

Table of Contents

Preface	V
Note on the Second Printing	VI
<hr/>	
Part I. Spot and Futures Markets	
<hr/>	
1. An Introduction to Financial Derivatives	3
1.1 Options	3
1.2 Futures Contracts and Options	6
1.3 Forward Contracts	7
1.4 Call and Put Spot Options	8
1.4.1 One-period Spot Market	10
1.4.2 Replicating Portfolios	11
1.4.3 Martingale Measure for a Spot Market	12
1.4.4 Absence of Arbitrage	14
1.4.5 Optimality of Replication	15
1.4.6 Put Option	18
1.5 Futures Call and Put Options	19
1.5.1 Futures Contracts and Futures Prices	20
1.5.2 One-period Futures Market	20
1.5.3 Martingale Measure for a Futures Market	22
1.5.4 Absence of Arbitrage	22
1.5.5 One-period Spot/Futures Market	24
1.6 Forward Contracts	25
1.6.1 Forward Price	25
1.7 Options of American Style	27
2. The Cox-Ross-Rubinstein Model	33
2.1 The CRR Model of a Stock Price	33
2.1.1 The CRR Option Pricing Formula	34
2.1.2 The Black-Scholes Option Pricing Formula	40
2.2 Probabilistic Approach	44
2.2.1 Martingale Measure	45
2.2.2 Risk-neutral Valuation Formula	47
2.3 Valuation of American Options	48

2.3.1	American Call Options	48
2.3.2	American Put Options	50
2.4	Options on a Dividend-paying Stock	53
2.5	Transaction Costs	55
2.5.1	Replication of Options	57
2.5.2	Perfect Hedging of Options	61
3.	Finite Security Markets	69
3.1	Finite Spot Markets	70
3.1.1	Arbitrage Opportunities	72
3.1.2	Arbitrage Price	72
3.1.3	Risk-neutral Valuation Formula	74
3.1.4	Price Systems	76
3.1.5	Completeness of a Finite Market	79
3.2	Finite Futures Markets	80
3.2.1	Self-financing Futures Strategies	81
3.2.2	Martingale Measures for a Futures Market	83
3.2.3	Risk-neutral Valuation Formula	84
3.3	Futures Prices Versus Forward Prices	85
4.	Market Imperfections	87
4.1	Perfect Hedging	88
4.1.1	Incomplete Markets	88
4.1.2	Constraints on Short-selling and Borrowing of Cash ...	96
4.1.3	Different Lending and Borrowing Rates	97
4.2	Mean-variance Hedging	99
4.2.1	Variance-minimizing Hedging	99
4.2.2	Risk-minimizing Hedging	102
5.	The Black-Scholes Model	109
5.1	Spot Market	110
5.1.1	Self-financing Strategies	112
5.1.2	Martingale Measure for the Spot Market	113
5.1.3	The Black-Scholes Option Valuation Formula	115
5.1.4	The Put-Call Parity for Spot Options	123
5.1.5	The Black-Scholes PDE	124
5.2	A Riskless Portfolio Method	127
5.3	Sensitivity Analysis	130
6.	Modifications of the Black-Scholes Model	135
6.1	Futures Market	135
6.1.1	Self-financing Strategies	136
6.1.2	Martingale Measure for the Futures Market	136
6.1.3	The Black Futures Option Formula	137
6.1.4	Options on Forward Contracts	141

6.2	Option on a Dividend-paying Stock	144
6.2.1	Case of a Constant Dividend Yield	144
6.2.2	Case of Known Dividends	146
6.3	Stock Price Volatility	150
6.3.1	Historical Volatility	151
6.3.2	Implied Volatility	151
6.3.3	Volatility Misspecification	153
6.3.4	Stochastic Volatility Models	154
6.3.5	Numerical Methods	157
7.	Foreign Market Derivatives	159
7.1	Cross-currency Market Model	159
7.1.1	Domestic Martingale Measure	160
7.1.2	Foreign Martingale Measure	162
7.1.3	Foreign Stock Price Dynamics	164
7.2	Currency Forward Contracts and Options	164
7.2.1	Forward Exchange Rate	165
7.2.2	Currency Option Valuation Formula	166
7.3	Foreign Equity Forward Contracts	169
7.3.1	Forward Price of a Foreign Stock	169
7.3.2	Quanto Forward Contracts	171
7.4	Foreign Market Futures Contracts	172
7.5	Foreign Equity Options	176
7.5.1	Options Struck in a Foreign Currency	176
7.5.2	Options Struck in Domestic Currency	178
7.5.3	Quanto Options	179
7.5.4	Equity-linked Foreign Exchange Options	181
8.	American Options	183
8.1	Valuation of American Claims	184
8.2	American Call and Put Options	192
8.3	Early Exercise Representation of an American Put	194
8.4	Analytical Approach	197
8.5	Approximations of the American Put Price	200
8.6	Option on a Dividend-paying Stock	203
9.	Exotic Options	205
9.1	Packages	206
9.2	Forward-start Options	207
9.3	Chooser Options	208
9.4	Compound Options	209
9.5	Digital Options	210
9.6	Barrier Options	211
9.7	Lookback Options	214
9.8	Asian Options	218

