
Contents

Introduction	1
I Foundations	15
1 The Classic Capital Asset Pricing Model	17
1.1 Introduction	17
1.2 Portfolio Selection	19
1.2.1 Wealth Constraints	19
1.2.2 Portfolio Choice: The “Capital Market Line”	20
1.2.3 Without the Safe Asset: The “Efficient Portfolio Frontier”	20
1.2.4 Risk-Return Trade-Offs in the Two-Asset Case	21
1.2.5 Risk Parity and the Global Minimum Variance Portfolio	23
1.2.6 The Market Portfolio	24
1.3 The Capital Asset Pricing Model	27
1.3.1 Restrictions on Securities Expected Returns	27
1.3.2 The Low-Beta Anomaly	29
1.3.3 Zero-Beta CAPM	30
1.3.4 An Excursion into Risk Premiums and Certainty Equivalents	31
1.3.5 Back to CAPM: Equilibrium with Expected Utility	35
1.3.6 The Black-Litterman Model	38
1.3.7 Knightian Uncertainty and Global Minimum Variance Portfolio	40
1.4 The Arbitrage Pricing Theory	42
1.4.1 Exact APT	42
1.4.2 Risk Neutral Tilts or the Fundamental Theorem of Asset Pricing	44
1.4.3 Uncertainty and Asset Evaluation	47
1.4.4 The APT with Idiosyncratic Risk and a Large Number of Assets	47
1.5 Empirical Evidence	48
1.5.1 Fama-MacBeth Two-Step Regressions	49
1.5.2 Macroeconomic Forces	49
1.5.3 The Fama and French Model	49
1.5.4 “Smart Beta,” or Factor Investing	52
1.5.5 “Lucky Factors”	53

1.A	Portfolio Choice	54
1.B	Market Portfolio and the Security Market Line	58
1.C	Risk and Risk Aversion	60
1.D	Money Demand and Liquidity Traps	64
1.E	Parameter Uncertainty	66
	References	67
2	Arbitrage, Equilibrium, and Pricing	69
2.1	Introduction	69
2.2	The Static General Equilibrium in a Nutshell	71
2.2.1	Walras's Law	72
2.2.2	Competitive Equilibrium	72
2.2.3	Optimality	73
2.3	The Role of Financial Securities in Markets with Uncertainty	77
2.3.1	Commodity Markets	77
2.3.2	Financial Securities and Rational Expectations	77
2.3.3	Laws of Large Numbers, Risk Aversion, and the Slicing of Risks	79
2.3.4	Arrow-Debreu Securities	81
2.4	Arbitrage and Replication: Examples	84
2.4.1	Rain and Sunshine	84
2.4.2	Replication and Pricing: The Role of Complete Markets	86
2.5	No-Arbitrage: Theory	87
2.5.1	Lands of Cockaigne	87
2.5.2	Enforced Asset Prices	89
2.6	Equivalent Martingales and Equilibrium	90
2.6.1	Equilibrium with Financial Markets: Definition	90
2.6.2	Rational Expectations	91
2.6.3	Pricing Kernels	92
2.6.4	Equilibrium, Risk Sharing, and Incomplete Markets	94
2.7	Consumption CAPM	100
2.7.1	Risk Neutral Pricing and Macroeconomic Risks	101
2.7.2	CCAPM versus CAPM	102
2.A	Proof of Selected Results	102
	References	104
3	Infinite Horizon Economies	107
3.1	Introduction	107
3.2	Consumption-Based Asset Evaluation	108
3.2.1	Recursive Plans: Introduction	108
3.2.2	Asset Pricing: The Marginalist Argument	110
3.2.3	Elasticity of Intertemporal Substitution	110
3.2.4	Lucas's Model	111
3.3	Production: Foundational Issues	115
3.3.1	Decentralized Economy	115
3.3.2	The Social Planner Solution	117

