business life.

Hence, regard divestments as a normal process for all organisations, not just sick and unsuccessful organisations. As Leonard Vignola, Jr. says: "A company lives by expanding and contracting, by growing and changing, by acquiring and divesting. These are the actions of a healthy, vital company, not a sick, dying company.[1]"

1. Leonard Vignola, Jr. *Strategic Divestment*, Amacom, New York: 1974.

Consider Divestment as One of the Many Responses to a Situation There are several options available when a business or project is under-performing. It may be continued as it is; it may be shut down till business conditions improve; new product lines may be added; an aggressive cost reduction programme may be initiated; manufacturing and/or distribution arrangements may be strengthened. When none of these alternatives seem feasible or desirable, consider divestment seriously.

Since divestment is one of the many responses, it must be considered as an integral part of the regular planning process. The planning group should be assigned responsibility for initiating divestment moves.

Approach Divestments Positively View a divestment as an opportunity, not a catastrophe. As Leonard Vignola, Jr. says:

> "Difficulties abound and optimum divestment is not overly easy to accomplish. Yet divestment ought to be viewed as a chance to turn a less than favourable situation into a future benefit to the divesting company.[2]"

Announce divestment decisions candidly and create an impression that the company has the ability to deal with a problem realistically and sensibly. As Leonard Vignola, Jr. says:

> "The decision to divest should be presented as a firm, aggressive, positive step on the part of the divesting company.[3]"

23.4 ADMINISTRATIVE ASPECTS OF CAPITAL BUDGETING

The discussion on administrative aspects of capital budgeting has been organised as follows:

- Identification of promising investment opportunities.
- Classification of investments.
- Submission of proposals.
- Decision making.
- Preparation of capital budget and appropriation.
- Implementation.
- Performance review.

Identification of Promising Investment Opportunities

Often firms have an abundance of investment proposals but a dearth of really worthwhile proposals. For identifying promising investment opportunities the following points should be borne in mind:

1. Monitor changes in market demand, sources of supply, profitability, competition, governmental policies, economic conditions, and technological developments.

2. Vignola *op. cit*
3. Vignola *op. cit*

2. Formulate long-range plans and perspectives based on analysis of opportunities and threats in the environment and assessment of internal strengths, weaknesses, capabilities, and limitations.
3. Communicate long-range plans and corporate perspectives to all persons who are likely to be involved in capital budgeting.
4. Encourage employees to make suggestions and reward them suitably for valuable suggestions.

In short, the relationship between the firm and its environment should be regularly analysed, corporate plans and perspectives must be widely shared, and the creativity and imagination of the employees must be tapped.

With regard to tapping the imagination of employees, it may be noted that in most organisations personnel at middle and lower levels do not contribute much to the pool of investment proposals. This is often due to the failure of the administration to cull out good ideas emanating from different echelons of the organisation. To generate ideas, suggestion schemes are usually recommended. Suggestion schemes by themselves, however, cannot achieve the objective. According to John B. Mathews, Jr.:

> "The solution seems to lie in that intangible thing known as 'climate', meaning in this case a receptivity to suggestions at all company levels and a pervading opinion that management has no monopoly on ideas and welcomes them from any and all sources."[4]

Classification

The classification of capital expenditure proposals refers to the grouping of similar proposals into separate categories. Classification helps in decision making, budgeting, and control.

Investment proposals may be classified in many ways. We suggest below a scheme of classification which can, with minor modification, be adopted for most manufacturing enterprises:

1. *Replacement Investments* These represent capital expenditures for the replacement of existing fixed assets—this may become necessary because of the expiry of normal life or because of a change in technology.
2. *Modernisation and Rationalisation Investments* These comprise capital expenditures for improving productivity, increasing efficiency, reducing costs, and ensuring greater reliability.
3. *Expansion Investments* These represent capital expenditures for increasing capacity.
4. *New Product Investments* These represent capital expenditures to manufacture new products.

4. J.B. Mathews, Jr. "How To Administer Capital Spending," *Harvard Business Review*, March–April, 1959.

5. *Research and Development Investments* These represent capital expenditures on basic research and development facilities.
6. *Obligatory and Welfare Investments* These represent expenditures on facilities which are obligatory and/or conducive to employee welfare.

Submission of Proposals

To ensure that all relevant information for proposals is gathered systematically, a standardised proposal form may be used by all the sponsors of investment projects. A suggested proposal form is shown in Exhibit 23.8.

To help the sponsor of the project in filling and submitting the form:

1. A procedures manual setting forth in detail the firm's capital budgeting policy and techniques may be prepared and widely disseminated.
2. Short duration training programmes may be organised.
3. The help of a staff person may be made available to the sponsor of the project.

The proposal form, before it reaches the capital budgeting committee, should normally be routed through persons who can comment on the estimates furnished by the sponsor. The routing channel, however, cannot be standardised. It will vary from one organisation to another and, perhaps, from one proposal to another.

Exhibit 23.8 ***Capital Investment Proposal Form***

(Useful particularly for replacement, modernisation, rationalisation, expansion, and new product investments.)

Sponsor's Name: Date:

Sponsor's Signature: Code No.:
(To be given by the capital budgeting committee)

Department:

Proposal:

A. *Project Features and Nature of Benefits*
(Describe the nature of the project and the kinds of benefits, both quantitative and qualitative, that are likely to accrue from it.)

B. *Cash Flow Summary Data*
(Give most probable values for cash flows. Cash flows must be defined consistently with the concept of funds employed. Show details of the cash flow calculation in an appendix.)

Period	*Outlay for assets*	*Cash flow from operations*	*Cash flow from disposal of assets*	*Net cash flow*
0				
1				
2				
3				
4				
5				
6				
7				

8
9
10

C. *Risk Characteristics of the Project*
(Describe the uncertainties relating to factors which have an important bearing on the project.)

D. *Project Worthwhileness Measures*
(Several criteria of project worthwhileness are given below. It may not be necessary to calculate all criteria of worthwhileness in every case. However, at least one discounted cash flow method should be given.)
1. (i) Net present value at average cost of capital (r =12% say)
   (ii) Net present value at cost of capital adjusted for risk (r = 15% say)
2. Internal rate of return
3. Profitability index
4. Accounting rate of return
5. Cash payback period
6. Undiscounted benefit cost ratio

E. *Comments of Reviewing Officers*
(Reviewing Officers are expected to give their frank and candid opinion about the project. They may seek clarification from the sponsor, if necessary.)

Reviewing Officer	*Initials*	*Date*
1.		
2.		
3.		
4.		

Space for Comments

Reviewing Officer 1
Reviewing Officer 2
Reviewing Officer 3
Reviewing Officer 4

Routing a proposal through several persons provides a mechanism for obtaining the views and judgments of others. For example, a proposal submitted by the plant superintendent may be routed through the production manager, sales manager, and engineering manager for their comments on different aspects of the project. This also facilitates coordination of inter-related activities. Obviously this system would yield benefits only when the persons through whom the proposal is routed give thought to it rather than merely forward it in a routine manner.

Decision Making

It may be argued that the optimal capital budget for the firm as a whole can be drawn up only when capital investment decisions are completely centralised. This, however, is not desirable in most cases because some decentralisation is required to facilitate quick decisions, develop executives, and conserve top management time for important matters. That is why most of the companies empower executives at different levels to take investment decisions

involving outlays up to certain limits. In one company, for example, the plant superintendent can okay investment outlays up to Rs 50,000, the factory manager up to Rs 100,000, the capital budgeting committee up to Rs 250,000, and the managing director up to Rs 500,000. Investments involving larger outlays need the consent of the board of directors.

While the system of rupee gateways has considerable merit there may be certain pitfalls. Managers may break a project into several parts so that no decision at a higher level becomes necessary. For example, a production manager who is empowered to undertake a project up to Rs 100,000 may split a project involving an outlay of Rs 150,000 into two parts of Rs 80,000 and Rs 70,000 so that it is not sent upwards for review. This tendency can be countered by asking managers, when they seek budgetary appropriations, to indicate the additional investment required in related areas in the future.

Another problem in the delegation of capital investment decision making arises from differences in risk attitudes. Managers at lower levels tend to be more averse to risks than top management. They may discard projects which top management may approve. This tendency can be overcome to some extent by communicating corporate strategy and risk disposition of top management to all those who are involved in capital budgeting. In addition, lower level executives should be encouraged to take risks consistent with corporate policy by designing an appropriate system of rewards and punishment.

Preparation of Capital Budget and Appropriation

Smaller projects which can be approved at lower levels may be covered by a blanket appropriation so that they can be undertaken expeditiously. Since these projects require small outlays, no elaborate funds planning is required for them. Projects of larger magnitude (which generally require the approval of the capital budget committee or managing director or the board of directors) may be included after approval in the tentative capital budget. The final capital budget, which serves as the basis of budgetary appropriations, should be drawn up after the availability of funds is ensured. Often careful planning of funds is required before budgetary appropriations are made.

While the capital expenditure budget is usually drawn up for one to two years, it is desirable to have a perspective plan ranging from 3 to 5 years. In some cases it may even be of a longer duration.

The capital expenditure budget, though it is based on a careful review of various factors, should not be regarded as inviolate. Changes in circumstances may warrant changes in the budget not originally contemplated. This is perhaps the reason why a final sanction is required before actual expenditure in many companies.

The coordination of the capital expenditure budget should preferably be done by a financial officer of the firm. In firms where a financial officer is not in charge of coordination, the budgetary process and the analysis of individual projects tend to be somewhat loose and sloppy.

Implementation

Delay in implementation and the consequent increase in the project cost are very common. Cases are not infrequent where the actual time for execution has exceeded planned time by 50 percent. Cost over-runs are also very common. In many cases over-runs have been between 30 percent and 100 percent. These facts emphasise the need for expeditious implementation at a reasonable cost. For this the following points are helpful:

1. *Adequate Formulation of Projects* Often delays occur because of insufficient preliminary studies and inadequate formulation of the project. Cases have come to notice where due to inadequate or limited investigation in regard to suitability of site, availability of required natural resources, other raw materials, etc. the execution of project has subsequently been delayed considerably resulting in substantial increase in cost and adversely affecting their economies.

   Such delays can be mitigated by bestowing greater care and attention on preliminary investigations and project formulation. The responsibility of investigation should be properly determined.

2. *Use of the Principle of Responsibility Accounting* By assigning definite responsibilities to project managers for completing the project on time, a sense of time consciousness can be instilled. This helps in expeditious implementation.

3. *Use of Network Techniques* Network techniques like PERT (Programme Evaluation Review Technique) and CPM (Critical Path Method) are helpful in project planning and control. With the help of these techniques, progress reporting becomes rather easy. Precise, prompt, and brief reports aid the management in appraisal and corrective action so as to ensure the successful completion of projects.

4. *Exercise of Proper Control* Once an appropriation is established the sponsor (or manager) of the project is authorised to incur expenditure. Proper control over this expenditure needs to be exercised. Periodical reports on expenditure along with information on the degree of physical completion are helpful in this respect. Note that unless information regarding physical completion is available control becomes difficult.

Performance Review

Performance review is meant for evaluating actual performance vis-à-vis projected performance. It is concerned with the verification of assumptions regarding both revenues and costs. In scope, it is broader than the popularly used accounting review which is concerned only with costs.

Despite its importance, performance review is one of the most neglected aspects of capital budgeting. The reasons seem to be:

- It is difficult to isolate the cash flows attributable to individual investments from financial accounts which are compiled for the firm as a whole and which are based on the accrual principle.
- There is an apprehension that a performance review may be used for punitive purposes.

The first problem can be overcome largely by using estimates and approximations wherever it is not possible to obtain accurate data. For example, if costs relating to a project have not been recorded separately, a reasonable estimate can usually be made on the basis of information relating to total costs and the activities of the firm. Likewise, cash flows from sales arising from a project can be roughly estimated by looking into the collection pattern of receivables as a whole.

The second problem can be overcome by making it clear to all project sponsors that the purpose of post-audit is to promote learning and not to penalise the persons involved. It provides feedback that is necessary for future improvements.

23.5 AGENCY PROBLEM

In theory, managers as agents of shareholders are supposed to take actions that maximise the welfare of the shareholders (the principals). In practice, managers enjoy substantial autonomy and have a natural inclination to pursue their own goals. This is the agency problem. To prevent from being dislodged from their position, managers may try to achieve some acceptable level of performance as far as shareholder welfare is concerned. However, beyond that their personal goals may acquire priority. *Inter alia*, they seek to:

- Preside over a big empire that gives them power, stature, and higher compensation.
- Pursue pet projects that draw on their special skills and competencies so that their position in the organisation is entrenched.
- Enjoy generous compensation and lavish perquisites.
- Shirk efforts because identifying and implementing high-*NPV* projects is a very demanding proposition.
- Avoid risks because acceptance of high firm-specific risks, although quite acceptable to diversified shareholders, can threaten the security of their job and the growth prospects with the firm.

Agency costs can be mitigated by monitoring the actions and behaviour of the managers and by offering them right incentives that motivate them to maximise value.

Monitoring

Monitoring helps in checking more visible agency problems like empire building, excessive perquisites, managerial absenteeism, and frauds. However, monitoring costs time and

money and may not be worthwhile beyond a point. The law of diminishing marginal returns applies to monitoring as it does elsewhere.

Even with tight and expensive monitoring, certain kinds of agency costs cannot be prevented. Suppose shareholders want to monitor the investment decisions of the firm. How can they be sure that the capital budget finalised by the top management includes all positive-*NPV* investment opportunities available to the firm? Or, how can they be sure that project sponsors have not massaged the cash flow forecasts to get their favourite projects included? After all managers know more about the prospects of the firm than the shareholders. The informational advantage enjoyed by managers gives them a lot of latitude to pursue their interests at the expense of the shareholders.

Incentive Compensation

Because monitoring has its imperfections and limitations, suitable compensation plans must be designed to give managers the right incentive. A well-conceived incentive compensation plan goes a long way in aligning the interest of managers and shareholders. Bear in mind the following guidelines in designing the incentive compensation plan.

Integrate the Incentive Plan into the Total Compensation Architecture The compensation package of a firm seeks to reward executives in a variety of ways: base salary, perquisites, retirement benefits, incentive compensation, promotion, and so on. The incentive compensation cannot be designed in isolation. As it has a bearing on the overall risk-reward structure of the compensation scheme, it has to be fitted into the same.

Select the Right Set of Performance Measures The incentive compensation plan must be linked to performance measures that are consistent with the responsibilities of the executives. Alfred Rappaport recommends the following hierarchy of performance measures:

Level	*Measure*
CEO and corporate level executives	Total return to shareholders
Operating unit executives	Shareholder value added
Frontline employees and managers	Leading indicators of value like time to market for new products and customer retention ratio.

Use Objective Criteria As far as possible the incentive compensation plan must be based on criteria that are easily observable by all parties and not amenable to manipulation. Use of objective criteria imparts credibility to the incentive plan and reduces subjectivity.

Reward Relative Performance Incentive compensation should be based on performance relative to that of some peer group rather than absolute performance. This ensures that the

general market influences or industry-specific influences are abstracted from the performance measure, thereby providing a distinctive contribution made by the executive(s) to the wealth or profitability of the firm.

Lengthen the Decision Making Horizon of the Executives One possible solution to mitigate the short-term decision making horizon of executives is to adopt 'performance plans' which provide deferred compensation when certain "long-term" (ranging, say, over a period of 3 to 7 years) goals are achieved.

