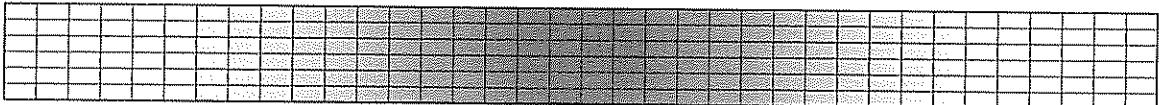


INVESTMENT SCIENCE



DAVID G. LUENBERGER

STANFORD UNIVERSITY

Bogazici University Library



39001101984451

14

New York Oxford
OXFORD UNIVERSITY PRESS
1998

CONTENTS

Preface *xiii*

1	INTRODUCTION	1
1.1	Cash Flows	2
1.2	Investments and Markets	3
1.3	Typical Investment Problems	6
1.4	Organization of the Book	8

Part I DETERMINISTIC CASH FLOW STREAMS

2	THE BASIC THEORY OF INTEREST	13
2.1	Principal and Interest	13
2.2	Present Value	18
2.3	Present and Future Values of Streams	19
2.4	Internal Rate of Return	22
2.5	Evaluation Criteria	24
2.6	Applications and Extensions*	28
2.7	Summary	34
	Exercises	35
	References	38
3	FIXED-INCOME SECURITIES	40
3.1	The Market for Future Cash	41
3.2	Value Formulas	44
3.3	Bond Details	49
3.4	Yield	52
3.5	Duration	57
3.6	Immunization	62
3.7	Convexity*	65
3.8	Summary	66

viii CONTENTS

Exercises	68
References	71
4 THE TERM STRUCTURE OF INTEREST RATES	72
4.1 The Yield Curve	72
4.2 The Term Structure	73
4.3 Forward Rates	77
4.4 Term Structure Explanations	80
4.5 Expectations Dynamics	83
4.6 Running Present Value	88
4.7 Floating Rate Bonds	90
4.8 Duration	91
4.9 Immunization	94
4.10 Summary	96
Exercises	97
References	101
5 APPLIED INTEREST RATE ANALYSIS	102
5.1 Capital Budgeting	103
5.2 Optimal Portfolios	108
5.3 Dynamic Cash Flow Processes	111
5.4 Optimal Management	114
5.5 The Harmony Theorem*	121
5.6 Valuation of a Firm*	124
5.7 Summary	128
Exercises	130
References	134

Part II SINGLE-PERIOD RANDOM CASH FLOWS

6 MEAN–VARIANCE PORTFOLIO THEORY	137
6.1 Asset Return	137
6.2 Random Variables	141
6.3 Random Returns	146
6.4 Portfolio Mean and Variance	150
6.5 The Feasible Set	155
6.6 The Markowitz Model	157
6.7 The Two-Fund Theorem*	162
6.8 Inclusion of a Risk-Free Asset	165
6.9 The One-Fund Theorem	166
6.10 Summary	169
Exercises	170
References	172
7 THE CAPITAL ASSET PRICING MODEL	173
7.1 Market Equilibrium	173
7.2 The Capital Market Line	175
7.3 The Pricing Model	177
7.4 The Security Market Line	181
7.5 Investment Implications	183

7.6	Performance Evaluation	184
7.7	CAPM as a Pricing Formula	187
7.8	Project Choice*	190
7.9	Summary	192
	Exercises	193
	References	195
8	MODELS AND DATA	197
8.1	Introduction	197
8.2	Factor Models	198
8.3	The CAPM as a Factor Model	205
8.4	Arbitrage Pricing Theory*	207
8.5	Data and Statistics	212
8.6	Estimation of Other Parameters	217
8.7	Tilting Away from Equilibrium*	218
8.8	A Multiperiod Fallacy	221
8.9	Summary	222
	Exercises	224
	References	227
9	GENERAL PRINCIPLES	228
9.1	Introduction	228
9.2	Utility Functions	228
9.3	Risk Aversion	231
9.4	Specification of Utility Functions*	234
9.5	Utility Functions and the Mean–Variance Criterion*	237
9.6	Linear Pricing	240
9.7	Portfolio Choice	242
9.8	Log-Optimal Pricing*	245
9.9	Finite State Models	247
9.10	Risk-Neutral Pricing	251
9.11	Pricing Alternatives*	252
9.12	Summary	254
	Exercises	255
	References	258

