

# Contents

<b>Preface</b> .....	VII
Motivation .....	VII
Aims, Readership and Book Structure .....	XII
Final Word and Acknowledgments .....	XIV
Description of Contents by Chapter .....	XIX
<b>Abbreviations and Notation</b> .....	XXXV

---

## Part I. BASIC DEFINITIONS AND NO ARBITRAGE

---

<b>1. Definitions and Notation</b> .....	1
1.1 The Bank Account and the Short Rate .....	2
1.2 Zero-Coupon Bonds and Spot Interest Rates .....	4
1.3 Fundamental Interest-Rate Curves .....	9
1.4 Forward Rates .....	11
1.5 Interest-Rate Swaps and Forward Swap Rates .....	13
1.6 Interest-Rate Caps/Floors and Swaptions .....	16
<b>2. No-Arbitrage Pricing and Numeraire Change</b> .....	23
2.1 No-Arbitrage in Continuous Time .....	24
2.2 The Change-of-Numeraire Technique .....	26
2.3 A Change of Numeraire Toolkit (Brigo & Mercurio 2001c) .....	28
2.3.1 A helpful notation: "DC" .....	35
2.4 The Choice of a Convenient Numeraire .....	37
2.5 The Forward Measure .....	38
2.6 The Fundamental Pricing Formulas .....	39
2.6.1 The Pricing of Caps and Floors .....	40
2.7 Pricing Claims with Deferred Payoffs .....	42
2.8 Pricing Claims with Multiple Payoffs .....	42
2.9 Foreign Markets and Numeraire Change .....	44

---

**Part II. FROM SHORT RATE MODELS TO HJM**

---

<b>3. One-factor short-rate models</b> .....	51
3.1 Introduction and Guided Tour .....	51
3.2 Classical Time-Homogeneous Short-Rate Models .....	57
3.2.1 The Vasicek Model .....	58
3.2.2 The Dothan Model .....	62
3.2.3 The Cox, Ingersoll and Ross (CIR) Model .....	64
3.2.4 Affine Term-Structure Models .....	68
3.2.5 The Exponential-Vasicek (EV) Model .....	70
3.3 The Hull-White Extended Vasicek Model .....	71
3.3.1 The Short-Rate Dynamics .....	72
3.3.2 Bond and Option Pricing .....	75
3.3.3 The Construction of a Trinomial Tree .....	78
3.4 Possible Extensions of the CIR Model .....	80
3.5 The Black-Karasinski Model .....	82
3.5.1 The Short-Rate Dynamics .....	83
3.5.2 The Construction of a Trinomial Tree .....	85
3.6 Volatility Structures in One-Factor Short-Rate Models .....	86
3.7 Humped-Volatility Short-Rate Models .....	92
3.8 A General Deterministic-Shift Extension .....	95
3.8.1 The Basic Assumptions .....	96
3.8.2 Fitting the Initial Term Structure of Interest Rates ...	97
3.8.3 Explicit Formulas for European Options .....	99
3.8.4 The Vasicek Case .....	100
3.9 The CIR++ Model .....	102
3.9.1 The Construction of a Trinomial Tree .....	105
3.9.2 Early Exercise Pricing via Dynamic Programming ....	106
3.9.3 The Positivity of Rates and Fitting Quality .....	106
3.9.4 Monte Carlo Simulation .....	109
3.9.5 Jump Diffusion CIR and CIR++ models (JCIR, JCIR++)	109
3.10 Deterministic-Shift Extension of Lognormal Models .....	110
3.11 Some Further Remarks on Derivatives Pricing .....	112
3.11.1 Pricing European Options on a Coupon-Bearing Bond	112
3.11.2 The Monte Carlo Simulation .....	114
3.11.3 Pricing Early-Exercise Derivatives with a Tree .....	116
3.11.4 A Fundamental Case of Early Exercise: Bermudan- Style Swaptions. ....	121
3.12 Implied Cap Volatility Curves .....	124
3.12.1 The Black and Karasinski Model .....	125
3.12.2 The CIR++ Model .....	126
3.12.3 The Extended Exponential-Vasicek Model .....	128
3.13 Implied Swaption Volatility Surfaces .....	129
3.13.1 The Black and Karasinski Model .....	130