23.6 EVALUATING THE CAPITAL BUDGETING SYSTEM OF AN ORGANISATION

The soundness of the capital budgeting system of an organisation may be evaluated in terms of the following criteria:

Results	Are the results of the capital budgeting system consistent with the goals of the organisation?
Techniques	Are efficient techniques being employed for purposes of capital expenditure planning, decision making, and control?
Communication	Are the premises underlying capital budgeting communicated to those who participate in this process?
Decentralisation	Is there meaningful delegation and decentralisation which permits decision making at appropriate levels?
Intelligibility	Are the policies, methods of analysis, and procedures understood by different segments of the organisation which are involved in capital budgeting?
Flexibility	Does the system have sufficient flexibility to respond to the dynamic changes in the environment and to permit variations in approaches for projects with differing characteristics?
Control	Are adequate controls being exercised in the implementation phase to ensure that slippages are mitigated?
Review	Is there a systematic review of capital investments which permits meaningful feedback for improving the system and its effectiveness?

SUMMARY

- It is necessary to exercise a strict control on in-progress projects. There are two aspects of controlling in-progress capital projects: (a) establishment of internal control procedures, and (b) use of regular progress reports.
- An audit of a project after it has been commissioned is referred to as post-audit or post-completion audit. It is a useful feedback and review tool.
- Performance evaluation may be done in terms of economic rate of return or book return on investment (ROI):

$$\text{Economic rate of return for a given year} = \frac{\text{Cash flow + Change in present value}}{\text{Present value at the beginning of the year}}$$

$$\text{Book ROI for a given year} = \frac{\text{Cash flow + Change in book value}}{\text{Book value at the beginning of the year}}$$

- It is a common practice to use book ROI (net income/book value of assets) for evaluating existing businesses and projects on a continuing basis.
- Although widely used, the book ROI has two serious flaws: (a) Even though a project may earn a constant economic rate of return, its book ROI displays wide variation across time. (b) There is an upward bias in the book ROI of a business which has substantial investment in intangible assets.
- A capital investment cannot be regarded as a commitment till the end of the project life. Hence it has to be periodically reappraised to determine whether it should be continued or terminated or divested.
- The techniques used to analyse a new project can also be used to analyse whether an existing project should be continued or not.
- To decide whether a project should be continued or terminated or divested, calculate *PVCF* (present value of expected cash flows), *SV* (salvage value), and divestiture value (*DV*). Choose the option that has the highest value.
- It appears that managers often overlook the logic of net present value in evaluating "continuation versus abandonment" decisions and have a tendency to get entrapped into losing projects. To overcome this tendency, the following measures may be used: (i) follow certain rules, (ii) develop proper rewards and penalties, and (iii) institute relatively independent reviews.
- For identifying promising investment opportunities, the relationship between the firm and its environment should be regularly analysed, corporate plans and perspectives must be widely shared, and the creativity and imagination of the employees must be tapped.
- Investment proposals may be classified in many ways. The following scheme of classification can with minor modification be adopted for most manufacturing enterprises: (i) replacement investments, (ii) modernisation and rationalisation investments, (iii)

expansion investments, (iv) new product investments, (v) research and development investments, and (vi) obligatory and welfare investments.

- To ensure that all relevant information for proposals is gathered systematically, a standardised proposal form may be used by all the sponsors of investment projects.
- Some decentralisation of capital budgeting is required to facilitate quick decisions, develop executives, and conserve top management time for important matters. That is why most companies empower executives at different levels to take investment decisions involving outlays up to certain limits.
- While the capital expenditure budget is usually drawn up for one to two years, it is desirable to have a perspective plan ranging from three to five years. In some cases it may even be of a longer duration. The coordination of the capital expenditure budget should preferably be done by a financial officer of the firm.
- For timely implementation of projects within reasonable costs, the following are helpful: adequate formulation of projects; use of the principle of responsibility accounting; use of network techniques; and exercise of proper control.
- Despite its importance, performance review tends to be one of the most neglected aspects of capital budgeting.
- The soundness of the capital budgeting system of an organisation may be evaluated in terms of the following criteria: results, techniques, communication, decentralisation, intelligibility, flexibility, control, and review.

Questions

1. Why should post-audit be done?
2. What is the difference between economic rate of return and book return on investment?
3. Explain the bias in book ROI.
4. Discuss the procedure for determining whether a project should be continued, terminated, or divested.
5. What is the difference between economic accounting and mental accounting?
6. Discuss measures for injecting greater rationality in project termination decisions.
7. What needs to be done to identify potential investment opportunities?
8. Suggest a scheme for classifying capital expenditure proposals in a manufacturing concern.
9. "The optimal capital budget for the firm as a whole can be drawn up only when capital investment decisions are completely centralised." Comment.
10. What are the advantages of conducting a performance review? What problems are encountered in performance review and how can they be overcome?
11. How would you evaluate the capital budgeting system of an organisation?

Problems

1. Prabhat Limited is considering a project involving an outlay of Rs 146.895 million. The projected cash inflows of this project over its 6-year life are as follows:

Year	1	2	3	4	5	6
Cash inflow (Rs in million)	25	30	40	45	50	30

This investment is a zero-*NPV* investment. Calculate the economic rate of return and the book return on income (assuming a straight line depreciation over the 6-year life) for the above project. The opportunity cost of capital is 12 percent.

2. Matrix Limited had set up a project 4 years ago. The project has a remaining life of 6 years. The cash flow forecast for the balance life is as follows:

Year	1	2	3	4	5	6
Cash flow forecast (Rs in million)	30	35	45	50	30	25

The salvage value of the project if terminated immediately is Rs 120 million. A third party has offered to buy the project for Rs 175 million. The discount rate is 12 percent. What should Matrix do?

CHAPTER 

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Appendix A



Table A.1 Future Value Interest Factor
$FVIF(r, n) = (1 + r)^n$

Period n	*1%*	*2%*	*3%*	*4%*	*5%*	*6%*	*7%*	*8%*	*9%*	*10%*	*11%*	*12%*	*13%*
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	1.010	1.020	1.030	1.040	1.050	1.060	1.070	1.080	1.090	1.100	1.110	1.120	1.130
2	1.020	1.040	1.061	1.082	1.102	1.124	1.145	1.166	1.188	1.210	1.232	1.254	1.277
3	1.030	1.061	1.093	1.125	1.158	1.191	1.225	1.260	1.295	1.331	1.368	1.405	1.443
4	1.041	1.082	1.126	1.170	1.216	1.262	1.311	1.360	1.412	1.464	1.518	1.574	1.630
5	1.051	1.104	1.159	1.217	1.276	1.338	1.403	1.469	1.539	1.611	1.685	1.762	1.842
6	1.062	1.126	1.194	1.265	1.340	1.419	1.501	1.587	1.677	1.772	1.870	1.974	2.082
7	1.072	1.149	1.230	1.316	1.407	1.504	1.606	1.714	1.828	1.949	2.076	2.211	2.353
8	1.083	1.172	1.267	1.369	1.477	1.594	1.718	1.851	1.993	2.144	2.305	2.476	2.658
9	1.094	1.195	1.305	1.423	1.551	1.689	1.838	1.999	2.172	2.358	2.558	2.773	3.004
10	1.105	1.219	1.344	1.480	1.629	1.791	1.967	2.159	2.367	2.594	2.839	3.106	3.395
11	1.116	1.243	1.384	1.539	1.710	1.898	2.105	2.332	2.580	2.853	3.152	3.479	3.836
12	1.127	1.268	1.426	1.601	1.796	2.012	2.252	2.518	2.813	3.138	3.498	3.896	4.335
13	1.138	1.294	1.469	1.665	1.886	2.133	2.410	2.720	3.056	3.452	3.883	4.363	4.898
14	1.149	1.319	1.513	1.732	1.930	2.261	2.579	2.937	3.342	3.797	4.310	4.887	5.535
15	1.161	1.346	1.558	1.801	2.079	2.397	2.759	3.172	3.642	4.177	4.785	5.474	6.254
16	1.173	1.373	1.605	1.873	2.183	2.540	2.952	3.426	3.970	4.595	5.311	6.130	7.067
17	1.184	1.400	1.653	1.948	2.292	2.693	3.159	3.700	4.328	5.054	5.895	6.866	7.986
18	1.196	1.428	1.702	2.026	2.407	2.854	3.380	3.996	4.717	5.560	6.544	7.690	9.024
19	1.208	1.457	1.754	2.107	2.527	3.026	3.617	4.316	5.142	6.116	7.263	8.613	10.197
20	1.220	1.486	1.806	2.191	2.653	3.207	3.870	4.661	5.604	6.728	8.062	9.646	11.523
25	1.282	1.641	2.094	2.666	3.386	4.292	5.427	6.848	8.623	10.835	13.585	17.000	21.231
30	1.348	1.811	2.427	3.243	4.322	5.743	7.612	10.063	13.268	17.449	22.892	29.960	39.116

Period n	14%	15%	16%	17%	18%	19%	20%	24%	28%	32%	36%	40%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	1.140	1.150	1.160	1.170	1.180	1.190	1.200	1.240	1.280	1.320	1.360	1.400
2	1.300	1.322	1.346	1.369	1.392	1.416	1.440	1.538	1.638	1.742	1.850	1.960
3	1.482	1.521	1.561	1.602	1.643	1.685	1.728	1.907	2.097	2.300	2.515	2.744
4	1.689	1.749	1.811	1.874	1.939	2.005	2.074	2.364	2.684	3.036	3.421	3.842
5	1.925	2.011	2.100	2.192	2.288	2.386	2.488	2.392	3.436	4.007	4.653	5.378
6	2.195	2.313	2.436	2.565	2.700	2.840	2.986	3.635	4.398	5.290	6.328	7.530
7	2.502	2.660	2.826	3.001	3.185	3.379	3.583	4.508	5.629	6.983	8.605	10.541
8	2.853	3.059	3.278	3.511	3.759	4.021	4.300	5.590	7.206	9.217	11.703	14.758
9	3.252	3.518	3.803	4.108	4.435	4.785	5.160	6.931	9.223	12.166	15.917	20.661
10	3.707	4.046	4.411	4.807	5.234	5.695	6.192	8.549	11.806	16.060	21.647	28.925
11	4.226	4.652	5.117	5.624	6.176	6.777	7.430	10.657	15.112	21.199	29.439	40.496
12	4.818	5.350	5.936	6.580	7.288	8.064	8.916	13.215	19.343	27.983	40.037	56.694
13	5.492	6.153	6.886	7.699	8.599	9.596	10.699	16.386	24.759	36.937	54.451	79.372
14	6.261	7.076	7.988	9.007	10.147	11.420	12.839	20.319	31.961	48.757	74.053	111.120
15	7.138	8.137	9.266	10.539	11.974	13.590	15.407	25.196	40.565	64.359	100.712	155.568
16	8.137	9.358	10.748	12.330	14.129	16.172	18.488	31.243	51.923	84.954	136.969	217.795
17	9.276	10.761	12.468	14.426	16.672	19.244	22.186	38.741	66.461	112.139	186.278	304.914
18	10.575	12.375	14.463	16.879	19.673	22.901	26.623	48.039	85.071	148.023	253.338	426.879
19	12.056	14.232	16.777	19.748	23.214	27.252	31.948	59.568	108.890	195.391	344.540	597.630
20	13.743	16.367	19.461	23.106	27.393	32.429	38.338	73.864	139.380	257.916	468.574	836.683
25	26.462	32.919	40.874	50.658	62.669	77.388	95.396	216.542	478.905	1033.590	2180.081	4499.880
30	50.950	66.212	85.850	111.065	143.371	184.675	237.376	634.820	1645.504	4142.075	10143.019	24201.432

Table A.2 *Future Value Interest Factor for an Annuity*

$$FVIF(r, n) = \frac{(1+r)^n - 1}{r}$$

Period n	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	2.010	2.020	2.030	2.040	2.050	2.060	2.070	2.080	2.090	2.100	2.110	2.120	2.130
3	3.030	3.060	3.091	3.122	3.152	3.184	3.215	3.246	3.278	3.310	3.342	3.374	3.407
4	4.060	4.122	4.184	4.246	4.310	4.375	4.440	4.506	4.573	4.641	4.710	4.779	4.850
5	5.101	5.204	5.309	5.416	5.526	5.637	5.751	5.867	5.985	6.105	6.228	6.353	6.480
6	6.152	6.308	6.468	6.633	6.802	6.975	7.153	7.336	7.523	7.716	7.913	8.115	8.323
7	7.214	7.434	7.662	7.898	8.142	8.394	8.654	8.923	9.200	9.487	9.783	10.089	10.405
8	8.286	8.583	8.892	9.214	9.549	9.897	10.260	10.637	11.028	11.436	11.859	12.300	12.757
9	9.369	9.755	10.159	10.583	11.027	11.491	11.978	12.488	13.021	13.579	14.164	14.776	15.416
10	10.462	10.950	11.464	12.006	12.578	13.181	13.816	14.487	15.193	15.937	16.722	17.549	18.420
11	11.567	12.169	12.808	13.486	14.207	14.972	15.784	16.645	17.560	18.531	19.561	20.655	21.814
12	12.683	13.412	14.192	15.026	15.917	16.870	17.888	18.977	20.141	21.384	22.713	24.133	25.650
13	13.809	14.680	15.618	16.627	17.713	18.882	20.141	21.495	22.953	24.523	26.212	28.029	29.985
14	14.947	15.974	17.086	18.292	19.599	21.015	22.550	24.215	26.019	27.975	30.095	32.393	34.883
15	16.097	17.293	18.599	20.024	21.579	23.276	25.129	27.152	29.361	31.772	34.405	37.280	40.417
16	17.258	18.639	20.157	21.825	23.657	25.673	27.888	30.324	33.003	35.950	39.190	42.753	46.672
17	18.430	20.012	21.762	23.698	25.840	28.213	30.840	33.750	36.974	40.545	44.501	48.884	53.739
18	19.615	21.412	23.414	25.645	28.132	30.906	33.999	37.450	41.301	45.599	50.396	55.750	61.725
19	20.811	22.841	25.117	27.671	30.539	33.760	37.379	41.446	46.018	51.159	56.939	63.440	70.749
20	22.019	24.297	26.870	29.778	33.066	36.786	40.995	45.762	51.160	57.275	64.203	72.052	80.947
25	28.243	32.030	36.459	41.646	47.727	54.865	63.249	73.106	84.701	98.347	114.413	133.334	155.620
30	34.785	40.568	47.575	56.805	66.439	79.058	94.461	113.283	136.308	164.494	199.021	241.333	293.199

Period *n*	*14%*	*15%*	*16%*	*17%*	*18%*	*19%*	*20%*	*24%*	*28%*	*32%*	*36%*	*40%*
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	2.140	2.150	2.160	2.170	2.180	2.190	2.200	2.240	2.280	2.320	2.360	2.400
3	3.440	3.473	3.506	3.539	3.572	3.606	3.640	3.778	3.918	4.062	4.210	4.360
4	4.921	4.993	5.066	5.141	5.215	5.291	5.368	5.684	6.016	6.362	6.725	7.104
5	6.610	6.742	6.877	7.014	7.154	7.297	7.442	8.048	8.700	9.398	10.146	10.946
6	8.536	8.754	8.977	9.207	9.442	9.683	9.930	10.980	12.136	13.406	14.799	16.324
7	10.730	11.067	11.414	11.772	12.142	12.523	12.916	14.615	16.534	18.696	21.126	23.853
8	13.233	13.727	14.240	14.773	15.327	15.902	16.499	19.123	22.163	25.678	29.732	34.395
9	16.085	16.786	17.518	18.285	19.086	19.923	20.799	24.712	29.369	34.895	41.435	49.153
10	19.337	20.304	21.321	22.393	23.521	24.709	25.959	31.643	38.592	47.062	57.352	69.814
11	23.044	24.349	25.733	27.200	28.755	30.404	32.150	40.238	50.399	63.122	78.998	98.739
12	27.271	29.002	30.850	32.824	34.931	37.180	39.580	50.985	65.510	84.320	108.437	139.235
13	32.089	34.352	36.786	39.404	42.219	45.244	48.497	64.110	84.853	112.303	148.475	195.929
14	37.581	40.505	43.672	47.103	50.818	54.841	59.196	80.496	109.612	149.240	202.926	275.300
15	43.842	47.580	51.660	56.110	60.965	66.261	72.035	100.815	141.303	197.997	276.979	386.420
16	50.980	55.717	60.925	66.649	72.939	79.850	87.442	126.011	181.868	262.356	377.692	541.988
17	59.118	65.075	71.673	78.979	87.068	96.022	105.931	157.253	233.791	347.310	514.661	759.784
18	68.394	75.836	84.141	93.406	103.740	115.266	128.117	195.994	300.252	459.449	700.939	1064.697
19	78.969	88.212	98.603	110.285	123.414	138.166	154.740	244.033	385.323	607.472	954.277	1491.576
20	91.025	102.44	115.380	130.033	146.628	165.418	186.688	303.601	494.213	802.863	1298.817	2089.206
25	181.871	212.793	249.214	292.105	342.603	402.042	471.981	898.092	1706.803	3226.844	6053.004	11247.199
30	356.787	434.745	530.321	647.439	790.948	966.712	1181.882	2640.916	5873.231	12940.859	28172.276	60501.081

