

Contents

List of Abbreviations	xxiii
------------------------------------	-------

Part I Foundations

1 An Overview of the Evaluation and Financing of Capital Projects ...	3
1.1 Evaluation and Funding of Projects	3
1.2 Project Financials	4
1.3 Evaluating the Project Based on Free Cash Flow	8
1.4 Profit (or Earnings) is Not Required for the Assessment of the Project	11
1.5 Investment Decision Precedes the Financing Decision	11
1.6 Past Expenses are Excluded from the Project Financials	12
1.7 Assessment of the Risk of the Project	12
1.8 Financing of a Capital Project	13
1.9 Summary	14
1.10 Looking Ahead	16
1.11 Review Questions	16
1.12 Exercises	17
2 The Theory and Practice of Decision-making Concerning Capital Projects	19
2.1 Introduction	19
2.2 Cost-benefit Analysis, Engineering Economics and Capital Budgeting	19
2.3 Perspectives for the Assessment of Projects	22
2.4 Enhancing Value for Investors	23
2.5 Business Context	24
2.5.1 Financial Stewardship Within a Business	24
2.5.2 Sources and Use of Funds	25
2.5.3 Investment and Financing Decisions Within the Business	27
2.5.4 Evaluation of Investment Opportunities	28

2.6	Business Decision-making	29
2.7	A Framework for Decision-making	31
2.7.1	Steps in the Decision-making Process	31
2.7.2	Frame: the Decision Context and Possible Alternatives	32
2.7.3	Evaluate: the Assessment of Alternatives Based on Criteria	34
2.7.4	Decide: the Act of Decision-making	35
2.8	The Practice of Decision-making for Capital Projects	36
2.8.1	Classification of Capital Projects	36
2.8.2	Relationship Between Projects	36
2.8.3	Decision Authority for Capital Projects	37
2.8.4	Case Study: Small Project	38
2.8.5	Case Study: Large Project	40
2.9	Summary	42
2.10	Looking Ahead	43
2.11	Review Questions	43
2.12	Exercises	44
3	Financial Statements	45
3.1	Introduction	45
3.2	Business Process and the Dual Nature of Transactions	45
3.2.1	The Dual Nature of Transactions	46
3.2.2	Business Process	48
3.3	Financial Records	49
3.4	Accounting Principles and Conventions	49
3.4.1	Business Entity	50
3.4.2	Accrual Accounting	50
3.4.3	Historical Cost	51
3.5	Financial Statements	52
3.5.1	Basic Transactions in a Business	52
3.5.2	Income Statement	55
3.5.3	Balance Sheet	60
3.5.4	Cash Flow Statement	62
3.6	Depreciation	65
3.7	The Interaction Between the Financial Statements	69
3.8	Relationship Between the Financial Statements and the Project Cash Flows	71
3.9	Case Study: Santa Anna Hydroelectric Power Scheme	72
3.9.1	Project Financials	72
3.9.2	Income Statement	74
3.9.3	Cash Flow Statement	75
3.9.4	Balance Sheet	76
3.10	Examining the Business Risks	77
3.11	Case Study: Apex Foods	78
3.12	Ratio Analysis and Financial Trees	83