9.9	Basket Options	221
9.10	Quantile Options	225
9.11	Combined Options	228
9.12	Russian Option	228
10.	Continuous-time Security Markets	229
10.1	Standard Market Models	230
10.1.1	Standard Spot Market	230
10.1.2	Futures Market	239
10.1.3	Choice of a Numeraire	241
10.1.4	Existence of a Martingale Measure	245
10.1.5	Fundamental Theorem of Asset Pricing	246
10.2	Multidimensional Black-Scholes Model	248
10.2.1	Market Completeness	250
10.2.2	Variance-minimizing Hedging	252
10.2.3	Risk-minimizing Hedging	253
10.2.4	Market Imperfections	260
<hr/>		
Part II. Fixed-income Markets		
<hr/>		
11.	Interest Rates and Related Contracts	265
11.1	Zero-coupon Bonds	265
11.1.1	Term Structure of Interest Rates	266
11.1.2	Forward Interest Rates	267
11.1.3	Short-term Interest Rate	268
11.2	Coupon-bearing Bonds	268
11.2.1	Yield-to-Maturity	269
11.2.2	Market Conventions	271
11.3	Interest Rate Futures	272
11.3.1	Treasury Bond Futures	272
11.3.2	Bond Options	274
11.3.3	Treasury Bill Futures	274
11.3.4	Eurodollar Futures	276
11.4	Interest Rate Swaps	277
11.4.1	Forward Rate Agreements	278
12.	Models of the Short-term Rate	281
12.1	Arbitrage-free Family of Bond Prices	282
12.1.1	Expectations Hypotheses	283
12.2	Case of Itô Processes	284
12.3	Single-factor Models	288
12.3.1	Time-homogeneous Models	288
12.3.2	Time-inhomogeneous Models	292
12.3.3	Model Choice	296

12.3.4	American Bond Options	297
12.3.5	Options on Coupon-bearing Bonds	298
12.4	Multi-factor Models	299
12.4.1	Consol Yield Model	300
12.5	Defaultable Bonds	302
13.	Models of Instantaneous Forward Rates	303
13.1	Heath-Jarrow-Morton Methodology	304
13.1.1	Ho-Lee Model	304
13.1.2	Heath-Jarrow-Morton Model	305
13.1.3	Absence of Arbitrage	307
13.1.4	Short-term Interest Rate	312
13.2	Forward Measure Approach	313
13.2.1	Forward Price	314
13.2.2	Forward Martingale Measure	316
13.3	Gaussian HJM Model	319
13.3.1	Markovian Case	321
14.	Models of Bond Prices and LIBOR Rates	325
14.1	Bond Price Models	326
14.1.1	Family of Bond Prices	327
14.1.2	Spot and Forward Martingale Measures	329
14.1.3	Arbitrage-free Properties	330
14.1.4	Implied Savings Account	331
14.1.5	Bond Price Volatility	336
14.2	Forward Processes	340
14.3	Models of Forward LIBOR Rates	344
14.3.1	Discrete-tenor Case	345
14.3.2	Continuous-tenor Case	348
14.3.3	Spot LIBOR Measure	351
14.4	Model of Forward Swap Rates	353
15.	Option Valuation in Gaussian Models	357
15.1	European Spot Options	358
15.1.1	Bond Options	359
15.1.2	Stock Options	362
15.1.3	Option on a Coupon-bearing Bond	365
15.1.4	Pricing of General Contingent Claims	368
15.1.5	Replication of Options	370
15.2	Futures Prices	373
15.2.1	Futures Options	374
15.3	PDE Approach to Interest Rate Derivatives	378
15.3.1	PDEs for Spot Derivatives	379
15.3.2	PDEs for Futures Derivatives	383

16. Swap Derivatives	387
16.1 Interest Rate Swaps	387
16.2 Gaussian Model	390
16.2.1 Forward Caps and Floors	390
16.2.2 Captions	394
16.2.3 Swaptions	394
16.2.4 Options on a Swap Rate Spread	399
16.2.5 Yield Curve Swaps	400
16.2.6 Exotic Caps	401
16.3 Model of Forward LIBOR Rates	403
16.3.1 Caps	403
16.3.2 Swaptions	406
16.4 Model of Forward Swap Rates	410
16.5 Flesaker-Hughston Model	411
16.5.1 Absence of Arbitrage	411
16.5.2 Valuation of Caps and Swaptions	414
16.6 Empirical Studies	417
17. Cross-currency Derivatives	419
17.1 Arbitrage-free Cross-currency Markets	420
17.1.1 Forward Price of a Foreign Asset	422
17.1.2 Valuation of Foreign Contingent Claims	426
17.1.3 Cross-currency Rates	427
17.2 Gaussian HJM Model	427
17.2.1 Currency Options	428
17.2.2 Foreign Equity Options	429
17.2.3 Cross-currency Swaps	434
17.2.4 Cross-currency Swaptions	445
17.2.5 Basket Caps	448
17.3 Model of Forward LIBOR Rates	449

Part III. APPENDICES

A. Conditional Expectations	455
B. Itô Stochastic Calculus	459
B.1 The Itô Integral	459
B.2 Girsanov's Theorem	466
B.3 Laws of Certain Functionals of a Brownian Motion	468
References	471
Index	513