3.13.2	The Extended Exponential-Vasicek Model .....	131
3.14	An Example of Calibration to Real-Market Data .....	132
<b>4.</b>	<b>Two-Factor Short-Rate Models .....</b>	<b>137</b>
4.1	Introduction and Motivation .....	137
4.2	The Two-Additive-Factor Gaussian Model G2++ .....	142
4.2.1	The Short-Rate Dynamics .....	143
4.2.2	The Pricing of a Zero-Coupon Bond .....	144
4.2.3	Volatility and Correlation Structures in Two-Factor Models .....	148
4.2.4	The Pricing of a European Option on a Zero-Coupon Bond .....	153
4.2.5	The Analogy with the Hull-White Two-Factor Model ..	159
4.2.6	The Construction of an Approximating Binomial Tree ..	162
4.2.7	Examples of Calibration to Real-Market Data .....	166
4.3	The Two-Additive-Factor Extended CIR/LS Model CIR2++ ..	175
4.3.1	The Basic Two-Factor CIR2 Model .....	176
4.3.2	Relationship with the Longstaff and Schwartz Model (LS) .....	177
4.3.3	Forward-Measure Dynamics and Option Pricing for CIR2 .....	178
4.3.4	The CIR2++ Model and Option Pricing .....	179
<b>5.</b>	<b>The Heath-Jarrow-Morton (HJM) Framework .....</b>	<b>183</b>
5.1	The HJM Forward-Rate Dynamics .....	185
5.2	Markovianity of the Short-Rate Process .....	186
5.3	The Ritchken and Sankarasubramanian Framework .....	187
5.4	The Mercurio and Moraleda Model .....	191

---

## Part III. MARKET MODELS

---

<b>6.</b>	<b>The LIBOR and Swap Market Models (LFM and LSM) ..</b>	<b>195</b>
6.1	Introduction .....	195
6.2	Market Models: a Guided Tour .....	196
6.3	The Lognormal Forward-LIBOR Model (LFM) .....	207
6.3.1	Some Specifications of the Instantaneous Volatility of Forward Rates .....	210
6.3.2	Forward-Rate Dynamics under Different Numeraires ..	213
6.4	Calibration of the LFM to Caps and Floors Prices .....	220
6.4.1	Piecewise-Constant Instantaneous-Volatility Structures ..	223
6.4.2	Parametric Volatility Structures .....	224
6.4.3	Cap Quotes in the Market .....	225
6.5	The Term Structure of Volatility .....	226
6.5.1	Piecewise-Constant Instantaneous Volatility Structures ..	228