3.13	Summary	86
3.14	Review Questions	86
3.15	Exercises	88
4	Cash Flows for a Project	91
4.1	Introduction	91
4.2	Determining the Cash Flows for a Project	91
4.3	Overview of the Stages of Engineering Design and Construction ..	92
4.4	Approval Procedure	93
4.5	Estimation of the Capital Costs	94
4.5.1	Components of Capital Cost Estimates	94
4.5.2	Classification of Capital Cost Estimates Based on their End Use	96
4.5.3	Classification of Capital Cost Estimates Based on their Level of Accuracy	97
4.6	Estimation Techniques for Capital Costs	101
4.6.1	Factored Estimate Techniques	101
4.6.2	Unit Costs Techniques	105
4.7	Estimation of the Total Operating Costs	106
4.7.1	Direct Production or Manufacturing Costs	107
4.7.2	Fixed Manufacturing Costs	108
4.7.3	Plant Overheads	108
4.7.4	General and Administrative	108
4.7.5	Royalties and Production Payment	109
4.8	Forecasts of the Sales or Revenue	109
4.9	Calculation of the Direct Taxes and Royalties	111
4.9.1	Corporate Tax	111
4.9.2	Capital Gains Tax	112
4.9.3	Royalties	113
4.10	Working Capital	113
4.11	Case Study: Order of Magnitude Estimate of the Capital Cost of a Plant	115
4.12	Case Study: Factored Estimate of the Capital Cost of a Plant	115
4.13	Summary	116
4.14	Looking Ahead	119
4.15	Review Questions	120
4.16	Exercises	120

Part II Evaluation of Capital Projects

5	Time Value of Money	125
5.1	Introduction	125
5.2	Interest and Interest Rates	126
5.3	Effect of Timing on the Value of Money	126
5.4	Future Value	128

5.5	Multiple Periods	128
5.6	Types of Interest Rates	130
5.6.1	Nominal and Period Interest Rate	130
5.6.2	Effective Rate	131
5.7	Compounding	132
5.7.1	Single Payments: Growth	132
5.7.2	Multiple Equal Payments: Annuities	140
5.7.3	Multiple Periods: Growth Annuities	143
5.7.4	Multiple Payments of Unequal Amounts	146
5.8	Discounting	146
5.8.1	Single Amounts of Future Cash Flow	147
5.8.2	Multiple Equal Amounts	148
5.8.3	Uneven Cash Flows	150
5.9	Compound Interest Formula	151
5.9.1	Single Payment Interest Formula	151
5.9.2	Multiple Equal Payments	151
5.9.3	A Notation for Interest Rate Factors	152
5.10	Case Study: Zero Coupon and Coupon Bonds	155
5.11	Summary	158
5.12	Looking Ahead	159
5.13	Review Questions	159
5.14	Exercises	160
6	Evaluation Criteria for Investment Decisions	163
6.1	Creating Value for the Investor	163
6.2	Non-discounted Cash Flow Techniques	164
6.2.1	Payback Period	164
6.2.2	Return on Investment	167
6.3	Discounted Cash Flow Techniques	168
6.3.1	Net Present Value	168
6.3.2	Profitability Index or Benefit-cost Ratio	172
6.3.3	Internal Rate of Return	173
6.3.4	Modified Internal Rate of Return	180
6.3.5	Discounted Payback Period	181
6.3.6	Benefit-Cost Ratio	183
6.3.7	Equivalent Annual Charge	183
6.4	Comparison Between Discounted Cash Flow Techniques	188
6.4.1	Relative and Absolute Measures	188
6.4.2	Agreement and Conflict Between Measures	189
6.4.3	The Reinvestment Assumption in the NPV and IRR	193
6.5	Case Study: Decision Criteria	195
6.6	Survey of the Most Used Criteria	198
6.7	Summary	199
6.8	Looking Ahead	200

