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
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

Chapter 6 Path Dependent Options

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