Part III DERIVATIVE SECURITIES

10	FORWARDS, FUTURES, AND SWAPS	263
10.1	Introduction	263
10.2	Forward Contracts	264
10.3	Forward Prices	266
10.4	The Value of a Forward Contract	273
10.5	Swaps*	273
10.6	Basics of Futures Contracts	275
10.7	Futures Prices	278
10.8	Relation to Expected Spot Price*	281
10.9	The Perfect Hedge	282
10.10	The Minimum-Variance Hedge	283

x CONTENTS

10.11 Optimal Hedging*	285
10.12 Hedging Nonlinear Risk*	287
10.13 Summary	291
Exercises	291
References	295
11 MODELS OF ASSET DYNAMICS	296
11.1 Binomial Lattice Model	297
11.2 The Additive Model	299
11.3 The Multiplicative Model	300
11.4 Typical Parameter Values*	303
11.5 Lognormal Random Variables	304
11.6 Random Walks and Wiener Processes	305
11.7 A Stock Price Process	308
11.8 Ito's Lemma*	312
11.9 Binomial Lattice Revisited	313
11.10 Summary	315
Exercises	316
References	318
12 BASIC OPTIONS THEORY	319
12.1 Option Concepts	320
12.2 The Nature of Option Values	322
12.3 Option Combinations and Put-Call Parity	325
12.4 Early Exercise	327
12.5 Single-Period Binomial Options Theory	327
12.6 Multiperiod Options	330
12.7 More General Binomial Problems	333
12.8 Evaluating Real Investment Opportunities	337
12.9 General Risk-Neutral Pricing*	344
12.10 Summary	345
Exercises	346
References	350
13 ADDITIONAL OPTIONS TOPICS	351
13.1 Introduction	351
13.2 The Black-Scholes Equation	351
13.3 Call Option Formula	355
13.4 Risk-Neutral Valuation*	357
13.5 Delta	358
13.6 Replication, Synthetic Options, and Portfolio Insurance*	360
13.7 Computational Methods	362
13.8 Exotic Options	368
13.9 Storage Costs and Dividends*	371
13.10 Martingale Pricing*	373
13.11 Summary	375
Appendix: Alternative Black-Scholes Derivation*	376
Exercises	378
References	381

14 INTEREST RATE DERIVATIVES	382
14.1 Examples of Interest Rate Derivatives	382
14.2 The Need for a Theory	384
14.3 The Binomial Approach	385
14.4 Pricing Applications	389
14.5 Leveling and Adjustable-Rate Loans*	391
14.6 The Forward Equation	395
14.7 Matching the Term Structure	397
14.8 Immunization	400
14.9 Collateralized Mortgage Obligations*	402
14.10 Models of Interest Rate Dynamics*	406
14.11 Continuous-Time Solutions*	408
14.12 Summary	410
Exercises	411
References	413
 Part IV GENERAL CASH FLOW STREAMS	
15 OPTIMAL PORTFOLIO GROWTH	417
15.1 The Investment Wheel	417
15.2 The Log Utility Approach to Growth	419
15.3 Properties of the Log-Optimal Strategy*	425
15.4 Alternative Approaches*	425
15.5 Continuous-Time Growth	427
15.6 The Feasible Region	430
15.7 The Log-Optimal Pricing Formula*	435
15.8 Log-Optimal Pricing and the Black-Scholes Equation*	438
15.9 Summary	440
Exercises	441
References	443
16 GENERAL INVESTMENT EVALUATION	444
16.1 Multiperiod Securities	444
16.2 Risk-Neutral Pricing	447
16.3 Optimal Pricing	448
16.4 The Double Lattice	452
16.5 Pricing in a Double Lattice	454
16.6 Investments with Private Uncertainty	458
16.7 Buying Price Analysis	463
16.8 Continuous-Time Evaluation*	469
16.9 Summary	471
Exercises	472
References	474
Appendix A BASIC PROBABILITY THEORY	475
A.1 General Concepts	475
A.2 Normal Random Variables	476
A.3 Lognormal Random Variables	477

xii CONTENTS

Appendix B CALCULUS AND OPTIMIZATION	479
B.1 Functions	479
B.2 Differential Calculus	480
B.3 Optimization	481
Answers to Exercises	484
Index	489