6.9	Review Questions	200
6.10	Exercises	201
7	Mutually Exclusive, Replacement and Independent Projects	205
7.1	Classification of Asset Allocation Decisions	205
7.2	Mutually Exclusive Alternatives	206
7.2.1	Ranking Mutually Exclusive Options with Equal Lives	207
7.2.2	Ranking Mutually Exclusive Projects with Unequal Lives	210
7.2.3	Selection of Mutually Exclusive Alternatives	217
7.3	Replacement Studies: Mutually Exclusive Decisions with an Incumbent	217
7.3.1	Economic Service Life	218
7.3.2	Selection of Defender or Challenger Based on Equivalent Annual Charge	221
7.3.3	Replacement for Service Required for Defined Period	223
7.4	Non-mutually Exclusive or Independent Projects	226
7.4.1	Effect of Starting Times Delays and Project Life	226
7.4.2	Ranking	229
7.4.3	Selection of Projects Under Capital Rationing	232
7.5	Summary	239
7.6	Review Questions	240
7.7	Exercises	241
8	Practical Issues in the Evaluation of Projects	247
8.1	Introduction	247
8.2	Inflation and Price Escalation	247
8.3	Taxation	253
8.3.1	Tax Position of the Company	253
8.3.2	Methods of Calculation of Depreciation	253
8.3.3	Comparison Between Depreciation Methods	260
8.3.4	Effect of the Depreciation Method on NPV and IRR	260
8.3.5	Disposal of a Depreciable Asset	263
8.4	Choice of the Discount Rate	264
8.5	Summary	267
8.6	Review Questions	268
8.7	Exercises	269
9	Sensitivity, Scenario and Other Decision Analysis Techniques	273
9.1	Introduction	273
9.2	Influence Diagrams	273
9.3	Sensitivity Analysis	277
9.4	Scenario Analysis	281
9.5	Strategy Space	282
9.6	Decision Analysis	283

9.7	Summary	286
9.8	Looking Ahead	288
9.9	Review Questions	288
9.10	Exercises	288
10	Case Studies on the Application of the Decision-making Criteria	291
10.1	Introduction	291
10.2	Santa Clara HEPS	291
10.2.1	Introduction	291
10.2.2	Decision Frame	293
10.2.3	Evaluation	293
10.2.4	Decide	299
10.3	Mobile Crusher	299
10.3.1	Introduction	299
10.3.2	Evaluation	300
10.3.3	Recommendation	302
10.4	Mobile Crusher Contractor	302
10.4.1	Introduction	302
10.4.2	Evaluation	302
10.5	Filtration Joint Venture	305
10.5.1	Introduction	305
10.5.2	Project Financials	306
10.5.3	Assessment	310
10.5.4	Sensitivity Analysis	311
10.5.5	Commercial Arrangement Between Alex and WasteTek	313
10.5.6	Financing of the Project	314
10.5.7	Recommendation	317
10.6	Bakersfield Water Pumps	318
10.6.1	Introduction	318
10.6.2	Project Financials	318
10.6.3	Sensitivity Analysis	321
10.6.4	Recommendation	323
10.7	Combine Harvester	323
10.7.1	Introduction	323
10.7.2	Project Financials	323
10.7.3	Evaluation	325
10.7.4	Sensitivity Analysis	325
10.7.5	Pricing	327
10.7.6	Recommendation	327
10.8	PetroGen Oil Field and Petroleum Refinery	327
10.8.1	Project Financials	328
10.8.2	Assessment	329
10.8.3	Financing of the Project	329
10.9	Looking Ahead	331