Table A.3 ***Present Value Interest Factor***

$$PVIF\,(r, n) = (1 + r)^{-n}$$

Period *n*	*1%*	*2%*	*3%*	*4%*	*5%*	*6%*	*7%*	*8%*	*9%*	*10%*	*11%*	*12%*	*13%*
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797	0.783
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712	0.693
4	0.961	0.924	0.889	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636	0.613
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567	0.543
6	0.942	0.888	0.838	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507	0.480
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452	0.425
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404	0.376
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	0.391	0.361	0.333
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322	0.295
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350	0.317	0.287	0.261
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319	0.286	0.257	0.231
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290	0.258	0.229	0.204
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263	0.232	0.205	0.181
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239	0.209	0.183	0.160
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218	0.188	0.163	0.141
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198	0.170	0.146	0.125
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180	0.153	0.130	0.111
19	0.828	0.686	0.570	0.475	0.396	0.331	0.276	0.232	0.194	0.164	0.138	0.116	0.098
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149	0.124	0.104	0.087
25	0.780	0.610	0.478	0.375	0.295	0.233	0.184	0.146	0.116	0.092	0.074	0.059	0.047
30	0.742	0.552	0.412	0.308	0.231	0.174	0.131	0.099	0.075	0.057	0.044	0.033	0.026

Period n	14%	15%	16%	17%	18%	19%	20%	24%	28%	32%	36%	40%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.877	0.870	0.862	0.855	0.847	0.840	0.833	0.806	0.781	0.758	0.735	0.714
2	0.769	0.756	0.743	0.731	0.718	0.706	0.694	0.650	0.610	0.574	0.541	0.510
3	0.675	0.658	0.641	0.624	0.609	0.593	0.579	0.524	0.477	0.435	0.398	0.364
4	0.592	0.572	0.552	0.534	0.516	0.499	0.482	0.423	0.373	0.329	0.292	0.260
5	0.519	0.497	0.476	0.456	0.437	0.419	0.402	0.341	0.291	0.250	0.215	0.186
6	0.456	0.432	0.410	0.390	0.370	0.352	0.335	0.275	0.227	0.189	0.158	0.133
7	0.400	0.376	0.354	0.333	0.314	0.296	0.279	0.222	0.178	0.143	0.116	0.095
8	0.351	0.327	0.305	0.285	0.266	0.249	0.233	0.179	0.139	0.108	0.085	0.068
9	0.308	0.284	0.263	0.243	0.226	0.209	0.194	0.144	0.108	0.082	0.063	0.048
10	0.270	0.247	0.227	0.208	0.191	0.176	0.162	0.116	0.085	0.062	0.046	0.035
11	0.237	0.215	0.195	0.178	0.162	0.148	0.135	0.094	0.066	0.047	0.034	0.025
12	0.208	0.187	0.168	0.152	0.137	0.124	0.112	0.076	0.052	0.036	0.025	0.018
13	0.182	0.163	0.145	0.130	0.116	0.104	0.093	0.061	0.040	0.027	0.018	0.013
14	0.160	0.141	0.125	0.111	0.099	0.088	0.078	0.049	0.032	0.021	0.014	0.009
15	0.140	0.123	0.108	0.095	0.084	0.074	0.065	0.040	0.025	0.016	0.010	0.006
16	0.123	0.107	0.093	0.081	0.071	0.062	0.054	0.032	0.019	0.012	0.007	0.005
17	0.108	0.093	0.080	0.069	0.060	0.052	0.045	0.026	0.015	0.009	0.005	0.003
18	0.095	0.081	0.069	0.059	0.051	0.044	0.038	0.021	0.012	0.007	0.004	0.002
19	0.083	0.070	0.060	0.051	0.043	0.037	0.031	0.017	0.009	0.005	0.003	0.002
20	0.073	0.061	0.051	0.043	0.037	0.031	0.026	0.014	0.007	0.004	0.002	0.001
25	0.038	0.030	0.024	0.020	0.016	0.013	0.010	0.005	0.002	0.001	0.000	0.000
30	0.020	0.015	0.012	0.009	0.007	0.005	0.004	0.002	0.001	0.000	0.000	0.000

Table A.4 *Present Value Interest Factor for an Annuity*

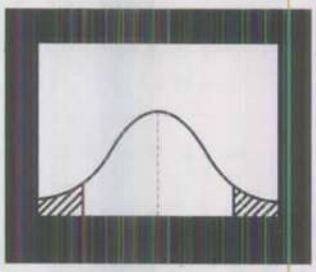
$$PVIF(r, n) = \frac{1 - \frac{1}{(1+r)^n}}{r}$$

Period *n*	*1%*	*2%*	*3%*	*4%*	*5%*	*6%*	*7%*	*8%*	*9%*	*10%*	*11%*	*12%*	*13%*
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690	1.668
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402	2.361
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037	2.974
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605	3.517
6	5.795	5.601	5.417	5.242	5.076	4.917	4.766	4.623	4.486	4.355	4.231	4.111	3.998
7	6.728	6.472	6.230	6.002	5.786	5.582	5.389	5.206	5.033	4.868	4.712	4.564	4.423
8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.146	4.968	4.799
9	8.566	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.537	5.328	5.132
10	9.471	8.983	8.530	8.111	7.722	7.360	7.024	6.710	6.418	6.145	5.889	5.650	5.426
11	10.368	9.787	9.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	6.207	5.938	5.687
12	11.255	10.575	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	6.492	6.194	5.918
13	12.134	11.348	10.635	9.986	9.394	8.853	8.358	7.904	7.487	7.103	6.750	6.424	6.122
14	13.004	12.106	11.296	10.563	9.899	9.295	8.745	8.244	7.786	7.367	6.982	6.628	6.302
15	13.865	12.849	11.938	11.118	10.380	9.712	9.108	8.559	8.060	7.606	7.191	6.811	6.462
16	14.718	13.578	12.561	11.652	10.838	10.106	9.447	8.851	8.312	7.824	7.379	6.974	6.604
17	15.562	14.292	13.166	12.166	11.274	10.477	9.763	9.122	8.544	8.022	7.549	7.120	6.729
18	16.398	14.992	13.754	12.659	11.690	10.828	10.059	9.372	8.756	8.201	7.702	7.250	6.840
19	17.226	15.678	14.324	13.134	12.085	11.158	10.336	9.604	8.950	8.365	7.839	7.366	6.938
20	18.046	16.351	14.877	13.590	12.462	11.470	10.594	9.818	9.128	8.514	7.963	7.469	7.025
25	22.023	19.523	17.413	15.622	14.094	12.783	11.654	10.675	9.823	9.077	8.422	7.843	7.330
30	25.808	22.397	19.600	17.292	15.373	13.765	12.409	11.258	10.274	9.427	8.694	8.055	7.496

Period n	14%	15%	16%	17%	18%	19%	20%	24%	28%	32%	36%	40%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.877	0.870	0.862	0.855	0.847	0.840	0.833	0.806	0.781	0.758	0.735	0.714
2	1.647	1.626	1.605	1.585	1.566	1.547	1.528	1.457	1.392	1.332	1.276	1.224
3	2.322	2.283	2.246	2.210	2.174	2.140	2.106	1.981	1.868	1.766	1.674	1.589
4	2.914	2.855	2.798	2.743	2.690	2.639	2.589	2.404	2.241	2.096	1.966	1.849
5	3.433	3.352	3.274	3.199	3.127	3.058	2.991	2.745	2.532	2.345	2.181	2.035
6	3.889	3.784	3.685	3.589	3.498	3.410	3.326	3.020	2.759	2.534	2.339	2.168
7	4.288	4.160	4.039	3.922	3.812	3.706	3.605	3.242	2.937	2.678	2.455	2.263
8	4.639	4.487	4.344	4.207	4.078	3.954	3.837	3.421	3.076	2.786	2.540	2.331
9	4.946	4.772	4.607	4.451	4.303	4.163	4.031	3.566	3.184	2.868	2.603	2.379
10	5.216	5.019	4.883	4.659	4.494	4.339	4.193	3.682	3.269	2.930	2.650	2.414
11	5.453	5.234	5.029	4.836	4.656	4.486	4.327	3.776	3.335	2.978	2.683	2.438
12	5.660	5.421	5.197	4.988	4.793	4.611	4.439	3.851	3.387	3.013	2.708	2.456
13	5.842	5.583	5.342	5.118	4.910	4.715	4.533	3.912	3.427	3.040	2.727	2.469
14	6.002	5.724	5.468	5.229	5.008	4.802	4.611	3.962	3.459	3.061	2.740	2.478
15	6.142	5.847	5.575	5.324	5.092	4.876	4.675	4.001	3.483	3.076	2.750	2.484
16	6.265	5.954	5.669	5.405	5.162	4.938	4.730	4.033	3.503	3.088	2.758	2.489
17	6.373	6.047	5.749	5.475	5.222	4.990	4.775	4.059	3.518	3.097	2.763	2.492
18	6.647	6.128	5.818	5.534	5.273	5.033	4.812	4.080	3.529	3.104	2.767	2.494
19	6.550	6.198	5.877	5.584	5.316	5.070	4.844	4.097	3.539	3.109	2.770	2.496
20	6.623	6.259	5.929	5.628	5.353	5.101	4.870	4.110	3.546	3.113	2.772	2.497
25	6.873	6.464	6.097	5.766	5.467	5.195	4.948	4.147	3.564	3.122	2.776	2.499
30	7.003	6.566	6.177	5.829	5.517	5.235	4.979	4.160	3.569	3.124	2.778	2.500

Table A.5 ***Normal Distribution***

(Area of the Normal Distribution, that is, Z Standard Deviations to the Left or Right of the Mean)



Number of Standard Deviations from Mean, (Z)	*Area to the Left or Right (One tail)*	*Number of Standard Deviations from mean (Z)*	*Area to the Left or Right (One tail)*
0.00	0.5000	1.70	0.0446
0.05	0.4801	1.75	0.0401
0.10	0.4602	1.80	0.0359
0.15	0.4404	1.85	0.0322
0.20	0.4207	1.90	0.0287
0.25	0.4013	1.95	0.0256
0.30	0.3821	2.00	0.0228
0.35	0.3632	2.05	0.0202
0.40	0.3446	2.10	0.0179
0.45	6.3264	2.15	0.0158
0.50	0.3085	2.20	0.0139
0.55	0.2912	2.25	0.0122
0.60	0.2743	2.30	0.0107
0.65	0.2578	2.35	0.0094
0.70	0.2420	2.40	0.0082
0.75	0.2264	2.45	0.0071
0.80	0.2119	2.50	0.0062
0.85	0.1977	2.55	0.0054
0.90	0.1841	2.60	0.0047
0.95	0.1711	2.65	0.0040
1.00	0.1587	2.70	0.0035
1.05	0.1469	2.75	0.0030
1.10	0.1357	2.80	0.0026
1.15	0.1251	2.85	0.0022
1.20	0.1151	2.90	0.0019
1.25	0.1056	2.95	0.0016
1.30	0.0968	3.00	0.0013
1.35	0.0885	3.05	0.0011
1.40	0.0808	3.10	0.0010
1.45	0.0735	3.25	0.0006
1.50	0.0668	3.50	0.00023
1.55	0.0606	4.00	0.00003
1.60	0.0548	4.99	0.0000003
1.65	0.0495		

Appendix B



Assessing the Tax Burden[1].

For preparing the profitability projection, the expected tax burden for the forecast period, which is usually eight to ten years, has to be figured out. This calls for familiarity with the provisions of the Income Tax Act that are relevant for determining the magnitude and timing of the tax burden for a new project. This appendix seeks to provide help in this respect. It is organised into four sections. The first section discusses the broad framework for deriving the taxable income; the second dwells on some important provisions relevant for computing the taxable income; the third focuses on the determination of tax burden and payment of tax; and finally, the fourth presents a comprehensive illustration of tax calculation. It should be emphasised here that taxation is a complex and specialised field which is best handled by experts. Our purpose here is to build a basic understanding of the tax framework relevant for financial appraisal of projects and not to provide a detailed exposition of the field.

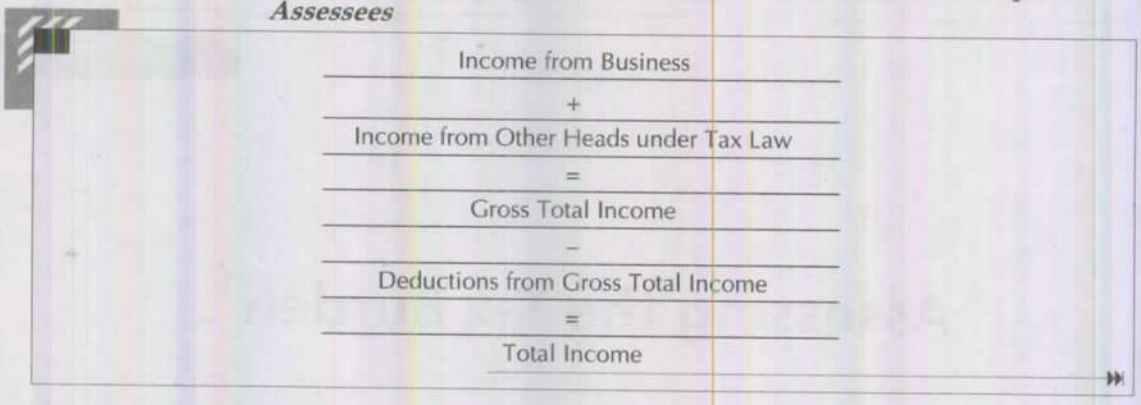
1. FRAMEWORK FOR DRIVING TAXABLE INCOME

Income tax is a charge calculated by applying the rates prescribed annually in the Finance Act on the base called the total income. The total income, also know as taxable income, is computed with reference to a period defined as the previous year. Exhibit D.1 shows the schematic diagram for determining the total income of a corporate assessee under the Income Tax Act (Act hereafter). As a part of the rationalisation and simplification process, the Income Tax Act is being amended by doing away with many of the incentive schemes, and at the same time reducing the overall corporate income tax rates. By this, the

1. This appendix has been contributed by Prof. Padmini Srinivasan Visiting Faculty IIM Bangalore.

Government hopes to reduce the complexities involved in the calculation of tax and administration of tax law would become easier

Exhibit B.1 ***Schematic Diagram for Determining the Total Income for Corporate Assessees***



Income from Business

This broadly consists of receipts less deduction associated with activities which can be attributed to the character of business/profession. The principal sources of receipts are sale proceeds, professional fees, and labour charges.