6.5.2	Parametric Volatility Structures .....	231
6.6	Instantaneous Correlation and Terminal Correlation .....	234
6.7	Swaptions and the Lognormal Forward-Swap Model (LSM) ..	237
6.7.1	Swaptions Hedging .....	241
6.7.2	Cash-Settled Swaptions .....	243
6.8	Incompatibility between the LFM and the LSM .....	244
6.9	The Structure of Instantaneous Correlations .....	246
6.9.1	Some convenient full rank parameterizations .....	248
6.9.2	Reduced-rank formulations: Rebonato's angles and eigen- values zeroing .....	250
6.9.3	Reducing the angles .....	259
6.10	Monte Carlo Pricing of Swaptions with the LFM .....	264
6.11	Monte Carlo Standard Error .....	266
6.12	Monte Carlo Variance Reduction: Control Variate Estimator .	269
6.13	Rank-One Analytical Swaption Prices .....	271
6.14	Rank- $r$ Analytical Swaption Prices .....	277
6.15	A Simpler LFM Formula for Swaptions Volatilities .....	281
6.16	A Formula for Terminal Correlations of Forward Rates .....	284
6.17	Calibration to Swaptions Prices .....	287
6.18	Instantaneous Correlations: Inputs (Historical Estimation) or Outputs (Fitting Parameters)? .....	290
6.19	The exogenous correlation matrix .....	291
6.19.1	Historical Estimation .....	292
6.19.2	Pivot matrices .....	295
6.20	Connecting Caplet and $S \times 1$ -Swaption Volatilities .....	300
6.21	Forward and Spot Rates over Non-Standard Periods .....	307
6.21.1	Drift Interpolation .....	308
6.21.2	The Bridging Technique .....	310
<b>7.</b>	<b>Cases of Calibration of the LIBOR Market Model .....</b>	<b>313</b>
7.1	Inputs for the First Cases .....	315
7.2	Joint Calibration with Piecewise-Constant Volatilities as in TABLE 5 .....	315
7.3	Joint Calibration with Parameterized Volatilities as in For- mulation 7 .....	319
7.4	Exact Swaptions "Cascade" Calibration with Volatilities as in TABLE 1 .....	322
7.4.1	Some Numerical Results .....	330
7.5	A Pause for Thought .....	337
7.5.1	First summary .....	337
7.5.2	An automatic fast analytical calibration of LFM to swaptions. Motivations and plan .....	338
7.6	Further Numerical Studies on the Cascade Calibration Algo- rithm .....	340

7.6.1	Cascade Calibration under Various Correlations and Ranks .....	342
7.6.2	Cascade Calibration Diagnostics: Terminal Correlation and Evolution of Volatilities .....	346
7.6.3	The interpolation for the swaption matrix and its impact on the CCA .....	349
7.7	Empirically efficient Cascade Calibration .....	351
7.7.1	CCA with Endogenous Interpolation and Based Only on Pure Market Data .....	352
7.7.2	Financial Diagnostics of the RCCAEI test results .....	359
7.7.3	Endogenous Cascade Interpolation for missing swaptions volatilities quotes .....	364
7.7.4	A first partial check on the calibrated $\sigma$ parameters stability .....	364
7.8	Reliability: Monte Carlo tests .....	366
7.9	Cascade Calibration and the cap market .....	369
7.10	Cascade Calibration: Conclusions .....	372
<b>8.</b>	<b>Monte Carlo Tests for LFM Analytical Approximations</b> .....	<b>377</b>
8.1	First Part. Tests Based on the Kullback Leibler Information (KLI) .....	378
8.1.1	Distance between distributions: The Kullback Leibler information .....	378
8.1.2	Distance of the LFM swap rate from the lognormal family of distributions .....	381
8.1.3	Monte Carlo tests for measuring KLI .....	384
8.1.4	Conclusions on the KLI-based approach .....	391
8.2	Second Part: Classical Tests .....	392
8.3	The "Testing Plan" for Volatilities .....	392
8.4	Test Results for Volatilities .....	396
8.4.1	Case (1): Constant Instantaneous Volatilities .....	396
8.4.2	Case (2): Volatilities as Functions of Time to Maturity .....	401
8.4.3	Case (3): Humped and Maturity-Adjusted Instantaneous Volatilities Depending only on Time to Maturity .....	410
8.5	The "Testing Plan" for Terminal Correlations .....	421
8.6	Test Results for Terminal Correlations .....	427
8.6.1	Case (i): Humped and Maturity-Adjusted Instantaneous Volatilities Depending only on Time to Maturity, Typical Rank-Two Correlations .....	427
8.6.2	Case (ii): Constant Instantaneous Volatilities, Typical Rank-Two Correlations .....	430
8.6.3	Case (iii): Humped and Maturity-Adjusted Instantaneous Volatilities Depending only on Time to Maturity, Some Negative Rank-Two Correlations .....	432