3.3.3	Dynamics	118
3.3.4	Stochastic Economies	120
3.4	Production-Based Asset Pricing	124
3.4.1	Firms	125
3.4.2	Consumers	129
3.4.3	Equilibrium	130
3.5	Production, Money, and Asset Prices in Overlapping Generations Models	130
3.5.1	Introduction: Endowment Economies	131
3.5.2	Monetary Economies	134
3.5.3	Capital Accumulation and Bubbles	137
3.6	Dynamic Efficiency	140
3.6.1	Production Economies	140
3.6.2	Money	142
3.A	Finite Difference Equations and Determinacy	142
3.B	Neoclassical Growth in Continuous Time	146
3.C	Optimization of Continuous Time Systems	151
	References	154
4	Continuous Time Models	157
4.1	Introduction	157
4.2	An Introduction to No-Arbitrage and Equilibrium	159
4.2.1	Time	159
4.2.2	The Origins: Black–Scholes	159
4.2.3	Asset Prices As Feynman–Kac Representations	165
4.2.4	The Girsanov Theorem	167
4.2.5	The APT in Continuous Time	170
4.2.6	Example: No-Arbitrage in the Lucas Tree	173
4.3	Martingales and Arbitrage I: Viability	179
4.3.1	Trees	179
4.3.2	Martingale Restrictions	180
4.3.3	Market Completeness	181
4.4	Martingales and Arbitrage II: Optimization	183
4.4.1	Complete Markets and Single Budget Constraints	183
4.4.2	Optimization	184
4.4.3	Marginal Utility of Income	185
4.4.4	Example: Log Utility	186
4.4.5	Equilibrium	186
4.5	Martingales and Arbitrage III: Distorsions and Numéraires	187
4.5.1	Leading Example: Consumption-Based Probabilities	188
4.5.2	Numéraire Pricing	190
4.6	Equilibrium with State Variables and a Representative Agent	193
4.6.1	Constant Investment Opportunity Sets	194
4.6.2	Stochastic Opportunity Sets	194
4.6.3	Arrow-Debreu Densities and Restrictions on Expected Returns	199
4.6.4	Interest Rates	203

4.7	Portfolio Constraints	205
4.7.1	Admissible Portfolio Choices	206
4.7.2	Artificial Markets	207
4.8	Inaction: The Economics of American Options	209
4.8.1	Early Exercise Premiums: An Introductory Example	209
4.8.2	Risk Aversion	211
4.8.3	Real Options Theory	212
4.8.4	Perpetual Puts	213
4.8.5	Perpetual Calls	215
4.8.6	Further Topics on Real Options and Controlled Brownian Motions	217
4.9	Jumps	220
4.9.1	Poisson Jumps	220
4.9.2	A Rare Event Interpretation	221
4.9.3	Properties and Related Distributions	222
4.9.4	Cox Processes	223
4.9.5	Asset Prices As Jump-Diffusion Processes	223
4.9.6	An Option Pricing Formula	225
4.A	Introduction to Stochastic Calculus for Finance	226
4.B	Self-Financed Strategies	244
4.C	Proof of Selected Results	246
4.D	The Green's Function	250
4.E	Portfolio Constraints	252
4.F	Jumps	254
	References	257
5	Information, Security Design, and Financial Contracting	261
5.1	Introduction	261
5.2	Conceptual Challenges to Frictionless Markets: Information Problems	262
5.2.1	The Economics of Information	262
5.2.2	Information Problems in Financial Markets	263
5.3	Three Information Problems	265
5.3.1	Adverse Selection and Trading	265
5.3.2	Moral Hazard and Securitization	266
5.3.3	Signaling: Callable Bonds, Equity, and Short-Term Debt	273
5.3.4	Other Classical Problems: Short-Term Debt and Equity Sales	279
5.4	The Classics: Capital Structure and Modigliani-Miller Propositions	284
5.4.1	Irrelevance of Capital Structure	284
5.4.2	Dynamic Versions of Irrelevance	286
5.5	Debt and Moral Hazard	287
5.5.1	Symmetric Information Again: Full Insurance	287
5.5.2	Moral Hazard	288
5.6	Debt with Costly State Verification	291
5.6.1	Symmetric Information	291
5.6.2	Asymmetric Information	291
5.6.3	Investments and Agency Costs	293

5.7	Liquidity Management and Dynamic Security Design	294
5.7.1	Liquidity Constraints and Optimal Dividend Policy	294
5.7.2	A Model of Continuous Time Contracting	299
5.A	Proofs for Section 5.3	305
5.B	Debt and Moral Hazard	307
5.C	Dynamic Problems	308
	References	310
6	Taking Models to Data	313
6.1	Introduction	313
6.2	Data Generating Processes	314
6.2.1	Models: Specification and Identification	314
6.2.2	Restrictions on the DGP	314
6.2.3	Parameter Estimation	315
6.2.4	Basic Properties of Density Functions	316
6.2.5	The Cramer-Rao Lower Bound	316
6.3	Maximum Likelihood Estimation	317
6.3.1	Definition	317
6.3.2	Factorizations	317
6.3.3	Asymptotic Properties	317
6.4	M-Estimators	319
6.5	Pseudo- or Quasi-Maximum Likelihood	321
6.6	Generalized Method of Moments	321
6.6.1	Theory	322
6.6.2	Early Asset Pricing Tests	324
6.7	Simulation-Based Estimators	325
6.7.1	Three Simulation-Based Estimators	326
6.7.2	Asymptotic Normality	328
6.7.3	A Fourth Estimator: Simulated Maximum Likelihood	331
6.7.4	Progress	333
6.7.5	In Practice? Latent Factors and Identification	333
6.A	Primers	334
6.B	Maximum Likelihood	337
6.C	Maximum Likelihood Estimator for Dependent Processes	338
	References	340
II	Empirical Lessons and Market Inefficiencies	343
7	Neoclassical Kernels and Puzzles	345
7.1	Introduction	345
7.2	The Equity Premium Puzzle	346
7.2.1	A Single-Factor Model	346
7.2.2	Equity Premium and Interest Rate Puzzles	349
7.3	The Hansen-Jagannathan Cup	352