The deductions can be classified as follows:

1. *Actual business expenses incurred* The major items included under this head are: (i) rent, rates, taxes, insurance, repairs and maintenance in respect of premises used for business (section 30)[1]; (ii) repairs, maintenance and insurance in respect of plant and machinery (section 31); (iii) expenditure on scientific research not being in the nature of capital expenditure related to the business of the assessee (section 35); (iv) expenditure on scientific research by certain notified businesses get weighted deductions (v) insurance premium paid in respect of insurance of stock or stores of the business; bad debt etc. (section 36); (vi) any other expenditure (not being in the nature of capital expenditure or personal expenses of the assessee) laid out or expended wholly and exclusively for the purposes of the business/profession (section 37).
2. *Amortisation of certain expenses* Certain expenses are incurred at one time and a percentage of such expenses is allowed to be deducted against the income over a number of years by way of amortisation. These include: (i) outlays on fixed assets which are depreciated at the rates prescribed under rule 5 of the Income Tax Rules (section 32); (ii) expenditure on patents and copyrights (section 35A); (iii) expenditure for acquiring know-how (section 35AB); (iv) preliminary expenses (section 35D); (v) expenditure on prospecting of minerals (section 35A); (vi) expenditure incurred by an Indian Company, for amalgamation or demerger of a company (section 35 DD) and (vii) capital expenditure on family planning of employees (section 36).

1. Sections refer to the sections of the Income Tax Act, 1961 as amended by Finance Act 2001.

3. *Capital expenditures of certain types* Though capital expenditures are not normally allowed as a deduction in computing the business income, the following capital expenditure can be deducted by virtue of certain provisions of the Act: (i) capital expenditures on scientific research related to the business carried on by the assessee [section 35(1) (iv)]; (ii) capital expenditure incurred in connection with the business consisting of prospecting for or extraction or production of mineral oils (section 42). (iii) capital expenditure incurred in connection with acquiring any rights to operate telecommunication services (section 35ABB).
4. *Certain contributions* Payments made to (a) certain recognised scientific research institutions to be used for scientific research [section 35 (1)(ii)]; (b) certain recognised institutions to be used for research in social science or statistical research [section 35(1)(iii)]; (c) approved public sector companies and institutions for promoting the social and economic welfare of, or the uplift of, the public (section 35 AC); and (d) certain associations and institutions for carrying out programmes of conservation of natural resources (section 35 CC B) can be deducted for tax purposes.

   In respect of contributions made to approved National Laboratories or a University or an Indian Institute of Technology with a specific direction that the amounts be used for scientific research undertaken under an approved programme, an amount equal to 125% of the contribution is allowed as deduction (35 2AA).
5. *Carried forward losses and allowances* In computing the business income, losses and allowances carried forward from the previous years can be deducted subject to compliance with certain conditions.

Income from Other Heads Under Tax Law

The various other heads, the nature of income, and the deductions allowed under these heads by the Act are shown below;

Head	Nature of Income	Deductions Allowed
Income from house property	Income arising from building and land appurtenant thereto owned by the assessee	Deductions are specified under Sections 23 and 24 of the Act
Capital gains	Full value of consideration on transfer of capital assets	(a) Indexed cost of acquisition of the assets (b) Indexed cost of improvements (c) Expenses on transfer (d) Certain exemptions
Income from other sources	Interest and other incomes which cannot be taken under any other head	Expenses incurred to earn the income and depreciation where applicable

Gross Total Income

This represents the summation of income from business and income from other heads under the Act as described above. This aggregation process involves setting off negative figures in the manner as prescribed in the Act. Such set off is done at two levels as follows:

(a) setting off negative figures under any source against positive figures under any other source within the same head of income; and

(b) setting off negative figures under any head of income against positive figures under any other head of income

These provisions are discussed separately in the next section.

Exemptions/Deductions from Gross Total Income Certain incomes enjoy special exemptions under Chapter III, and do not form part of the total income.

The important exemptions are

1. Exemption of such profits or gains from the export of articles or things or computer software established in a Free Trade Zone etc (Section 10A)
2. Exemptions of such profits or gains from the export of articles or things or computer software from 100% export oriented unit (Section 10B)

Deductions from Gross Total Income

Chapter VI A of the Act deals with various deductions that are allowed from the gross total income. The deductions under this chapter are allowed irrespective of the source of income and are akin to incentives. They are different from other deductions discussed earlier which are related to a specific head of income. If the gross total income is negative than no deduction under Chapter VI A is allowable. These deductions cannot make a gross total income negative.

The important deductions under chapter VI A are as follows:

1. Deduction in respect of profits and gains from projects or execution of work outside India (Section 80 HHB)
2. Deduction in respect of profits and gains from housing projects in certain areas and which are aided by work bank (Section 80 HHBA)
3. Deduction in respect of export of goods or merchandise outside India subject to certain conditions. (Section 80 HHC)
4. Deduction in respect of earnings in convertible foreign exchange from the business of hotel and tour operators (Section 80 HHD)
5. Deduction in respect of profits from export of computer software etc., (Section 80 HHE)
6. Deduction in respect of profits from export or transfer of film software, television software etc. (Section 80 HHF)
7. Deduction in respect of profits and gains from new industrial undertaking providing infrastructure facility after a certain date (Section 80IA)

8. Deduction in respect of profits and gains of business from new industrial undertaking other than infrastructure facility as mentioned above (Section 80 IB)
9. Deductions in respect of profits and gains from business of collecting and processing bio-degradable waste (Section 80JJ)
10. Deduction in respect of employment of new workmen (Section 80 JJAA)
11. Deduction in respect of royalties etc received from certain foreign enterprises (Section 80 O)

(Deduction under Section 80 HHB, 80HHBA, 80HHC, 80HHD, 80HHE, 80HHF, 800 are being phased out in a gradual manner such that no deduction will be available for the assessment years commencing on 1.4.2005 and subsequent years)

Total Income

This represents the difference between the gross total income and the deductions from the gross total income and is the base on which the tax rate is applied to arrive at the tax liability.

2. IMPORTANT PROVISIONS AND CONSIDERATIONS RELEVANT FOR DERIVING TAXABLE INCOME

In applying the framework for deriving the taxable income, discussed in the preceding section, certain provisions and considerations relating to the following must be borne in mind:

- Expenses incurred during construction period
- Depreciation
- Deduction in respect of expenditure on scientific research
- Deduction in respect of certain capital expenditure
- Deduction in respect of profits derived from export business
- Deduction in respect of profits and gains from projects outside India
- Deductions in respect of profits from the export of computer software and other related technical services
- Exemptions in respect of profits and gains of newly set up industrial undertakings in free trade zone
- Deduction in respect of profits and gains from newly set up industrial undertakings engaged in infrastructure development
- Deduction in respect of profits and gains from certain industrial undertakings other than infrastructure development undertakings
- Disallowances
- Set off, carry forward, and order of deduction for computing income from business.

Expenses Incurred During Construction Period

The first question that need to be answered is what is construction period or what is the data from which the computation of profits and gains of the business should be reckoned for the purpose of income tax. Section 3 of the Act dealing with the definition of previous year (the period with reference to which total income in computed) provides a clue in the matter. According to this Section, the previous year in respect of any business commences from the date on which it is 'set up'. In the case of a factory, the date of 'set up' will be the date on which the unit is 'ready' to commence production after trial run, etc., though the actual commercial production may not start due to various reasons such as non-availability of raw material, power supply etc. This date of 'set up' is the cut off date and all the expenditures incurred after this date are to be treated as revenue expenditure deductible in computing the income from business. It may not matter at this stage whether the unit is effecting sales or not for computing income under the head 'Profits and Gains of Business or Profession' for the purposes of income tax.

Once the date of 'set up' of business is determined, the treatment of various expenses incurred up to the date of the setting up of the unit (other than direct expenses relating to construction) may be discussed.

During the construction stage of a project, a new company incurs various expenses. These expenses can be broadly classified as: (a) direct expenses relating to construction and (b) expenses other than direct expenses.

The expenses which are directly related to construction, are considered as part of plant, machinery, building etc. The treatment of other expenses need some consideration. These expenses (other than direct) may be classified as follows: (i) preliminary expenses, (ii) indirect expenditure relating to construction, (iii) indirect expenditure not relating to construction, (iv) expenditure relating to technical know-how, (v) expenditure relating to a new project of an existing company, and (vi) income earned during the construction period.

Preliminary Expenses Preliminary expenses consists of the following: (a) expenditure in connection with preparation of feasibility report, preparation of project report, engineering services, market survey or any other survey necessary for the business of the assessee; (b) legal charges for drafting any agreement between the assessee and any other person for any purpose relating to the setting up or conduct of the business of the assessee; (c) legal charges for drafting the memorandum and articles of association, fees for registration of the company under the provisions of the Companies Act, cost of issue for public subscription of shares and debentures of the company; (d) such other items of expenditure (not being expenditure eligible for any allowance or deduction under any other provision of this Act) as may be prescribed.

According to Section 35D of the Act, 20 percent of the preliminary expenses can be claimed as deduction for each of the five successive previous years beginning with the previous year in which the business commences or the extension of the industrial

undertaking is completed. The maximum amount of preliminary expenses that can be amortised is five percent of the cost of the project or capital employed (as defined in Section 35D) whichever is more.

Indirect Expenditure Relating to Construction These consist of expenses like financial charges, remuneration of various personnel engaged in construction activity, travelling and other expenses incurred for the purpose of implementing the project, depreciation on various assets used for the purpose of construction and trial production expenses. These expenses are allowed to be capitalised, i.e., added to the value of various assets set up by allocating them over the items of plant, machinery, buildings, etc., on some reasonable basis. The unit is permitted to claim depreciation on the enhanced value of these assets arrived at after such allocation and this value is referred to as the 'actual cost' of the assets. Such actual cost is reduced by that portion, if any, as has been met directly or indirectly by any other person or authority [Section 43(1)].

Indirect Expenditure not Relating to Construction There are several expenses incurred during the construction period which are not in any way related to construction. *Examples*: expenses on the marketing department, expenses incurred due to the corporate status of the unit. Such expenses are not allowed to be capitalised nor are they allowed to be deducted from the income of the subsequent years. From the point of view of financial accounting these expenses are treated as deferred revenue expenses and are written off over a period of time. From the income tax point of view, however, the company does not derive the benefit of charging these expenses against revenue. Hence it is preferable that such expenses are incurred, as far as possible, after the date of setting up of the unit.

Expenditure on Technical Knowhow Capital Expenditure incurred on technical know-how, incurred after 1st April, 1998 can be capitalised as direct expenditure related to construction or can be by itself treated as an intangible asset, on which depreciation can be claimed under section 32. Revenue expenditure on technical know how can be claimed as expenses under section 37 (1).

Expenditure Relating to a New Project of an Existing Company When an existing company with ongoing business activities sets up a new project, expenses which are directly relatable to the construction of the project is capitalised. Other indirect expenses incurred during the construction period are allowed to be claimed as a deduction from the incomes earned from other existing activities of the company. However, this does not preclude the company from capitalising all indirect expenses relating to construction without claiming it as a deduction from other incomes as aforesaid.

Income Earned during Construction Period Income earned during construction period which is attributable to construction activity can be reduced from the construction cost of the asset itself. Examples of such income are sale of products produced during trial run, sale of packing material used for machinery, hire charges received for plant and machinery which was given to the sub contractor, sale of packing material used of machinery etc.

Other types of incomes like interest received and share transfer fees received are normally treated as income for the purpose of Income-Tax Act.

Depreciation According to Section 31(1) of the Income Tax Act, depreciation at prescribed rates on the actual cost (as determined in the manner stated in the preceding heading) in respect of (i) buildings, plant and machinery and furniture and fittings being tangible assets and (ii) know-how, patents, copyrights, trademarks, licences, franchises or other business other business or commercial rights being intangible assets used for business/professional purposes is a tax deductible expenses. For claiming the depreciation allowance the assets should be owned and used for the purpose of business by the assessee.

When a capital asset is imported by incurring a liability in foreign exchange and the rupee equivalent of such liability is outstanding at the end of each year or at the time of repayment increases/decreases due to fluctuation in rates of exchange then such increases/decreases are adjusted against the actual cost (Section 43 A). The actual cost so adjusted at the end of each year is treated as if it was the actual cost from the date of acquisition of the asset. This necessitates adjustment toward depreciation in each year in respect of earlier years.

Depreciation is charged on blocks of assets which represent a group of assets, within the broad class of assets, of buildings, plant, machinery, and furniture, for which a common rate of depreciation is applicable. Depreciation will be calculated by applying the prescribed rate (which varies between 5% and 100%) on the written down value (WDV) of the entire block. When an asset is sold the amount realised from the sale of such asset (after deducting expense on sales) will simply be deducted from the WDV of that block. If the amount realised is greater than the WDV of the block, the difference will be treated as short term capital gain. In a case where all the assets in the block are disposed off and there is still a balance in the account of the block, such amount will be treated as short term capital loss.

To illustrate the above provisions, let us consider an example. A block of assets consisting of 10 items acquired during 1995 to 2000 has a written down value of Rs. 3 million as on 1st April 2000. During 2000–2001, the assessee sells an asset for Rs. 2 million (on which an expense of Rs. 0.1 million is incurred on sale) and acquires an asset for Rs. 0.5 million.

The net block of assets for depreciation purposes at the end of 2000–2001 will be:

Opening WDV	Rs. 2 million
Value of addition during the year	Rs 0.5 million
	Rs 2.5 million
Less	
Sale proceeds (after deducting selling expense) for the asset sold	Rs. 1.9 million
Net block for purposes of depreciation	Rs. 0.6 million

In the above example, if the sale proceeds (after deducting selling expense) had been Rs. 5 million, the difference between this amount and Rs 2.5 million should be treated as short-term capital gain and the net block for purposes of depreciation will be zero. Suppose, all the assets in the block (including the assets acquired during the year) are sold for Rs. 2.2 million (after deducting selling expense), the balance of Rs 0.3 million remaining in the block amount will be treated as short-term capital loss.

It may be noted that when any asset is acquired and put to use during the previous year for a period less than 180 days then depreciation will be allowed only to the extent of 50 percent of the prescribed rate for that asset in respect of the year of acquisition.

Deduction in Respect of Expenditure on Scientific Research

Under Section 35, the following expenses relating to scientific research incurred during the previous year are allowed as deduction in computing the income from business:

- All expenses, both revenue and capital (other than cost of land) incurred on scientific research relating to the business of the assessee. Such expenditures incurred within three years before the commencement of business shall also be deemed to be incurred in the year of commencement of business and accordingly deductible in that year.
- Contributions to approved scientific research associations/institutions, University/College, and to be used for scientific research are eligible for deduction of 125% of the contribution made [section 35(1)(ii)]
- In respect of contributions made to approved National Laboratories or University or Indian Institute of Technology, with a specific direction that the amounts be used for scientific research undertaken under an approved programme, an amount equal to 125% of the contribution is allowed as a deduction. [section 35 (2AA)]
- Contributions to approved institutions to be used for research in social science or statistical research whether related to business or not are eligible for a deduction of 125% of the contribution [section 35(1)(iii)]
- Section 35 (2 AB) allows a weighted deduction of one and one half times, on revenue and capital expenditure (other than land and building) incurred on approved in-house research and development, of companies engaged in manufacturing and production of drugs and pharmaceuticals, telecommunication equipment, chemicals, bio-technology, computers and others notified from time to time. This deduction is available up to March 31, 2005. [section 35(2AB)]
- Expenditure in the nature of capital expenditure incurred for acquiring any right to operate telecommunication services, either before the commencement of business or thereafter. Deduction can be claimed under section 35 ABB, starting from the year in which the payment is made (or the business had commenced), in equal instalments and ending in the year in which the licence comes to an end.

Deduction in Respect of Profits Derived from Export Business

Section 80 HHC allows deduction of a certain percentage out of the profits derived from export business of a resident business entity or an Indian company. Various conditions governing the grant of this deduction are as follows.