8.6.4	Case (iv): Constant Instantaneous Volatilities, Some Negative Rank-Two Correlations.....	438
8.6.5	Case (v): Constant Instantaneous Volatilities, Perfect Correlations, Upwardly Shifted $\Phi$ 's .....	439
8.7	Test Results: Stylized Conclusions .....	442

---

**Part IV. THE VOLATILITY SMILE**

---

<b>9.</b>	<b>Including the Smile in the LFM .....</b>	<b>447</b>
9.1	A Mini-tour on the Smile Problem .....	447
9.2	Modeling the Smile .....	450
<b>10.</b>	<b>Local-Volatility Models .....</b>	<b>453</b>
10.1	The Shifted-Lognormal Model.....	454
10.2	The Constant Elasticity of Variance Model .....	456
10.3	A Class of Analytically-Tractable Models .....	459
10.4	A Lognormal-Mixture (LM) Model .....	463
10.5	Forward Rates Dynamics under Different Measures .....	467
10.5.1	Decorrelation Between Underlying and Volatility .....	469
10.6	Shifting the LM Dynamics .....	469
10.7	A Lognormal-Mixture with Different Means (LMDM) .....	471
10.8	The Case of Hyperbolic-Sine Processes .....	473
10.9	Testing the Above Mixture-Models on Market Data .....	475
10.10	A Second General Class .....	478
10.11	A Particular Case: a Mixture of GBM's .....	483
10.12	An Extension of the GBM Mixture Model Allowing for Implied Volatility Skews .....	486
10.13	A General Dynamics à la Dupire (1994) .....	489
<b>11.</b>	<b>Stochastic-Volatility Models .....</b>	<b>495</b>
11.1	The Andersen and Brotherton-Ratcliffe (2001) Model .....	497
11.2	The Wu and Zhang (2002) Model.....	501
11.3	The Piterbarg (2003) Model .....	504
11.4	The Hagan, Kumar, Lesniewski and Woodward (2002) Model .....	508
11.5	The Joshi and Rebonato (2003) Model .....	513
<b>12.</b>	<b>Uncertain-Parameter Models .....</b>	<b>517</b>
12.1	The Shifted-Lognormal Model with Uncertain Parameters (SLMUP) .....	519
12.1.1	Relationship with the Lognormal-Mixture LVM .....	520
12.2	Calibration to Caplets .....	520
12.3	Swaption Pricing .....	522
12.4	Monte-Carlo Swaption Pricing .....	524
12.5	Calibration to Swaptions .....	526

12.6	Calibration to Market Data .....	528
12.7	Testing the Approximation for Swaptions Prices .....	530
12.8	Further Model Implications .....	535
12.9	Joint Calibration to Caps and Swaptions .....	539

---

## Part V. EXAMPLES OF MARKET PAYOFFS

---

<b>13.</b>	<b>Pricing Derivatives on a Single Interest-Rate Curve .....</b>	<b>547</b>
13.1	In-Arrears Swaps .....	548
13.2	In-Arrears Caps .....	550
13.2.1	A First Analytical Formula (LFM) .....	550
13.2.2	A Second Analytical Formula (G2++) .....	551
13.3	Autocaps .....	551
13.4	Caps with Deferred Caplets .....	552
13.4.1	A First Analytical Formula (LFM) .....	553
13.4.2	A Second Analytical Formula (G2++) .....	553
13.5	Ratchet Caps and Floors .....	554
13.5.1	Analytical Approximation for Ratchet Caps with the LFM .....	555
13.6	Ratchets (One-Way Floaters) .....	556
13.7	Constant-Maturity Swaps (CMS) .....	557
13.7.1	CMS with the LFM .....	557
13.7.2	CMS with the G2++ Model .....	559
13.8	The Convexity Adjustment and Applications to CMS .....	559
13.8.1	Natural and Unnatural Time Lags .....	559
13.8.2	The Convexity-Adjustment Technique .....	561
13.8.3	Deducing a Simple Lognormal Dynamics from the Adjustment .....	565
13.8.4	Application to CMS .....	565
13.8.5	Forward Rate Resetting Unnaturally and Average-Rate Swaps .....	566
13.9	Average Rate Caps .....	568
13.10	Captions and Floortions .....	570
13.11	Zero-Coupon Swaptions .....	571
13.12	Eurodollar Futures .....	575
13.12.1	The Shifted Two-Factor Vasicek G2++ Model .....	576
13.12.2	Eurodollar Futures with the LFM .....	577
13.13	LFM Pricing with "In-Between" Spot Rates .....	578
13.13.1	Accrual Swaps .....	579
13.13.2	Trigger Swaps .....	582
13.14	LFM Pricing with Early Exercise and Possible Path Dependence .....	584
13.15	LFM: Pricing Bermudan Swaptions .....	588
13.15.1	Least Squared Monte Carlo Approach .....	589
13.15.2	Carr and Yang's Approach .....	591

