

Contents

Chapter 1 General Characteristics of Financial Derivative Models

1.1 Financial options and their trading strategies	2
1.1.1 Trading strategies involving options	5
1.2 Rational boundaries for option values	11
1.2.1 Effects of dividend payments	17
1.2.2 Put-call parity relations	19
1.2.3 Foreign currency options	20
1.3 Asset price dynamics and stochastic processes	22
1.3.1 Normal and lognormal distributions	22
1.3.2 Random walk model and Brownian motion	24
1.3.3 Geometric Brownian motion	28
1.3.4 Stochastic calculus and Ito's lemma	28
1.4 Black-Scholes formulation of option pricing	32
1.4.1 Riskless hedging principle	33
1.4.2 Risk neutrality argument	35
1.4.3 Self-financing dynamic trading strategy	39
Exercises	42

Chapter 2 Pricing Models for One-asset European Options

2.1 Black-Scholes pricing formulas and their properties	50
2.1.1 Black-Scholes formulas for European options	51
2.1.2 Transition density function	55
2.1.3 Comparative statics	56
2.1.4 Calculation of implied volatility	62
2.1.5 Pricing biases of the Black-Scholes model	64

2.2 Extended option pricing models	68
2.2.1 Options on dividend-paying assets	68
2.2.2 Effects of transaction costs	73
2.2.3 Compound options	77
2.2.4 Chooser options	81
2.3 Options on futures	82
2.3.1 Relation between forward and futures prices	83
2.3.2 Values and prices of forward contracts/futures	85
2.3.3 Governing equation and valuation formulas for futures options	88
Exercises	90

Chapter 3 Pricing models for Multi-asset European Options

3.1 Generalized multi-state Black-Scholes pricing models ...	97
3.2 Foreign currency option models	104
3.2.1 Takeover-contingent foreign exchange call options	104
3.2.2 Foreign currency options with stochastic bond rates	108
3.2.3 Cross-currency options	111
3.2.4 Exchange options	113
3.2.5 Equity options with exchange rate risk exposure	115
3.3 Options on the extremum of several risky assets	118
3.3.1 European call options on the extremum of two risky assets .	119
3.3.2 European put options on the extremum of two risky assets .	124
3.3.3 Generalization to European options on the extremum of several risky assets	125
Exercises	127

Chapter 4 American Options

4.1 Characterization of the optimal exercise boundaries	136
4.1.1 American options on an asset paying continuous dividend yield	137
4.1.2 High contact condition along the optimal exercise boundary	138
4.1.3 Properties of the optimal exercise boundary for American calls	140

4.1.4 Put-call symmetry relations 144

4.1.5 Properties of the optimal exercise boundary for American puts 146

4.1.6 American options on an asset paying discrete dividends 149

4.2 Analytic formulations of the American option pricing models 157

4.2.1 Non-homogeneous Black-Scholes equation 158

4.2.2 Formulation for American put options 159

4.2.3 Formulation for American call options 163

4.2.4 Linear complementarity formulation 164

4.2.5 Optimal stopping problem 165

4.3 Approximate valuation methods for American options .. 165

4.3.1 Method of interpolation between bounds 167

4.3.2 Compound option approximation method 169

4.3.3 Numerical solution of the integral equation 172

4.3.4 Quadratic approximation method 174

4.3.5 Analytic method of lines 177

Exercises 180

Chapter 5 Numerical Schemes for Pricing Options

187

5.1 Principles of binomial pricing models 189

5.1.1 Formulation of the replicating portfolio 189

5.1.2 Binomial option pricing formula 191

5.1.3 Multiplicative process 192

5.1.4 Various versions of the binomial model 195

5.1.5 Asymptotic limit of the binomial formula 199

5.1.6 Asymptotic limit to the Black-Scholes price formula 200

5.2 Extensions of the binomial pricing model 203

5.2.1 Trinomial schemes 203

5.2.2 Multi-state options 206

5.2.3 Discrete dividend models 208

5.2.4 American options 211

5.3 Finite difference algorithms 212

5.3.1 Explicit schemes 214

5.3.2 Implicit schemes 216

5.3.3 Truncation errors and order of convergence 219

5.3.4 Numerical stability	221
5.3.5 Projected successive-over-relaxation method	223
5.4 Monte Carlo simulation	224
5.4.1 Variance reduction techniques	226
5.4.2 Low discrepancy sequences	229
5.4.3 Valuation of American options	230
Exercises	235
<hr/>	
Chapter 6 Path Dependent Options	
<hr/>	
6.1 Barrier options	246
6.1.1 European down-and-out calls	247
6.1.2 Transition density function and first passage time	251
6.1.3 Method of images	252
6.1.4 American down-and-out calls	255
6.1.5 European options with an external barrier	257
6.1.6 Computational schemes	261
6.1.7 Discrete monitoring of the barriers	266
6.2 Lookback options	267
6.2.1 European floating strike lookback options	268
6.2.2 Differential equation formulation	273
6.2.3 European fixed strike lookback options	275
6.2.4 More exotic forms of European lookback options	276
6.2.5 Russian options	278
6.2.6 Binomial schemes	280
6.2.7 Discrete monitoring for extremum values	282
6.3 Asian options	282
6.3.1 Differential equation formulation	284
6.3.2 Average strike options with continuous arithmetic averaging	285
6.3.3 Average value options with continuous arithmetic averaging	286
6.3.4 Average value options with geometric averaging	288
6.3.5 Average value options with discrete arithmetic averaging	292
6.3.6 Numerical algorithms	297
Exercises	301

Chapter 7 Bonds and Interest Rate Derivatives

7.1 Bonds and interest rate models	314
7.1.1 Bond pricing with deterministic interest rates	315
7.1.2 Term structure of interest rates	315
7.1.3 One-factor bond pricing models	319
7.1.4 Vasicek mean reversion model	322
7.1.5 Cox-Ingersoll-Ross model	324
7.1.6 Generalized one-factor interest rate models	325
7.1.7 Multi-factor interest rate models	326
7.2 No arbitrage interest rate models	331
7.2.1 Alternative characterizations of a yield curve model	332
7.2.2 Short rate models that fitted to the initial term structure of interest rates	335
7.2.3 Heath-Jarrow-Morton model	338
7.3 Bond options and other interest rate derivatives	339
7.3.1 Extensions of the Black-Scholes framework	339
7.3.2 Bond option models based on the evolution of bond prices .	340
7.3.3 Bond option models based on one-factor short rate models .	342
7.3.4 Convertible bonds	345
7.3.5 Commodity-linked bonds	349
7.3.6 Swaps, swaptions and interest rate caps	351
Exercises	353
References	365
Author Index	375
Subject Index	379