1. The assessee should be engaged in the business of export out of India of any goods and merchandise. Exports of mineral oils and minerals and ores (other than processed minerals and ores specified in the twelfth schedule to the Income-Tax Act) do not qualify for this deduction.
2. The sale proceeds from exports of such goods are receivable by the assessee in convertible foreign exchange within a period of six months or such extended time given by the Appropriate Authority from the end of the previous year in which the export took place.
3. The profits derived from export business (hereinafter referred to as exempted profits) is determined under 3 cases, viz. where the exported goods are manufactured or processed by the assessee, where the exported goods are trading goods and where the exported goods consist of both types.

Case 1: *Export of manufactured goods*

$$\text{Eligible profit} = \text{Profit of the business} \times \frac{\text{Export turnover of manufactured goods}}{\text{Total turnover of the business}}$$

Case 2: *Export of trading goods*

Eligible profit = Export turnover of trading goods—Direct and indirect costs attributable to export of such goods

Case 3: *Export of both manufactured and trading goods*

(a) For manufactured goods:

$$\text{Eligible profit} = \text{Adjusted profit of the business} \times \frac{\text{Adjusted export turnover}}{\text{Adjusted total turnover}}$$

(b) For trading goods:

Eligible profit = Export turnover of trading goods—Direct and indirect costs attributable to export of such goods.

The percentage rate of deduction of the eligible profits shall be an amount equal to: 70, 50 and 30 percent for the financial year beginning from April 1, 2001, 2002. And 2003 respectively.

No deduction is allowed from the assessment year beginning 1.4.2005.

Note: For purposes of making the above computations various expressions used thereunder have the meanings as stated below:

(a) 'Total Turnover' does not include freight, insurance and export incentives;
(b) 'Export Turnover' means the sale proceeds received or brought into India in convertible foreign exchange within six months of the previous year or such extended time limit but does not include freight and insurance (beyond customs limit)
(c) 'Profits of the Business' means the amount computed under the head 'Profits and Gains of Business or Profession' and reduced by (i) 90% of the export incentives, brokerage, commission, interest, rent or receipt of similar nature included in such profit and (ii) the profits of any branch office, warehouse or any other establishment of the assessee situated outside India;
(d) 'Direct Costs' means costs directly attributable to the exported trading goods including the purchase price of such goods;
(e) 'Indirect Costs' means costs, not being direct costs, allocated in the ratio of the export turnover of trading goods to the total turnover;
(f) 'Adjusted Total Turnover' means the total turnover of the business as reduced by the export turnover of trading goods;
(g) 'Adjusted Export Turnover' means the export turnover as reduced by the export turnover of trading goods;
(h) 'Adjusted Profits of the Business' means the profits of the business as reduced by the profits derived from the business of export of trading goods.

4. An assessee selling the eligible goods to an Export/Trading House holding a valid certificate issued by the Chief Controller of Imports and Exports is also entitled to the deduction as stated above on the basis of a certificate of export turnover issued by such Export Trading House and a Chartered Accountant. On issue of such certificate, the amount of deduction available to the Export Trading House will be reduced by the amount calculated as follows:

   Export turnover certificed/Total export turnover × Total profit of the export business

5. A certificate from a Chartered Accountant certifying that the deduction has been correctly claimed is to be furnished along with the return of income.

Deduction in Respect of Profits and Gains from Projects Outside India (Section 80 HHB)

This deduction is applicable to Indian companies or to persons resident in India, engaged in executing foreign projects like construction of buildings, dams, roads, the assembly or installation of plant or machinery etc., for which compensation is payable in convertible foreign exchange [Section 80 HHB]

The conditions governing the deduction are as follows:

- Separate books of accounts are to be maintained for such projects
- The accounts must be audited and a report prepared in the prescribed format
- The assessee is required to credit the Foreign Projects Reserve Account the specified percentage of profits. The amount credited to the 'Reserve Account' is required to be

utilised by the assessee before the expiry of a period of five years following the previous year in which the amount was credited which must be used for the purpose of the business and not for distribution as dividends.

- The specified percentage of profits is also required to be remitted to India in convertible foreign exchange
- The amount that can be claimed is specified percentage of the profits and gains of such business.

The specified percent is 30% for the assessment year commencing from 1-4-02 and there after this deduction is reduced by 10% each year. No deduction is allowed from the assessment year beginning 1.4.2005.

Profits from the Export of Computer Software and Other Related Technical Service [Section 80 HHE]

The deduction is allowed for an Indian Company or a person other than company resident in India, and is a Software developer, and has export out of India of computer software or its transmission from India to a place outside India by any means or has providing technical services outside India in connection with the development or production of computer software.

For this purpose, profit derived from the business specified above is determined as follows:

$$\text{Eligible Profits} = \frac{\text{Export turnover}}{\text{Total turnover}} \times \text{Profit of the business}$$

The deduction allowable is 60% of eligible profits for the assessment year 2002–2003 and reduced to 40% and so on in the subsequent assessment years and is being phased out in a gradual manner such that no deduction will be available for the assessment years commencing on 1.4.2005 and subsequent years.

The terms export turnover, total turnover and profit of business have been defined specifically in the section.

In order to claim the deduction, the assessee is required to furnish an audit report in the prescribed form along with the return of income.

Exemptions in Respect of Profits and Gains of Newly Set Up Industrial Undertakings in Free Trade Zones [Section 10A]

Newly established industrial undertakings in free trade zones, electronic hardware technology parks, software technology parks, or special economic zones, can claim exemption of 100% of their profits and gains derived from such exports for a period of ten years beginning with the assessment year relevant to the previous year in which the industrial undertaking begins to manufacture or produce articles or things.

Sale proceeds must be brought into India in convertible foreign exchange within the specified period. The exemption will not go beyond assessment year 2009–10. The amount of profit that is eligible for deduction is calculated in the ratio of the export turnover to total turnover of the business. This section applies to Kandla Free Trade Zone, Santacruz Electronics Export Processing Zone or any other free trade zone as prescribed by the central government by notification in the Official Gazette or the technology parks set up under a scheme notified by the central government, for the purposes of this section.

Newly Established Hundred Per Cent Export Oriented Undertakings [Section 10B]

This provision extends the same type of benefit as allowed for the industrial undertakings set up in a free trade zone or technology park, to newly established undertakings recognised as 100% Export Oriented Undertaking. For the purposes of this section "hundred per cent export oriented undertakings" means an undertaking which has been approved as a hundred per cent export oriented undertaking by the Central Government. All the other provisions are similar to the above Section 10 A.

Deduction in Respect of Profits and Gains from Newly Set Up Industrial Undertakings Engaged in Infrastructure Development

Section 80 IA, allows a certain deduction in respect of profits and gains of an industrial undertaking, being an Indian company or a consortium, carrying on the business of developing, or maintaining and operating, or developing, maintaining and operating.

(a) infrastructure facility like roads, bridges, airports, inland waterways, ports, highway projects water supply projects, irrigation sanitation and sewerage treatment system
(b) telecommunication service
(c) industrial parks
(d) generation, distribution and transmission of power

The allowable deductions are as follows:

Infrastructure Facility started after 1.4.95

- The deductio n will be hundred percent (from assessment year 2002–03) of profits and gains derived from such business for ten consecutive years beginning from the initial assessment year and falling within the fifteenth (twenty in some cases) assessment year from the year in which the enterprise begins operating and maintaining the infrastructure facility.

Telecommunication Services:

- Telecommunication services are services that include basic or cellular services including radio paging, domestic satellite services, network of trucking and broad band network and internet services.

- These services should have started or starts providing telecommunication service after a 1st April 1995 but before 31.3.2003;
- The deduction will be hundred percent for the first five years and thirty percent thereafter (next five years) for ten consecutive year starting from the initial assessment year and falling within fifteen years from which the enterprise begins operations.

Industrial Park:

- An undertaking which develops and operates industrial parks or (or special economic zones from the assessment year 2002–2003) on or after 1 April, 1997 but before 31.3.2006.
- The amount of deduction is 100 percent of profits from the assessment year 2002–2003 for ten consecutive years starting from the initial assessment year and falling within fifteen years from which the enterprise begins operations.

Generation and Distribution of Power:

- An undertaking which is set up in any part of India for, Generation or generation and distribution of power or transmission or distribution by laying network of new lines, begins on the 1st April, 1999 but before 31.3.06.
- The industrial undertaking is not formed by splitting up or reconstruction of a business already in existence. However, if the business is re-established or revived by the assessee which was discontinued due to damage of building machinery etc on account of floods, earthquake typhoon etc. or riots and civil disturbances or by fire or explosion or act of war etc. the business will be treated as a new industrial undertaking.
- Amount of deduction will be 100 percent from the assessment year 2002-2003. For ten consecutive years starting from the initial assessment year and falling within fifteen years from which the enterprise begins operations.
- The amount of profits eligible for deduction will be limited to the activities undertaken by the undertaking for example: If the undertaking is engaged in generation of power, then profits generation of power is eligible

Additional conditions that need to be fulfilled by the business is:

(i) For the purpose of calculating the amount of deduction, such industrial undertaking or eligible business is treated as if it was the only source of income

(ii) Goods and services transferred by the eligible business or those transferred to the eligible business by any other business carried on by the assessee has to be at the market value. And the assessing officer has the right to recompute the profits and gains as he may deem fit.

Deduction in Respect of Profits and Gains from Certain Industrial Undertakings Other than Infrastructure Development Undertakings

Section 80 IB allows a certain deduction in respect of the profits and gains derived from any newly set up industrial undertaking, other than infrastructure development

undertaking referred to as eligible business which must have commenced operation before 31.3.2002.

The allowable deductions are as follows:

- In the case of industrial undertakings located in an industrially backward state (or district as specified or set up in any part of India for the generation, or generation and distribution, of power which begins to manufacture or produce articles or things or to operate its cold storage plant or plants or to generate power at any time during the period from 1st April, 1994 to 31st March, 2002, the deduction will be 100% for the first five years and 30% for the next 5 years. An undertaking refining mineral oil gets 100% deduction for initial 7 assessment years.
- Other small-scale Industrial undertakings manufacturing or things or operating its cold storage plants, for initial assessment year and nine succeeding assessment years the deduction allowed is @ 30% of profits and gains derived from such industries.

For purposes of computing the amount of deduction, such industrial undertakings is treated as if it was the only source of income.

For computing the profits of the eligible business as aforesaid, past losses and Unabsorbed allowances relating to such business is deducted even though such past losses, etc., have already been absorbed by other incomes in the past.

For both Sections 80 IA and 80 IB the following conditions apply:

(i) It is not formed by the splitting up, or reconstruction, of a business already in existence.

(ii) It is not formed by the transfer to a new business[2] of a machinery or plant previously used for any purpose[3].

(iii) In the case of an industrial undertaking other than a small scale industry or an industry set up in a backward state, it manufactures or produces any articles or things other than articles or things specified in the list in the Eleventh Schedule;

(iv) It employs ten or more workers in a manufacturing process carried on with the aid of power or employs twenty or more workers in a manufacturing process carried on without the aid of power.

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2. Where the industrial undertaking is formed by transfer to a new business of any machinery or plant previously used for any purpose and the value of such machinery or plant does not exceed 20 percent of the total value of the machinery or plant used in the eligible business, the benefit will be available to the industrial undertaking.

3. Any machinery or plant which was used outside India by any person other than the assessee shall not be regarded as machinery or plant previously used for any purpose, provided that (i) such machinery or plant was imported into India from any country outside India, (ii) no depreciation for any period prior to date of installation by the assessee in respect of the said asset has been allowed to any person under this Act, and (iii) the said asset was not used in India at any time previous to the date of installation by the assessee.

Disallowances

The Income Tax Act provides that though certain expenses are incurred by the assessee during the previous year, they will not be allowed as a deduction (partly or fully) in computing the income under the head 'Profits and Gains of Business or Profession' under certain circumstances. The more important of these items are mentioned below:

1. Advertisement expenditure in the material published by any political party is disallowed in full [Section 37 (2B)].
2. Any expenditure incurred by the assessee which is prohibited by law will not be allowed as deduction. (Section 37)
3. Expenditure on account of supply of goods, services, or facilities by certain specified related persons/organisations, which is in the opinion of the assessing officer is excessive or unreasonable can be disallowed [Section 40A (2)].
4. Expenditure in respect of which payment is made in a sum exceeding Rs. 20,000, at a time, otherwise than by crossed cheque or bank draft (except in certain exempted cases) is disallowed in full [Section 40A(3)].
5. Contributions to unapproved gratuity or other funds of employees are disallowed in full [Section 40 A (7 and 9)].
6. Expenditures of the following kinds are allowed if they are not paid for within the previous year or within a stipulated time after the previous year: (a) expenses on account of tax, duty, or fees, (b) contributions to any provident/superannuation/gratuity/other welfare fund of employees, (c) payment of bonus or commission to employees, and (d) interest on any loan or borrowing from public financial institution (e) Interest on term loan from scheduled banks (f) provision made for amount payable as in lieu of any leave (leave encashment) (as defined in Section 4A of the Companies Act, 1956) (Section 43B)[4].

Set off, Carry Forward, and Order of Deduction for Computing Income from Business

Various deductions and allowances are considered in computing the income from business as discussed in the first section. If the result after providing for such deductions and allowances is a negative figure in any year, this is allowed to be set off against income from other heads and the remaining unabsorbed amount, if any, can be carried forward to the next year and set off against the income of that year and so on. The provisions relating to set off of negative income and aggregation and the order of deduction for computing income from business are as follows:

4. It may be noted that this section makes an exception to the general principle of allowing expenditures as a deduction in the previous year in which they are incurred, irrespective of whether they are paid or not.

- The first step in the aggregation process is the determination of income under each head by setting off losses against incomes under different sources. The rules for such set off are as follows:

(a) Losses from any source under a given 'head of income' can be set off only against income from any other source under the same 'head of income', with exceptions noted in (b) below.

(b) Losses from speculation business (which falls under the head of income 'profits and gains of business or profession') can be set off only against profits from speculation business. Likewise losses from owning and maintaining race horses can be set off against profits from similar activity.

- Aggregation of income from all heads of income is done by setting off losses from one head of income against income from other head/s. The rules regarding set off and carry forward are as follows:

(a) Subject to (i) above losses under any head of income other than the head capital gains can be set off against the income under any other head of income. Losses under the head house property to the extent it relates to the interest on loan taken for construction, purchase or repair of such property can be set off against income from any other head. In the subsequent year the carried forward loss should be set off against income from house property and the balance loss can be carried forward for a period of eight subsequent years from the year in which the loss was first computed.

(b) Losses that remain under the head capital gains can be carried forward and set off against income under the head capital gains of subsequent years and so on. Such carry forward can be done for a period of eight subsequent years from the year in which the loss was computed.

(c) Unabsorbed business loss (other than speculation business loss) of any year can be carried forward and set off against income under the head of business of subsequent years. Such carry forward can be done for eight subsequent years from the year in which the loss was computed.

(d) Unabsorbed loss from speculation business can be carried forward and set off against income from speculation business. Such carry forward can be done for eight subsequent years.

- Unabsorbed depreciation can be carried forward and set off against the income from any other head of subsequent years without any limitation as to the number of years.
- Capital expenditure on scientific research which is not absorbed by available current profits is treated in the same way as unabsorbed depreciation.

Order of Deduction for Computing Income from Business For the purposes of carry forward and set off, the unabsorbed benefits from an earlier year are divided into various categories and are considered for set off, along with certain current allowances, in the order given below in computing the income from business of the current year:

- Current scientific research capital expenditure
- Current depreciation
- Carried forward business loss
- Unabsorbed depreciation and Unabsorbed capital expenditure on scientific research

A loss cannot be carried forward unless the return of Income Tax is filed within the time allowed under Section 139 (1) of the Act.

3. DETERMINATION OF THE TAX BURDEN AND PAYMENT OF TAX

Once the taxable income of the company is derived, the next step is the determination of the tax burden and its payment. For this purpose, we need to know: (i) tax rates for companies, (ii) calculation of Minimum Alternate Tax, (iii) provisions for payment of advance tax, and (iv) provisions for payment of tax along with the filing return.