13.15.3	Andersen's Approach .....	592
13.15.4	Numerical Example .....	595
13.16	New Generation of Contracts .....	601
13.16.1	Target Redemption Notes .....	602
13.16.2	CMS Spread Options .....	603
<b>14.</b>	<b>Pricing Derivatives on Two Interest-Rate Curves .....</b>	<b>607</b>
14.1	The Attractive Features of G2++ for Multi-Curve Payoffs ...	608
14.1.1	The Model .....	608
14.1.2	Interaction Between Models of the Two Curves "1" and "2" .....	610
14.1.3	The Two-Models Dynamics under a Unique Conve- nient Forward Measure .....	611
14.2	Quanto Constant-Maturity Swaps .....	613
14.2.1	Quanto CMS: The Contract .....	613
14.2.2	Quanto CMS: The G2++ Model .....	615
14.2.3	Quanto CMS: Quanto Adjustment .....	621
14.3	Differential Swaps .....	623
14.3.1	The Contract .....	623
14.3.2	Differential Swaps with the G2++ Model .....	624
14.3.3	A Market-Like Formula .....	626
14.4	Market Formulas for Basic Quanto Derivatives .....	626
14.4.1	The Pricing of Quanto Caplets/Floorlets .....	627
14.4.2	The Pricing of Quanto Caps/Floors .....	628
14.4.3	The Pricing of Differential Swaps .....	629
14.4.4	The Pricing of Quanto Swaptions .....	630
14.5	Pricing of Options on two Currency LIBOR Rates .....	633
14.5.1	Spread Options .....	635
14.5.2	Options on the Product .....	637
14.5.3	Trigger Swaps .....	638
14.5.4	Dealing with Multiple Dates .....	639

---

## Part VI. INFLATION

---

<b>15.</b>	<b>Pricing of Inflation-Indexed Derivatives .....</b>	<b>643</b>
15.1	The Foreign-Currency Analogy .....	644
15.2	Definitions and Notation .....	645
15.3	The JY Model .....	646
<b>16.</b>	<b>Inflation-Indexed Swaps .....</b>	<b>649</b>
16.1	Pricing of a ZCIIS .....	649
16.2	Pricing of a YYIIS .....	651
16.3	Pricing of a YYIIS with the JY Model .....	652
16.4	Pricing of a YYIIS with a First Market Model .....	654