10.10 Review Questions and Exercises 331

 10.10.1 Santa Clara HEPS 331

 10.10.2 Mobile Crusher 332

 10.10.3 Mobile Crusher Contractor 332

 10.10.4 Filtration Operation 332

 10.10.5 Water Pumps 333

 10.10.6 Combine Harvester 333

 10.10.7 Petroleum Field and Refinery 334

Part III Risk Assessment

11 Risk and Return 337

 11.1 Introduction 337

 11.2 Returns 338

 11.3 Certainty and Uncertainty 343

 11.3.1 Business Risks 344

 11.3.2 Financing Risks 345

 11.3.3 Investment Risk 345

 11.4 Portfolio Risk 346

 11.5 Diversification 350

 11.6 The Attainable Region and the Efficient Frontier 351

 11.7 Capital Asset Pricing Model 355

 11.8 Portfolio Selection 357

 11.9 Critique of Finance Theory 360

 11.10 Summary 360

 11.11 Looking Ahead 361

 11.12 Review Questions 362

 11.13 Exercises 362

12 Cost of Capital 367

 12.1 Introduction 367

 12.2 Cost of Equity 368

 12.2.1 Calculating the Cost of Equity from the CAPM 368

 12.2.2 Calculating the Cost of Equity from the Growth Model . . 370

 12.2.3 Calculating the Cost of Equity
 from the Historical Returns 370

 12.3 Interest Rates and the Cost of Debt 371

 12.4 Pooling of Funds 373

 12.5 Weighted Average Cost of Capital 375

 12.6 Entity Versus Equity Basis 376

 12.7 Practices in the Calculation of WACC 379

 12.7.1 Cost of Equity Capital 379

 12.7.2 Risk-free Rate 379

 12.7.3 Market-risk Premium 380

 12.7.4 Beta 380

12.7.5	Weighting Factors in WACC	382
12.7.6	Tax Rate	382
12.7.7	Review Period	383
12.8	WACC, Leverage and Debt Financing	383
12.9	Opportunity Cost of Capital, MARR and the Hurdle Rate	386
12.10	Summary	387
12.11	Review Questions	389
12.12	Exercises	389
13	Risk in Engineering Projects	391
13.1	Introduction	391
13.2	Sources of Uncertainty	391
13.2.1	Company-level Risks	392
13.2.2	Project-level Risks	392
13.3	Probability Method	393
13.4	Risk-adjusted Discount Rate	398
13.4.1	Company-risk Premium	399
13.4.2	Project-risk Premium	399
13.5	Certainty Equivalent Method	403
13.5.1	Certainty Equivalent Coefficients	404
13.5.2	Certainty Equivalent Risk Premiums	406
13.6	Relationship Between the RADR and the CE Methods	407
13.7	Risk Adjustment Practices	408
13.8	Monte Carlo Simulation	408
13.8.1	Discrete and Continuous Distributions	409
13.8.2	Drawing a Random Sample	412
13.8.3	Monte Carlo Simulation of a Project with One Source of Uncertainty	413
13.8.4	Value at Risk (VaR)	415
13.8.5	Monte Carlo Simulation with Multiple Sources of Uncertainty	416
13.8.6	Review of Assumptions	421
13.9	Summary	421
13.10	Looking Ahead	422
13.11	Review Questions	422
13.12	Exercises	423
14	Decision Tree Analysis and Utility Theory	427
14.1	Introduction	427
14.2	Decision Tree Analysis	428
14.2.1	Decision, Event and Terminal Nodes	428
14.2.2	Basic Decision Trees	429
14.2.3	Events and Probabilities	430
14.2.4	Value of Terminal Nodes	432
14.2.5	Expected Value and Decision Trees	433

14.2.6	Net Present Value	435
14.2.7	Joint Probability	436
14.2.8	Short-cut Notation	437
14.3	Decision Analysis	437
14.4	Utility Theory and Risk	444
14.4.1	Utility	444
14.4.2	Utility Function	444
14.4.3	Lotteries and Certainty Equivalents	445
14.4.4	Expected Utility	445
14.4.5	Utility and Risk Premium	448
14.4.6	Exponential Utility Function	450
14.4.7	Using Utility to Account for Risk in NPV Calculations ..	451
14.5	Summary	453
14.6	Review Questions	454
14.7	Exercises	454
15	Real Options Analysis	457
15.1	Introduction	457
15.2	Financial Options	457
15.2.1	Options Contracts	457
15.2.2	Payoff from an Option	460
15.2.3	Price of an Option	461
15.2.4	Use of Options	462
15.3	Options on Non-financial Assets: Real Options	463
15.4	Examples of Real Options	465
15.4.1	Option to Invest (or Deferral Option)	465
15.4.2	Time-to-built Options	466
15.4.3	Growth Options	466
15.4.4	Abandonment Options	467
15.4.5	Switching Options	467
15.5	The Valuation of Financial Options	467
15.5.1	Risk-free Portfolio	467
15.5.2	Risk-neutral Probability	469
15.5.3	Binomial Lattice	470
15.5.4	Black–Scholes Option Pricing Formula	474
15.6	Valuation of Real Options	476
15.6.1	Option to Invest	476
15.6.2	Option to Abandon	478
15.6.3	Option to Temporarily Close Operations	480
15.6.4	Option to Expand or Contract	480
15.6.5	Option to Switch Between Alternatives	482
15.7	Decision-making Process	482
15.8	Real Options Analysis is Not Decision Tree Analysis	483
15.9	Strategic Thinking and Real Options	484