Tax Rates for Companies

For tax purposes, companies are classified as domestic companies and foreign companies and are taxed at 35% and 48% respectively. Though the rates of income-tax are prescribed annually in the Finance Act, the Income Tax Act itself stipulates the rates of income tax in respect of certain types of incomes and these generally relate to foreign companies in respect of incomes of the nature of royalties, technical know-how fees, interest and dividends. In respect of long term capital gains, the Act prescribes rates of tax both for domestic as well as foreign companies.

Such incomes are taxed at rates mentioned in the Act and the remaining total income is taxed at the rates stated above.

The total tax liability computed as above is increased by an amount of surcharge (at present 2 percent) on the tax computed.

Minimum Alternate Tax

In the case of an assessee, being a company, if the income-tax is payable on the total income as computed under the Act, is less than 7.5% of its book profit, the tax payable for the relevant previous year shall be deemed to be 7.5% of such book profit. That is every company will now be paying atleast 7.5% of the book profits as tax. [Section 115JB(1), inserted with effect from 1.4.2001].

In addition, a report in the prescribed format, from the accountant certifying that the book profit has been computed in accordance with the provisions of this section must be filed along with the return of income.

The annual accounts prepared are in accordance with Parts II and III of Schedule VI of the Companies Act using the accounting policies, accounting standards and methods of depreciation and which are presented before the annual general meeting of the company.

Book profits means the net profit shown in the profit and loss account and should be increased by:

- The amount of provision for income tax
- The amount carried to any reserve
- The amount set aside for unascertained liabilities
- The provision for losses of subsidiary companies
- The amounts paid or proposed as dividends
  Similarly the following should be deducted from the profit and loss account
- The amount withdrawn from any reserves or provision credited to profit and loss account
- The amount of loss brought forward or unabsorbed depreciation whichever is less as per books of accounts
- The net amount of income as reduced by expenses included in the profit and loss account which is exempt from tax under Sections 10, 10A or 10B shall be excluded.
- The amounts of profit which are eligible for deduction under Section 80 HHC, or 80 HHE or 80 HHF and is also excluded for the purposes of calculation if MAT.

No tax credits are available under the MAT as calculated under Section 115JJB.

Provision for Advance Tax

Advance tax is payable on the current income of the company in four instalments during the financial year as follows:

On or before	*Advance tax that should have been paid by the due date (as a percentage of the estimated total tax liability)*
15th June	15
15th September	45
15th December	75
15th March (succeeding)	100

For practical purposes, these provisions mean that income tax is payable along with the earnings. Thanks to this 'pay as you earn' principle, there is hardly any lag between earnings and tax payment.

Payment of Taxes along with Filing Return

At the time of filing return, the assessee is required to compute the tax liability based on the income stated in the return of income. If there is a shortfall between this tax liability and the sum of the advance tax paid and the tax deducted at source on incomes due to the company, then such shortfall is required to be paid before the return is filed. Such tax is referred to as self assessment tax. Along with such shortfall in tax the assessee is also required to pay interest on (a) the shortfall in the advance tax payable in any instalment and (b) the self assessment tax, if the return is filed beyond the due date. The due date for filing of return for companies is 31st October of the relevant assessment year.

4. ILLUSTRATION OF TAX CALCULATION

Bolt Infra Ltd., engaged in infrastructure projects in the area of construction of highway and toll roads both in India and abroad started its operation on 10.10.2001. The following details are available:

(All figures in millions)

1. The balance sheet of the company as on 10.10.2001 is as follows:

Liabilities		**Assets**	
Share capital	8.00	Plant and machinery	7.00
Central subsidy	1.50	Building	9.00
Term loan	10.50	Current assets, loans and advances etc.	1.00
Deposits	3.00	Preliminary and preoperative expenses	6.00
	23.00		23.00

2. The projected revenues and expenses for eight years ending 31st March are:

Revenues:

1	2	3	4	5	6	7	8
15.00	25.00	40.00	55.00	65.00	75.00	85.00	100.00

Expenses:

1	2	3	4	5	6	7	8
20.00	23.00	30.00	40.00	50.00	60.00	70.00	80.00

3. The company has projected to add equipment for carrying out scientific research relating to their business @ Rs. 0.01 million for each of the eight years.
4. Expenses include provision for retirement of employees in the 6th, 7th and 8th years at Rs. 0.3 million, Rs. 0.4 million and Rs. 0.5 million respectively.
5. Details of preliminary and preoperative expenses are as follows:

Rs. 1.5 million—Indirect expenses relating to construction—Plant and Machinery;
Rs. 1.0 million—Indirect expenses relating to construction—Buildings;
Rs. 1.0 million—Preliminary expenses;
Rs. 2.5 million—Indirect expenses not relating to construction.

6. Rate of Depreciation: 25% for plant and machinery and 10% for buildings.

Required Compute the total income and total tax liability for each of the eight years. Assume a tax rate of 35 percent and a surcharge of 2 percent on income tax.

Solution

The computation of the tax liability is shown in Exhibit D.2.

Exhibit B.2 ***Bolt Infra Limited Computation of Tax Liability*** *(Rs. in million)*

	Yr. 1	*Yr. 2*	*Yr. 3*	*Yr. 4*	*Yr. 5*	*Yr. 6*	*Yr. 7*	*Yr. 8*
Revenue	15.00	25.00	40.00	55.00	65.00	75.00	85.00	100.00
Less								
Expenses (See Note 1):	19.83	22.83	29.83	39.83	49.83	59.35	69.25	79.15
	(4.83)	2.17	10.17	15.17	15.17	15.65	15.75	20.85
Less								
1. Current Depreciation (See Note 2)	—	2.17	2.25	1.82	1.48	1.21	1.00	0.84
2. Current Capital Expenditure on Scientific Research	—	—	0.1	0.10	0.10	0.10	0.10	0.10
	—	—	7.82	13.25	13.59	14.34	14.65	19.91
Less:								
1. Carried Forward Business Loss	—	—	4.83					
2. Unabsorbed Depreciation	—	—	2.20					
3. Unabsorbed Capital Expenditure on Scientific Research	—	—	0.2					
Gross Total Income (G.T.I)	—	—	0.59	13.25	13.59	14.34	14.65	19.91
Less: Deductions from G.T.I								
2. Under Section 80 1A —Deduction for New Industrial Undertaking @100% (5 years)/30% thereafter of G.T.I beginning from year 3	—	—	0.59	13.25	13.59	14.34	14.65	5.97
Total Income	—	—	—	—	—	—	—	13.94
Income Tax								
(1) Basic Tax @ 35% of Total Income	—		—	—	—	—	—	4.88
(2) Surcharge @ 2% of Basic Tax		—	—	—	—	—	—	0.10
(3) Total	—	—	—	—	—	—	—	4.98
Benefits Carried Forward								
(1) Business Loss	4.83	4.83						
(2) Unabsorbed Depreciation	1.56	2.20						
(3) Unabsorbed Capital Expenditure on Scientific Research	0.10	0.20						

Working Notes

1. Expenses under the head `Business' before depreciation and capital expenditure on scientific research:

	Yr. 1	*Yr.2*	*Yr.3*	*Yr.4*	*Yr.5*	*Yr.6*	*Yr.7*	*Yr.8*
Expenses as per statement	20.00	23.00	30.00	40.00	50.00	60.00	70.00	80.00
*	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
	19.65	22.65	29.65	39.65	49.65	59.65	69.65	79.65
**	0.18	0.18	0.18	0.18	0.18			
	19.83	22.83	29.83	39.83	49.83	59.65	69.65	79.65
Less:								
Provision for Gratuity Not allowed U.S. 40 A(7)	-	-	-	-	-	0.30	0.40	0.50
	19.83	22.83	29.83	39.83	49.83	59.35	69.25	79.15

*Less: Preliminary Expenses Amortised under financial accounting (10 + 25 = 35) over 10 years.

**Add: Preliminary Expenses allowed under Section 35D @ 20% of (5% of Capital employed of Rs. 18.5 million).

2. Depreciation

Actual Cost:

Plant and Machinery	7.0 + 15 = 8.5 million
Buildings	9.0 +1.0 = 10.0 million
Rate of Depreciation	@25% for Plant and Machinery and 10% for Building. Since these assets were used for less than 180 days during the first year of operation, depreciation @ 50% of normal allowance is available for this year.

Schedule of Depreciation:

	Yr.	*Yr.2*	*Yr.3*	*Yr.4*	*Yr.5*	*Yr.6*	*Yr.7*	*Yr.8*
Plant and Machinery:	1.06	1.86	1.40	1.05	0.79	0.59	0.44	0.33
Building:	0.5	0.95	0.85	0.77	0.69	0.62	0.56	0.51
Total	1.56	2.81	2.25	1.82	1.48	1.21	1.00	0.84

Appendix C



Environmental Appraisal of Projects[1]

1. INTRODUCTION

The effects of actions that are not accounted for in the normal market transactions need to be considered explicitly in the decision-making processes on projects. These effects are to be identified, assessed, and evaluated against the economic advantages arising out of a given action. In this context, the environmental impact assessments/appraisals are considered to be the first step in this process because they give an *opportunity* to man to consider the effects of his actions on the environment.

Economics development is the result of the interaction between natural resources and technology supported by and designed for people. People are the centre for development. Therefore, it is rightly said that all human activity, be it economic, social or anything else is essentially directed at satisfying "needs" and "wants" of man through "altering" and "using" environmental resources.

2. TYPES AND DIMENSIONS OF A PROJECT

Broadly, there are two types of projects. The first one refers to those projects that produce physical goods like cement, steel, paper, chemicals etc. These projects, in fact, convert the natural resource endowments into saleable and exchangeable products. As a matter of fact, these projects inflict a large number of physical changes and disruptions on environ-

1. This appendix has been contributed by Dr. Naganna, Professor, Indian Institute of Management, Bangalore. This is based upon the author's class notes on the same subject.

ment and, hence, disturb the environmental and ecological balance. Environmentalists are mostly concerned with such type of projects. The second type refers to those that produce/render various kinds of services such as health, education, transport, energy, defence, law and order, etc. Such projects also cover actions like land reforms, agricultural extension services, sales promotion compaigns, etc. Projects of this type are non-physical in nature and they do not directly cause any physical changes in the environment. However, they bring about significant changes of far-reaching consequences on values, attitudes, life-styles, social relations, and so on. The net effect of such projects is the creation of new wants and needs in society. They ultimately promote consumerism in the society and thereby increase the number of manufacturing projects. Thus, both are interrelated.

Each project has two dimensions: (a) the intended objectives/purposes—they are also called stated goals/benefits; and (b) the unintended consequences. They are also called externalities or social costs which are unplanned, unwanted, and unanticipated. Environmental management or planning is the study of the unintended consequences of a project. Its purpose is to identify, examine, assess, and evaluate the likely and probable impacts of a proposed project on environment and, thereby, to work out the remedial action plans to minimize the incidence of adverse impacts. It is not anti-development nor is it against the projects. Its goal is development without damage or least damage.

3. STRESSES ON ENVIRONMENT

Environmentalists have identified four types of different stresses or pressures that are being continuously inflicted on environment. They are:

(i) *Eutrophic Stress* Refers to the release of various kinds of wastes into the river and other water bodies and their consequent drying.

(ii) *Exploitative Stress* Refers to the exploitation of natural resources endowment for production and consumption purposes through agriculture, industry, extraction, fishing etc. It is important to note that the rate of exploitation has a relevance to the nature's capacity to reproduce.

(iii) *Disruptive Stress* Refers to the physical alterations in nature resulting from such activities like forest clearance, highways, railways, factory buildings and so on. These physical changes disturb the environmental and ecological balance.

(iv) *Chemical and Industrial Stress* This results mainly from the developments in "science and technology" and their applied fields like industry, warfare and agriculture. This comprises mainly the pollutants and effluents of all types, radiation etc.

Strategies to meet these threats to natural environment through pollution, destruction and over-use can be: (a) preventive or (b) regulatory. It is in this context that the environmental appraisal of projects is gaining significance with a hope of achieving sustainable development in harmony with environment.

4. MEANING AND SCOPE OF ENVIRONMENT

The word "environment" is defined to include everything external to man/organism. It covers the region, surroundings, or circumstances in which anything exists. It is broadly divided into two components. The first one is the abiotic or inorganic milieu, comprising the physical elements like land, water, atmosphere, climate, sound, odours, and tastes. They are the inanimate elements of the habitat systems. The other one is the biotic or the organic milieu consisting of animals, plants, bacteria, viruses, all other living organisms, and the social factors including aesthetics. They are the animate elements.

There is another definition particularly relevant in the context of projects. Here, the term "environment" is defined as:

> *The surrounding zone (the specific zone to be affected by the project), all natural resources (physical and biological), and the human resources (people, economic development and quality of life values).*

This definition is comparatively more specific, focussed, and clear cut than the earlier one which was too general and unfocussed. This is more suited to operationalise, quantify, and measure the environmental impacts of a given action. The contentious issue in this definition is the surrounding zone or the project vicinity. However, a distinction has to be made between the "legal boundary" which is the area legally occupied by a project, and the "environmental boundary" which stretches much beyond the legal boundary. In fact, this is the area around the project that is likely to be affected environmentally by the project operations. The extent of environmental boundary for a project depends, among other things, on the diffusion factors like wind speeds and directions, elevations, etc. It varies from project to project and location to location for the same project.

There is yet another definition of environment as below:

> *The external, natural, physical and residential conditions which affect man directly and indirectly and which are, in turn, influenced by economic decisions and technological developments.*

This definition implies a complex interactive model between man, environment, and science and technology, the outcome of which will be economic development. As a matter of fact, projects facilitate such an interaction.

Environmental management, a term encompassing environmental planning, protection, monitoring, assessment, research, education, conservation, and sustainable use of resources, is now accepted as a major guiding factor in all the economic decision-making processes on development or otherwise. Subsequently, a wide network of legislation came into being. Now, environmental clearance for all the major projects on the basis of their Environmental Impact Statement (EIS) has become legally mandatory.

5. ENVIRONMENTAL RESOURCES/VALUES (ER/Vs)

Since the word 'environment' is an all-inclusive concept encompassing everything external to us, it is difficult to operationalise and apply to particular situations like the projects. For the purposes of operationalisation and practical application, the environmentalists have developed a concept called 'Environmental Resources/Values' (ER/Vs). It is defined as an aspect of environment which is of benefit to man. The environmentalists have identified and classified various components of environment (that is, ER/Vs) into four levels as below:

(a) Level–1: *Physical Resources*, covering land, water and air.
(b) Level–2: *Ecological Resources*, consisting of aquatic, terrestrial and endangered (rare) species (other than man).
(c) Level–3: *Human Use Values*, covering transport, agriculture, water supply, recreation, mining, industry, flood control, etc.
(d) Level–4: *Quality of Life Values*, covering socio-economic, cultural and aesthetic aspects.

Thus the whole environment is decomposed into several operationally feasible components or elements. These elements can further be subdivided into several related items. Alternatively, some other environmentalists identify and classify the various elements of environment broadly under eight types which are called *Environmental Attributes* (EA). They are: (a) air, (b) water, (c) land, (d) ecology, (e) sound, (f) human aspects, (g) economics, and (h) resources. Each one can further be subdivided into different related elements.

In the context of environmental appraisal of projects, one can follow either of the classifications, viz., Environmental Resources/Values (ER/Vs) or the Environmental Attributes (EA). As a matter of fact, they can be evaluated and assessed individually with respect to the impacts they receive or the changes they undergo due to the proposed project. Since there will be a variety of types of impacts of varying degrees from a project, the decomposition of environment unit into various quantifiable elements will enable the analyst to give focus and direction to his impact assessment analysis.