16.5 Pricing of a YYIIS with a Second Market Model ..... 657

**17. Inflation-Indexed Caplets/Floorlets** ..... 661

    17.1 Pricing with the JY Model ..... 661

    17.2 Pricing with the Second Market Model ..... 663

    17.3 Inflation-Indexed Caps ..... 665

**18. Calibration to market data** ..... 669

**19. Introducing Stochastic Volatility** ..... 673

    19.1 Modeling Forward CPI's with Stochastic Volatility ..... 674

    19.2 Pricing Formulae ..... 676

        19.2.1 Exact Solution for the Uncorrelated Case ..... 677

        19.2.2 Approximated Dynamics for Non-zero Correlations ... 680

    19.3 Example of Calibration ..... 681

**20. Pricing Hybrids with an Inflation Component** ..... 689

    20.1 A Simple Hybrid Payoff ..... 689

**Part VII. CREDIT**

**21. Introduction and Pricing under Counterparty Risk** ..... 695

    21.1 Introduction and Guided Tour ..... 696

        21.1.1 Reduced form (Intensity) models ..... 697

        21.1.2 CDS Options Market Models ..... 699

        21.1.3 Firm Value (or Structural) Models ..... 702

        21.1.4 Further Models ..... 704

        21.1.5 The Multi-name picture: FtD, CDO and Copula Func-  
                tions ..... 705

        21.1.6 First to Default (FtD) Basket. .... 705

        21.1.7 Collateralized Debt Obligation (CDO) Tranches. .... 707

        21.1.8 Where can we introduce dependence? ..... 708

        21.1.9 Copula Functions. .... 710

        21.1.10 Dynamic Loss models. .... 718

        21.1.11 What data are available in the market? ..... 719

    21.2 Defaultable (corporate) zero coupon bonds ..... 723

        21.2.1 Defaultable (corporate) coupon bonds ..... 724

    21.3 Credit Default Swaps and Defaultable Floaters ..... 724

        21.3.1 CDS payoffs: Different Formulations ..... 725

        21.3.2 CDS pricing formulas ..... 727

        21.3.3 Changing filtration:  $\mathcal{F}_t$  without default VS complete  
                 $\mathcal{G}_t$  ..... 728

        21.3.4 CDS forward rates: The first definition ..... 730

21.3.5	Market quotes, model independent implied survival probabilities and implied hazard functions . . . . .	731
21.3.6	A simpler formula for calibrating intensity to a single CDS . . . . .	735
21.3.7	Different Definitions of CDS Forward Rates and Analogies with the LIBOR and SWAP rates . . . . .	737
21.3.8	Defaultable Floater and CDS . . . . .	739
21.4	CDS Options and Callable Defaultable Floaters . . . . .	743
21.5	Constant Maturity CDS . . . . .	744
21.5.1	Some interesting Financial features of CMCDS . . . . .	745
21.6	Interest-Rate Payoffs with Counterparty Risk . . . . .	747
21.6.1	General Valuation of Counterparty Risk . . . . .	748
21.6.2	Counterparty Risk in single Interest Rate Swaps (IRS) . . . . .	750
<b>22.</b>	<b>Intensity Models . . . . .</b>	<b>757</b>
22.1	Introduction and Chapter Description . . . . .	757
22.2	Poisson processes . . . . .	759
22.2.1	Time homogeneous Poisson processes . . . . .	760
22.2.2	Time inhomogeneous Poisson Processes . . . . .	761
22.2.3	Cox Processes . . . . .	763
22.3	CDS Calibration and Implied Hazard Rates/ Intensities . . . . .	764
22.4	Inducing dependence between Interest-rates and the default event . . . . .	776
22.5	The Filtration Switching Formula: Pricing under partial information . . . . .	777
22.6	Default Simulation in reduced form models . . . . .	778
22.6.1	Standard error . . . . .	781
22.6.2	Variance Reduction with Control Variate . . . . .	783
22.7	Stochastic Intensity: The SSRD model . . . . .	785
22.7.1	A two-factor shifted square-root diffusion model for intensity and interest rates (Brigo and Alfonsi (2003)) . . . . .	786
22.7.2	Calibrating the joint stochastic model to CDS: Separability . . . . .	789
22.7.3	Discretization schemes for simulating $(\lambda, r)$ . . . . .	797
22.7.4	Study of the convergence of the discretization schemes for simulating CIR processes (Alfonsi (2005)) . . . . .	801
22.7.5	Gaussian dependence mapping: A tractable approximated SSRD . . . . .	812
22.7.6	Numerical Tests: Gaussian Mapping and Correlation Impact . . . . .	815
22.7.7	The impact of correlation on a few “test payoffs” . . . . .	817
22.7.8	A pricing example: A Cancellable Structure . . . . .	818
22.7.9	CDS Options and Jamshidian’s Decomposition . . . . .	820
22.7.10	Bermudan CDS Options . . . . .	830