15.10	Case Study: Phased Expansion of Gas-to-Liquids Operation	485
15.10.1	Introduction	485
15.10.2	Staging the Investment Decision	486
15.10.3	Real Options Analysis	486
15.10.4	Concluding Comments	489
15.11	Case Study:	
	Value of the Joint Venture Contract for Cuprum	489
15.11.1	Introduction	489
15.11.2	Market for Copper Concentrates	490
15.11.3	Revenues	491
15.11.4	Capital and Operating Costs for Cuprum and Smelters	492
15.11.5	NPV of Copper Smelting and Cuprum's Process	493
15.11.6	The Value of the Technology	495
15.11.7	Concluding Comments	500
15.12	Summary	500
15.13	Looking Ahead	501
15.14	Review Questions	501
15.15	Exercises	502

Part IV Financing of Capital Projects

16	Sources of Finance	507
16.1	Introduction	507
16.2	Lenders, Borrowers and Financial Institutions	507
16.3	Financial Securities	509
16.3.1	Equity Instruments	509
16.3.2	Debt Instruments	511
16.3.3	Types of Loans	512
16.3.4	Long-term Debt	517
16.3.5	Short-term Debt	518
16.3.6	Public Issue and Private Placement of Financial Securities	519
16.4	Financial Markets	519
16.4.1	Equity Markets	521
16.4.2	Bond Markets	521
16.4.3	Futures and Derivatives Markets	522
16.5	Financing Decisions Within a Company	525
16.5.1	Capital Structure	525
16.5.2	Dividend Policy	525
16.6	Comparison of Equity and Debt Financing	527
16.7	Summary	527
16.8	Review Questions	528
16.9	Exercises	528

17 Financing Engineering Projects 531

17.1 Introduction 531

17.2 Financing Engineering Construction of Capital Projects 531

17.2.1 Project Delivery Systems 531

17.2.2 Risk in Engineering Contracting 533

17.2.3 Construction Loans 534

17.2.4 Financial Guarantees 534

17.2.5 Indiantown Cogeneration Facility 535

17.2.6 Eurotunnel 536

17.3 Project Finance 537

17.3.1 Overview of Project Finance 537

17.3.2 Project Structure 537

17.3.3 Risks and Risk Mitigation 538

17.3.4 Assessing Debt Capacity 539

17.3.5 Application of Project Finance 540

17.3.6 Project Finance for the Pembroke Cracking Company ... 541

17.3.7 Project Finance for the Ras Gas Project 541

17.4 Public-private Partnerships and the Funding of Public Infrastructure 542

17.4.1 Risk Sharing in Public-private Partnerships 543

17.4.2 Structuring of a Public-private Partnership 545

17.4.3 The A1-M1 Link Road 545

17.5 Case Study: Project Finance of a Cogeneration Facility 546

17.5.1 Introduction 546

17.5.2 Legal Structure 546

17.5.3 Contractual Arrangements for the Project 547

17.5.4 Project Financials 549

17.5.5 Assessment 552

17.5.6 Financing 552

17.5.7 Concluding Remarks 555

17.6 Summary 556

17.7 Review Questions 556

17.8 Exercises 556

A Equivalent US and UK Terms Used in the Financial Statements 559

B Answers to Selected Exercises 561

Glossary 595

Bibliography 601

Index 607