An environmental effect is considered as the effect of natural or man-made actions which alter environment (as measured by physical, chemical, and biological parameters). Our concern is, however, on man-made actions. The nature and extent of environmental impacts including magnitude, severity, urgency, risk etc., of a project in the ultimate analysis depends upon:

(a) Nature, size and type of the project: such as manufacturing, services, agriculture, mining, logging, power, harbour, chemicals, sugar, etc.
(b) Technology.
(c) Location/eco-region: such as urban or rural areas, coastal, river valley, forest/hill areas or any of the eco-systems as described earlier.

6. MEANING AND SCOPE OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL IMPACT STATEMENT (EIS)

Environmental Impact Assessment (EIA) and the Environmental Impact Statement (EIS) are said to be the instruments through which the environmental management tries to accomplish its objective. The basic premise behind the EIS/EIA is that no one has any right to use the precious environmental resources resulting in greater loss than gain to society. From this, it follows that the aim of EIS is to seek ways by which the project can proceed without any irrepairable losses to environment and minimum losses if any, so that the net effect will be a desirable gain.

Environmental Impact Assessment (EIA) is defined as: "An activity designed to identify, predict, interpret, and communicate information about the impact of an action on man's health and well-being (including the well-being of ecosystems on which man's survival depends). In turn, the action is defined to include any engineering project, legislative proposal, policy programme, or operational procedure with environmental implications." An EIA, therefore, is a study of the probable changes in the various socio-economic and biophysical attributes of the environment which may result from a proposed action.

On the other hand, Environmental Impact Statement (EIS) is defined as:

> A report, based on studies, disclosing the likely or certain environmental consequences of a proposed action, thus alerting the decision-maker, the public and the government to environmental risks involved; the findings enable better informed decisions to be made, perhaps to reject or defer the proposed action or permit it subject to compliance with specific conditions.

The EIS is a document prepared by an expert agency on the environmental impacts of a proposed action/project that significantly affects the quality of environment. The EIS is used mainly as a tool for decision-making. At times, the EIA and EIS are used interchangeably as synonyms. But both are different activities with a lot of commonalities and with a common purpose. The basic difference between the two is that the EIA is carried out by the expert agency while the EIS as a tool is given to the decision-makers in different formats. As a matter of fact, the EIS is the outcome of EIA. It is better to consider the environmental consequences during the project planning and design stage itself so as to avoid higher costs of future remedial actions by prudent planning and early preventive measures.

Objectives of EIS

(a) To identify and describe (in as quantified a manner as possible) the environmental resources/values (ER/Vs) or the environmental attributes (EA) which will be affected by the proposed project, under existing or "with or without project" conditions.

(b) To describe, measure, and assess the environmental effects that the proposed project will have on the ER/Vs (again, in as quantified a manner as possible), including positive effects which enhance ER/Vs as well as the negative effects which impair

them. Direct or indirect and short term or long term effects are to be considered. This would also include the description of the specific ways by which the project plan or design will minimize the adverse effects and maximize positive effects.

(c) To describe the alternatives to the proposed project which could accomplish the same results but with a different set of environmental effects. Energy generation by thermal, hydel, and nuclear modes would explain the case in point. Further, alternative locations are also considered.

Guidelines on the Scope and Contents of EIS/EIA

The following are the commonly accepted points to be covered in an EIS study/report:

(a) A description of the project proposed action; a statement of its purpose and a description of all relevant technical details to give a complete understanding of the proposed action, including the kinds of materials, manpower/resources etc., involved.

(b) The relationship of the proposed action to the land-use plans, policies and controls in the affected area or the project-vicinity. It is necessary to gain a complete understanding to the affected environment. What is the nature of biophysical and socio-economic characteristics that may be changed by the action?

(c) The probable impacts of the proposed project on environment is a very important aspect to be considered in detail. It is necessary to project the proposed action into the future and to determine the possible impacts on the environmental attributes. The changes are to be quantified wherever possible.

(d) Alternatives to the proposed action, including those not within the existing authority/agency.

(e) Any probable adverse environmental effects that cannot be avoided and stating how each avoidable impact will be mitigated.

(f) The relationship between local short term uses of man's environment and the maintenance of an enhancement of long term productivity.

(g) Any irreversible and irretrievable commitments of resources (including natural, cultural, labour, and materials).

(h) An indication of what other interests and considerations of governmental policy or programme are thought to offset the adverse effects identified.

As seen by its purpose, scope and contents, the EIA is a very complex exercise due to the fact that many and varied types of projects are proposed for an equally numerous and varied kinds of environmental settings. Each combination of projects and the complex environmental settings results in a unique cause-condition-effect relationships with regard to their impacts. Therefore, each combination must be studied individually in order to accomplish a comprehensive analysis.

7. METHODOLOGY FOR CONDUCTING AN EIS STUDY

So far, there is no consensus on any particular procedure. This is because of the difficulties in quantifying the effects which are often intangible, complex, and imperceptible in nature. It is difficult to develop meaningful parameters to represent the effects and their quantification. The major problems in this regard are:

(i) The diffused nature of impacts both over time and space; and the lags in impacts after the cause worked.
(ii) An environmental effect is the joint product of several pollutants.
(iii) Inadequacy of techniques to estimate the impacts and their costs.
(iv) Since the impacts are imperceptible, people are not aware of the impacts.

Due to the complex problems involved in identification and quantification of effects, all attempts to develop quantitative approaches to EIA (including the checklists, matrices, networks, flowchart relationships, and map overlays) have been essentially subjective with the quantification depending mostly on the background and bias of the investigator or observer.

At present, the generally accepted approach for making the EIS is an item-by-item review of effects on the individual environmental resources/values (ER/Vs), including both the identification of ER/Vs, and description and quantification of the effect to the extent possible. Then, it is possible to group these effects in a systematic manner. The following are the major practical steps in this approach.

(a) Make a rapid or quick scanning or appraisal of the basic environmental resources viz., land, water and air, at the macrolevel, say at the district level in which the project is to be located. This scanning is meant to evaluate the extent of fragility and exploitation of the endowed resource-base, including the human resources. Then, relate the project to the regional environmental in broad terms.
(b) Demarcate the project vicinity or the surrounding zone of the project. Maps can also be used.
(c) Identify, assess, and describe all the environmental attributes as given in a tabular form earlier; or the environmental resources/values (ER/Vs under four levels) as given earlier, endowed in the project vicinity. This would give a total description of the environment before the start of the project.
(d) Rank or prioritise the identified ER/Vs by their fragility, importance, relevance and quality. This would help to concentrate on the very significant items rather than spreading the efforts too thinly over a large number of items of lesser significance.
(e) Carry out the item-by-item review of effects of the proposed project on the already identified individual ER/Vs embedded in the project vicinity.
(f) Arrange or group the effects in a systematic manner, preferably in a format.
(g) Prepare the remedial plans for mitigating the adverse effects. They can be: (i) Corrective; (ii) Compensatory; or (iii) Enhancing.

By following the above practical steps sequentially in that order, one can make an environmental appraisal of any type of project. Through EIS/EIA, the environmental protection planning is made compatible with the developmental perspectives.

Some Major Issues in the Preparation of EIS/EIA

The following are the major issues reported to be encountered commonly while conducting and preparing the EIS/EIA. Some of the issues cannot be resolved. In the absence of better alternatives, the analyst has to accept the issues as they are.

(i) Determining the Environmental Impacts This is the central theme in any EIS/EIA. It is a very complex process. At the outset, a distinction has to be made between the environmental impact and the changes in environmental attributes. Our interest is on the "impacts" and not on the 'changes' which normally take place even without the project. The determination of environmental impacts involves: (a) identification of impacts on environmental attributes or the ER/Vs, (b) measurement of impacts on attributes, and (c) aggregation of impacts on attributes to reflect the total impact on environment.

(ii) With and Without the Project The environmental impacts are measurement of attributes with and without the project or activity at a given point in time. But the changes in the attributes take place over time without the activity. Therefore the impact must be measured in terms of "net" change in the attribute at a given point in time.

(iii) Identifying the Impacts The number of attributes to be evaluated is practically infinite because any characteristic of the environment is considered to be an attribute. Therefore, they have to be reduced to manageable numbers. Thus, duplicative, redundant, difficult to measure, and obscure attributes may be eliminated in favour of those that are more tractable. This implies that some attributes which are difficult to measure or conceptualise, may still remain to be examined. In this case, bias and subjectivity are likely to be crept in.

(iv) Characteristics of the Base Conditions Prior to the Activity: The nature of the impact is determined by the conditions of the environment existing before the project. The assessment of the characteristics of the base is a critical factor.

Geographic Characteristics: The same activity produces different impacts on a particular attribute, say water quality, over different geographical areas. The spatial distribution of different activities introduces one of the difficult elements in comparing one activity and its impact with another. This issue becomes particularly critical while making choices between projects.

(v) Role of Attributes Though the impacts are considered to be the effects on the definite discrete attributes of the environment, the actual impacts are not correspondingly well categorised. Nature does not necessarily respect man's discrete categories. Rather, the actual impacts may be the effects of varying severity on a variety of interrelated attributes. The issue is one of identifying and assessing the cause-condition-effect in order to work out the remedial measures.

(vi) Measurement of Impact Ideally, all impacts must be translatable into common units. However, this is not possible because of the difficulty in defining impacts in common units (e.g., on income and on water quality). In addition, the quantification of some impacts may be beyond the state of the art.

(vii) Aggregation Problem After measuring the project impacts on various individual attributes or ER/Vs, one encounters the problem of how to aggregate all impacts (quantitative and qualitative) thus assessed to arrive at a single composite measure to represent the 'total activity impact'. This would involve expressing the various impact measures in common units which is very difficult. Some use a weighting procedure to accomplish this which is again subjective. There is another associated problem of summing up and comparing with the impact of an alternative activity.

(viii) Secondary Impacts Secondary or indirect impacts on environment should also be considered particularly in relation to the infrastructure investments that stimulate or induce secondary effects in the form of associated investments and changed patterns of social and economic activity. Such induced growth brings significant changes in the natural conditions. Similarly, there can also be significant secondary impacts in the biophysical environment.

(ix) Cumulative Impacts Here, cumulation refers to the similar activities spread over in an environmental setting like hotels, beach resorts, surface or underground mines, industrial estates, etc. A single individual activity may produce a negligible effect on environment. However, a series of similar activities may produce significant cumulative effect on certain aspects of environment. This raises the question of how to deal with these significant cumulative effects. Therefore, it is suggested to prepare an environmental impact assessment (EIA) on broad programmes rather than on a series of component actions (e.g., industrial estates, mining sector, tourism industry, etc.). Or, alternatively, one can prepare an EIA for a particular geographical area where a series of similar activities are located (e.g., mining areas, coastal line for beach resorts, etc.).

(x) Reporting Findings The results should be displayed in such a way that it makes easy and clear to comprehend the total impacts of an activity from a brief review. It is suggested to display the impacts on a summary sheet in a matrix form.

The knowledge about the issues as explained above, however complex they are, will be useful in understanding the processes and complexities involved in preparing an EIS/EIA. Such an awareness will help improve the understanding of EIS, leading to more objective, informed and unbiased decision-making on activities/projects.

Choice of a Methodology

Many impact assessment methodologies have been developed in the Western industrialised countries as a response to the various legislative control and regulatory measures as also to suit divergent environmental situations and purposes.

The choice will decide the depth of analysis to be carried out in a particular impact assessment. The choice of a methodology depends on: (a) needs of the user, (b) type of project; its size and technology, and (c) location; type of ecosystem.

Depending on these factos, one may be more useful than the other methodology. Therefore, the analyst must decide which one will best fit for a given task and situation. The following are the important considerations for making a choice on the methodology for preparing an EIS/EIA.

(i) *Use:* Is the EIS for a decision or for information? If it is for a decision, it requires greater emphasis on identification of key issues, quantification and comparison of alternatives. If it is for information, it requires a more comprehensive analysis and concentration on interpretation of the significance of a broad list of possible impacts.
(ii) *Alternatives:* Are alternatives fundamentally or incrementally different?
(iii) Resources: How much time, skills, money, and data are available? More in-depth and quantitative analysis require more of everything.
(iv) *Familiarity:* Is the analyst familiar with both the types of project proposed and the physical site?
(v) *Issue Significance:* How big is the issue? The bigger the issue, the greater the need to be explicit, to quantify, and to identify key issues.
(vi) *Administrative Constraints:* Are choices limited by governmental procedures and format requirements? Some policy guidelines may rule out some tools by specifying the range of impacts to be addressed.

Impact Assessment Methodologies

The impact identification and assessment can be made through several ways. Each one represents a methodology. Besides the one already explained, there are six other different methodologies in the literature based on the way the impacts are identified and assessed. A critical overview of the methodologies in given in Exhibit C.1.

(1) *Ad Hoc:* These methodologies provide a minimum guidance for impact assessment. They merely suggest broad areas of possible impacts (e.g., impacts on lakes, forests, etc.,) rather than defining specific parameters to be investigated. This is given exogenously to the analyst.
(2) *Overlays:* These methodologies depend upon a set of maps on the environmental characteristics (physical, social, ecological, and aesthetic) of the proposed project's vicinity. These maps are overlaid to produce a composite characterisation of the regional environment. Impacts are then identified by noting the impacted environmental attributes within the project boundaries.
(3) *Checklists:* The methodologies present a specific list of environmental attributes to be investigated for possible impacts. They need not necessarily attempt to establish the

cause-effect links to project activities. They may or may not include guidelines about how attribute data are to be measured and interpreted.

(4) *Matrices:* These methodologies incorporate a list of project activities with a checklist of potentially impacted environmental attributes. Then, the two lists are related in a matrix form which identifies the cause-effect relationships between specific activities and impacts. The matrix methodologies may either specify which actions affect which attributes, or may simply list the range of project activities and environmental attributes in an open matrix to be completed by the analyst.

(5) *Networks:* These methodologies work from a list of project activities to establish cause-condition-effect relationships. It is generally felt that a series of impacts may be triggered by a project action. They define a set of possible networks and allow the user to identify impacts by selecting and tracing out the appropriate project actions.

(6) *Combination Computer-aided:* These methodologies use a combination of matrices, networks, analytical models, and a computer-aided systematic approach. Since this is a combination of difficult methodologies, it is a multiple-objective approach to; (a) identify activities associated with the governmental policies and programmes; (b) identify potential environmental impacts at different levels; (c) provide guidance for abatement and mitigation techniques; (d) provide analytical models to establish cause-effect relationships and to quantitatively determine potential environmental impacts, and (e) provide a methodology and a procedure to utilise this comprehensive information in decision-making.

Evaluation of a Methodology

An environmental impact assessment (EIA) must effectively deal with four key problems: (a) impact identification; (b) impact measurement; (c) impact interpretation, and (d) impact communication to users. These criteria can be used for analysing a methodology and determining its weaknesses and strengths. It also helps in choosing methods which are most appropriate for a particular situation. The above six methodologies display variety in conceptual framework, data formats and data requirements as well as in manpower, monetary and time resource requirements. An EIA team can use more than one method.

Exhibit C.1 *A Critical Overview of EIA Methodologies*

Methodology	*Areas of usefulness*	*Drawbacks*
(a) Ad Hoc	— Simple and no training/skills needed. — Indepth and focussed analysis on few; When no expertise and resources available, this is the best. — Gives preliminary understanding — Project's effects on environment given without any weighting and cause-effect relations.	— Restricts to broad areas only. — Not all relevant impacts covered. — Selective and biased. — Lacks consistency due to different criteria to evaluate different groups of factors.