22.8	Stochastic diffusion intensity is not enough: Adding jumps.	
	The JCIR(++) Model .....	830
22.8.1	The jump-diffusion CIR model (JCIR) .....	831
22.8.2	Bond (or Survival Probability) Formula.....	832
22.8.3	Exact calibration of CDS: The JCIR++ model .....	833
22.8.4	Simulation.....	833
22.8.5	Jamshidian's Decomposition. ....	834
22.8.6	Attaining high levels of CDS implied volatility .....	836
22.8.7	JCIR(++) models as a multi-name possibility.....	837
22.9	Conclusions and further research .....	838
<b>23.</b>	<b>CDS Options Market Models .....</b>	<b>841</b>
23.1	CDS Options and Callable Defaultable Floaters .....	844
23.1.1	Once-callable defaultable floaters .....	846
23.2	A market formula for CDS options and callable defaultable floaters.....	847
23.2.1	Market formulas for CDS Options .....	847
23.2.2	Market Formula for callable DFRN .....	849
23.2.3	Examples of Implied Volatilities from the Market .....	852
23.3	Towards a Completely Specified Market Model .....	854
23.3.1	First Choice. One-period and two-period rates .....	855
23.3.2	Second Choice: Co-terminal and one-period CDS rates market model .....	860
23.3.3	Third choice. Approximation: One-period CDS rates dynamics .....	861
23.4	Hints at Smile Modeling.....	863
23.5	Constant Maturity Credit Default Swaps (CMCDS) with the market model .....	864
23.5.1	CDS and Constant Maturity CDS .....	864
23.5.2	Proof of the main result .....	867
23.5.3	A few numerical examples .....	869

---

## Part VIII. APPENDICES

---

<b>A.</b>	<b>Other Interest-Rate Models .....</b>	<b>877</b>
A.1	Brennan and Schwartz's Model .....	877
A.2	Balduzzi, Das, Foresi and Sundaram's Model.....	878
A.3	Flesaker and Hughston's Model .....	879
A.4	Rogers's Potential Approach .....	881
A.5	Markov Functional Models.....	881

<b>B. Pricing Equity Derivatives under Stochastic Rates</b> .....	883
B.1 The Short Rate and Asset-Price Dynamics .....	883
B.1.1 The Dynamics under the Forward Measure .....	886
B.2 The Pricing of a European Option on the Given Asset .....	888
B.3 A More General Model .....	889
B.3.1 The Construction of an Approximating Tree for $r$ ....	890
B.3.2 The Approximating Tree for $S$ .....	892
B.3.3 The Two-Dimensional Tree .....	893
<b>C. A Crash Intro to Stochastic Differential Equations and Poisson Processes</b> .....	897
C.1 From Deterministic to Stochastic Differential Equations ....	897
C.2 Ito's Formula .....	904
C.3 Discretizing SDEs for Monte Carlo: Euler and Milstein Schemes	906
C.4 Examples .....	908
C.5 Two Important Theorems .....	910
C.6 A Crash Intro to Poisson Processes .....	913
C.6.1 Time inhomogeneous Poisson Processes .....	915
C.6.2 Doubly Stochastic Poisson Processes (or Cox Processes)	916
C.6.3 Compound Poisson processes .....	917
C.6.4 Jump-diffusion Processes .....	918
<b>D. A Useful Calculation</b> .....	919
<b>E. A Second Useful Calculation</b> .....	921
<b>F. Approximating Diffusions with Trees</b> .....	925
<b>G. Trivia and Frequently Asked Questions</b> .....	931
<b>H. Talking to the Traders</b> .....	935
<b>References</b> .....	951
<b>Index</b> .....	967