(b) Checklists	— Strong in impact identification. — Effective in evoking public attention. — Simple and easy to understand; comprehensive. — Most useful at the stage of initial environmental examination (IEE).	— Scaling and weighting subjective. — Leaves interpretation to decision makers. — Measurement deficient.
(c) Matrices	— Provides cause-effect relations between project activities and impacts on various attributes. — Graphical display of impacts gives better understanding. — Strong in impact identification and their interaction is possible.	— Information is lost due to quantification. — Scaling and weighting become subjective.
(d) Networks	— Capable of identifying both direct and indirect effects and their interaction. — Capable of incorporating mitigation and management measures at the planning stage of a project.	— Less useful in considering socio-economic environment. — Display becomes large and unwidely when large industrial complexes or regional plans are considered.
(e) Overlays	— Useful in site and route selection. — Effective presentation and display. — Useful in transport projects and road route alternatives: land use planning.	— Quantification and measurement weak. — Not all impacts covered. Higher order impacts cannot be identified. — Social environment not considered. Subjective — Self limiting in scope.

Appendix D



Application for Financial Assistance

The central financial institutions have prescribed a common application form, 54 pages long, which seeks information along the following lines.

1. ***General Name:*** Form of organisation; date of incorporation/registration; date of commencement of business, sector business house to which the concern belongs, applicability of the MRTP Act; location; nature of project (new/expansion/modernisation/diversification); brief particulars of the project; nature of industry and products; financial assistance applied for; and foreign currency loan/guarantee applied for.

2. ***Promoters:*** Bio-data of the main promoter, brief write-up of other companies promoted by the promoter—in case the promoter is a limited company, a brief write-up on the activities and past performance of the company.

3. ***Particulars of the Industrial Concern:*** Brief history; list of subsidiaries; particulars of holding company; details of directors; certified copies of audited balance sheets and profit and loss account for the last five years and brief explanations for year-to-year variations in production, sales, stocks, profits, etc., and contingent liabilities; details of asset revaluation, if any, during the existence of the company and the reasons thereof; list and bio-data of existing key technical and executive staff and number of supervisory, skilled, semi-skilled and unskilled personnel; organisation chart showing the lines of authority; existing long-term and short-term borrowings as set out in Forms II and III; distribution of shareholding as per Form IV; company's tax status; manufacturing facilities separately at each plant; figures of licensed capacity, installed capacity, production and sales (quantities and value net of excise duty) of each major products/product group requirement of various utilities and services and the arrangements for their supply; details of insurance; details of pending litigation; details of research and development activities of the company; preventive maintenance adopted by the company.

4. *Particulars of the Project:* Details of the project for which financial assistance is required in terms of the following (copy of the project report/feasibility report, if any, to be enclosed).

A. *Capacity:* Present installed capacity, maximum production achieved, proposed installed capacity, and maximum production envisaged for various products; section-wise capacities for the major sections of the plant; specifications of major products and by-products.

B. *Process:* Details of technical process; labour intensiveness of the process; advantages/disadvantages of the alternative process with reference to employment potential; reasons for choosing the particular process; copy of process flow chart with material balance, utilities and process parameters; application of the proposed process in the country.

C. *Technical Arrangements:* Technical arrangements made/proposed; write-up on the collaborator, in case of collaboration; copy of collaboration agreement, copy of government approval for the collaboration, copy of government approval for availing of the services of foreign technicians; particulars of consultants.

D. *Management:* Proposed arrangements for executive management, particulars of proposed key technical, administrative and accounting personnel; proposed organisation chart; proposed cost and budgetary control system, management reporting and inventory control system, purchase of raw materials, components etc.

E. *Location and Land:* Location of the plant, land requirement and the arrangements thereof, locational advantages; particulars in respect of the land acquired/proposed to be acquired; copy of sale/lease deed, copy of soil test report, copy of government order converting the land into industrial land if applicable, location map, site plan.

F. *Buildings:* Arrangements made/proposed for constructing the buildings (particulars of buildings as per Form V); copy of master plan showing location of buildings and roads, power receiving station, railway siding, tube well, etc., copy of equipment layout or plan of buildings indicating the flow of materials; particulars of architect; copy of agreement with architects, copy of published write up/brochure on architects.

G. *Plant and Machinery:* Basis of selection of equipment, list of imported and indigenous plant and machinery acquired/to be acquired along with detailed specifications as per Forms VI and VII, layout of the plant and machinery indicating the flow of material.

H. *Raw Materials:* Requirement of raw materials, components, chemicals, etc., as per Form VIII; price or distribution controls if any, on any of the items listed above, detailed note on the arrangements made for obtaining the raw materials/chemicals; mining lease, if any, and details thereof; copy of agreement for mining lease and expert's report regarding the quantity and value of reserves.

I. *Utilities:* Details about power (source of power and supply voltage, maximum demand, connected load, peak hour requirements, contracted load, power tariff, cost of power), copy of letter of sanction for power, copy of agreement with Electricity Board, copy of electrical layout of the plant, a note on power generation, demand

and supply of power in the State, present and projected; details about water (requirement for various purposes, sources of water, sources of water arrangements proposed and water charges payable, capacities of tanks, reservoirs, water treatment arrangements proposed), layout for water system, copy of letter of sanction of water by municipal/local authorities, where applicable, copy of water analysis report; details for steam (steam requirement and steam balance, capacity and type of the boiler with detailed specifications), layout of the steam system; details for compressed air, fuel, etc., copies of letter of allotment of coal/furnace oil from the concerned authorities, details for transport (arrangements proposed for carrying raw materials and finished goods, provision for own trucks, railway siding etc., and arrangements with private truck operators indicating rates, subsidy, if any, available, etc.)

J. *Effluents:* Details of the nature of atmosphere, soil and water pollution likely to be created by the project and the measures proposed for control of pollution permissions for the disposal of effluents where necessary; copy of approval from concerned authorities for the proposed arrangements.

K. *Labour:* Estimates of total requirements and availability of skilled and unskilled labour, plans for training of personnel, manpower development programme, category-wise classification of total personnel requirements.

L. *Quarters and Labour Housing:* Existing and proposed arrangements for housing staff and workers, classified as follows; senior executives, other executives, supervisors, labour.

M. *Schedule of Implementation:* Manner in which the design, engineering, erection, installation and commissioning of the projects will be carried out; progress made so far in the implementation of the project; schedule of implementation showing the commencement and completion of the following acquisition of land, development of land, civil work, placement of order and delivery at site of plant and machinery (imported, and indigenous), arrangements for power, arrangements for water, erection of equipment, commissioning, procurement of raw material and chemicals, training of personnel, trial runs, and commercial production, PERT chart.

N. *Other Projects of the Concern:* Details of any other new/expansion/modernisation, etc., projects which are under implementation or which the company/promoters propose to implement, giving the estimated cost, means of financing and the present status.

5. ***Cost of the Project:*** Estimate of cost of project under the following heads (details may be furnished as per Form IX): (i) land and site development, (ii) buildings, (iii) plant and machinery (imported and indigenous), (iv) technical know-how fees, (v) expenses on foreign technicians and training of Indian technicians abroad, (vi) miscellaneous fixed assets, (vii) preliminary and preoperative expenses, (vii) provision for contingencies, and (ix) margin money for working capital; basis of cost estimate (such as quotations, orders placed etc.) bringing out the built-up provision for cost escalation, if any; estimates of contingency/escalation provisions as per Form IX-A and margin money for working capital as per Form IX-B.

6. ***Means of Financing:*** Means of financing envisaged divided as follows: share capital (equity and preference), rupee loans, foreign currency loans, debentures, internal cash accruals, and others; details of the means of financing envisaged and the proposals for raising share capital as per Form X and Form XA respectively; basis of estimation of internal accruals; arrangements of letter sanctioning assistance; sources of foreign exchange and arrangements, if any, made for obtaining foreign exchange; sources from which expenditure already incurred has been financed as per Form XB; promoters' contribution to project cost; list of persons/firms who would be contributing to the promoters' share of the capital and the respective amounts; details of security proposed to be offered for loan and/or guarantee for deferred payments on plant and machinery or guarantee for foreign currency loans; copy of letter from bank indicating its willingness to guarantee a loan, in case a bank guarantee is proposed to be offered instead of mortgage of fixed assets.

7. ***Marketing and Selling Arrangements:*** Copy of market survey report, if any, conducted by the company or independent consultants; brief notes on the products, their major uses, scope of the market, possible competition from substitute products, etc., special features (regarding quality, price, etc.) of the product which would result in consumer preference in relation to competitive products; detailed notes on the existing and future demand and supply of the products proposed to be manufactured; assessment of likely competition in the future and special features of the project which may enable it to meet the competition; export possibilities and the nature of competition to be faced in foreign countries—comparative data on manufacturing costs and prices in selected competing countries; export commitments of the company as part of the government requirements and arrangements proposed for meeting the same—export incentives available; international CIF, FOB prices and landed costs of the proposed products; list of principal customers and particulars of any firm arrangements entered into with them; particulars of government controls, restrictions, etc., if any, on the sale price, distribution, import, export, etc., in respect of the products proposed to be manufactured; nature of selling arrangement (direct, through distributors, or through selling agents), nature of proposed selling organisation for direct sales, particulars of proposed selling arrangements both in India and abroad and commission proposed to be paid, brief note on the selling agent's organisation; copy of the agreements with selling agent; particulars of any sole selling agency, where proposed, for any of its products; details regarding the trend in prices during the last five years; the basis on which prices are fixed, if the prices ae controlled by the government or on a voluntary basis; in case of agro-based/agriculture input industries, the company's scheme for educating the farmers to use the product/to grow the produce required.

8. ***Profitability and Cash Flow:*** Estimates of cost of production and working results for the first ten years of operation as per Forms XI and XII respectively (for expansion/diversification of existing companies two sets of profitability statements may be prepared—one for the project and the other for the existing operations only); cash flow statement for the company as a whole for ten operating years of the project in Form XIV, based on working

results in Form XII, projected balance sheet for ten operating years for the company as a whole as per Form XV; break-even capacity level.

9. ***Economic Considerations:*** Prices of competing import/export products giving a break up as FOB, CIF, landed cost (including import duty) and selling price; detailed explanation for differences in selling prices of the products and those of imported goods with quantitative data on differences in cost of production (such as scale of operation, differences in costs of inputs and various local duties and taxes); international/CIF/FOB prices of all inputs which can either be imported/exported; details of duties, taxes and incentives (excise duty, export duty, export assistance in the form of replenishment license, duty drawback, cash subsidy, any other); brief write up on the economic benefits to the country in general and the region in particular, on account of the proposed project; contribution of the unit to the establishment of ancillary industries in the region.

10. ***Government Consents:*** Details of the following licenses/consents required for the project in terms of date of issue, validity period, and present issue, if not already issued; (i) letter of intent, (ii) industrial license, (iii) capital goods clearance, (iv) import license, (v) foreign exchange permission, (vi) approval of technical/financial collaboration,(vii) clearance under MRTP Act, (viii) consent of the Controller of Capital Issues, (ix) any other (specify); copies of licenses/consents etc., received; special conditions attached to the licenses/consents and the undertakings given by the company in connection with them.

11. *Declaration:* A declaration by the applicant that the information, statements, and papers furnished are true and correct.

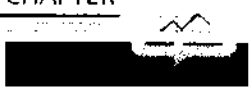
List of Forms

The following is the list of forms to be submitted along with the application for financial assistance.

I Letter Addressed to the Bankers
II Existing Long-term Borrowings
III Existing Short-term Borrowings
IV Distribution of Shareholdings
V Particulars of Buildings
VI Particulars of Imported Machinery
VII Particulars of Indigenous Machinery
VIII Raw Materials Requirements
IX Estimates of the Cost of Project
IXA Calculation of Contingency
IXB Calculation of Margin Money
X Means of Financing
XA Proposal for Raising Share Capital
XB Sources of Expenditure Incurred

XI Estimates of Cost of Production
XII Estimates of Working Results
XIIA Estimates of Production and Sales
XIIB Calculation of Wages and Salaries
XIII Unit Cost of Production
XIV Cash Flow Statement
XI Projected Balance Sheet
XII Break-even Point

CHAPTER



Index

Accounting rate of return 207-210
Adjusted cost of capital 393
Adjusted present value 389
Agency problem 638-685
Applied utility theory 336-339
Asset beta 372
Average time 632

Bar chart 608-9
BCG matrix 24-25
Benefit cost ratio 193-194
Beta 364-369
Binomial model 483-486
Black and Scholes model 486-490
BOOT 568
BOT 568
Break-even analysis 292-294
Business risk 526
Buyer's credit 562

Call option 475
Capital asset pricing model 356-362
Capital market line 357-359
Cash credits 550-551
Certainty equivalent method 321-322
Chain ratio method 84-85
Coefficient of variation 286
Commercial paper 556-57
Concentric diversification 23
Conglomerate diversification 23
Continuous compounding
and discounting 181-182
Convertible debentures 546
Cost of debt 254-255
Cost of equity 256-260
Cost of project 117-121
CPM model 651-657
Critical path 636-637

Debentures 545-550
Debt service coverage ratio 326-327
Decision tree analysis 307-315
Deep discount bonds 546
Deferred credit 553
Delphi method 78
Divisional organisation 604-5
Domestic resources cost 432

Earliest occurrence time 633-34
Ecological analysis 11-12
Econometric method 88-89
Economic analysis 11
Economic rate of return 426-429
Effective interest rate 174
Effective rate of protection 430-431
Efficient frontier 350
End use method 87
EPC contract 572

Equity capital 530-536
Eurobonds 560-561
Eurocurrency loans 558-560
Exponential smoothing method 81-82

Factoring 557
Feasibility study 12
Feasible combination approach 449-450
Feasible region 350
Finance lease 553-554
Financial analysis 11
Financial risk 526-527
Floating rate bonds 547
Free float 638
Future value interest factor of annuity 164-165
Future value interest factor 157-158

General Electric Stoplight Matrix 25-26
Global depository receipts 561
Goal programming model 461-466

Hire purchase 554-555
Hypothecation 552

Income elasticity of demand 85-86
Independent float 638
Indexed bonds 548
Informational asymmetry 514
Initial public offering 532-533
Integer linear programming model 456-461
Internal accruals 537-538
Internal rate of return 194-201

Jury of executive opinion method 77-78

Latest occurrence time 635-36
Leading indicator method 88
Lease finance 553
Least squares method 80
Letter of credit 551
Line and staff organisation 604
Linear programming model 451-456
Little-Mirrlees approach 422-425

Market analysis 10
Market risk premium 362-364
Matrix organisation 605
Means of finance 121-123
Modified IRR 201-203
Modified net present value 190-191
Most likely time 631
Moving average method 82-84

Net present value 184-190
Network cost system 657-660

O&M contract 574
Operating lease 554
Optimal portfolio 352
Optimistic time 631

Payback period 204-207
Performance analysis 614-616
PERT model 646-651
Pessimistic time 631
Pledge 552
Porter model 48-50
Power purchase agreement 574-578
Preference capital 536-537
Preferential allotment 534-535
Present value interest factor of annuity 168
Present value interest factor 161-162
Present value of perpetuity 173
Price elasticity of demand 86-87
Private placement 534
Project analysis 627-630
Project loan agreement 573
Project rating index 55-56
Put call parity theorem 479
Put option 475-476

Rights issue 533-534
Risk adjusted discount rate method 319-320
Risk profile method 318-319
Risk-free rate 362
Risk-neutral valuation 485-486

Scenario analysis 290-292
Seasoned offering 533

Secured premium notes 547
Security market line 359-362
Semi-variance 286-287
Sensitivity analysis 288-290
Separation theorem 354
Shareholders agreement 572
Simulation analysis 298-306
Standard deviation 286
Strategic Position and Action Evaluation (SPACE) 27-30
Structured notes 547-48
Supplier's credit 562-563
SWOT analysis 44

Technical analysis 10
Term loans 538-545
Total float 637-638
Trend projection method 78

UNIDO approach 405-422
Uniform annual equivalent 382

VC investors 584
Vertical integration 22

Weighted average cost of capital 261-262
Weighted marginal cost of capital 262-267