7.4	Multifactor Extensions: The Aggregate Equity Market	355
7.4.1	Exponential Affine Pricing Kernels	355
7.4.2	With Log-Normal Returns	357
7.5	Relations to the Classic Capital Asset Pricing Model	359
7.5.1	Market Portfolios and Pricing Kernel Bounds	359
7.5.2	A Semantic Digression on Market Portfolios	359
7.5.3	The Maximum Correlation Portfolio	360
7.5.4	Duality	362
7.6	The Conditional Capital Asset Pricing Model	363
7.A	Proof of Selected Results	365
	References	369
8	Aggregate Fluctuations in Equity Markets	371
8.1	Introduction	371
8.2	Empirical Evidence: A Bird's Eye View	372
8.2.1	Equity Markets and the Business Cycle	373
8.2.2	Predictability	377
8.2.3	Risk-Return Trade-offs	379
8.3	Volatility: A Business Cycle Perspective	380
8.3.1	Volatility Cycles	381
8.3.2	Understanding the Empirical Evidence	383
8.3.3	What to Do with Stock Market Volatility?	386
8.3.4	What Did We Learn?	392
8.4	Rational Market Fluctuations	392
8.4.1	The Dynamics of Asset Returns	392
8.4.2	Markov Pricing Kernels, Asset Returns, and Volatility	394
8.5	Time-Varying Risk Premiums	396
8.5.1	External Habit	397
8.5.2	Countercyclical Statistics	398
8.5.3	Some Additional Literature	402
8.5.4	The Term Structure of Interest Rates	402
8.6	Large Price Swings As a Learning-Induced Phenomenon	404
8.6.1	Information	404
8.6.2	An Introductory Model of Learning	405
8.6.3	Convexity Again and Two Models of Learning	409
8.7	Retained Earnings and Market-to-Book Ratios	413
8.7.1	Plowbacks and Growth Opportunities	416
8.7.2	Random Dividends Distribution	414
8.A	Estimation, Calibration, and Simulation Methods	416
8.B	A Multifactor Security Model	420
8.C	Arrow-Debreu Partial Differential Equations	420
8.D	Volatility, Options, and Convexity	421
8.E	Linearity-Generating Processes	431
8.F	Habit	433

8.G	Learning	435
8.H	Market-to-Book Ratios	437
	References	437
9	Macrofinance	441
9.1	Introduction	441
9.2	Nonexpected Utility	444
9.2.1	Recursive Formulations	444
9.2.2	Preferences for Early Resolution of Uncertainty and Long-Run Risks	446
9.2.3	Testable Restrictions	448
9.2.4	Risk Premiums and Interest Rates	449
9.2.5	The Campbell-Shiller Approximation	451
9.2.6	Risks for the Long Run	451
9.3	Heterogeneous Agents and “Catching up with the Joneses”	453
9.4	Idiosyncratic Risk and Incomplete Markets	456
9.4.1	A Static Model of Idiosyncratic Risk	456
9.4.2	Idiosyncratic Shocks Unrelated to Aggregate Risk	458
9.4.3	Self-Insurance and Persistence of Idiosyncratic Shocks	459
9.4.4	Countercyclical Income Inequality	459
9.4.5	A Model with Restricted Market Participation	461
9.5	Disagreement and Learning	464
9.5.1	Learning with Multiple Signals	465
9.5.2	Overconfidence and Bubbles	465
9.5.3	General Equilibrium Without Frictions	470
9.6	Coping with Knightian Uncertainty	479
9.6.1	Prelude	479
9.6.2	Uncertainty Aversion and the Ellsberg Paradox	480
9.6.3	Portfolio Selection and Market Participation	483
9.6.4	A Model of Multiple Likelihoods	487
9.7	Government Spending and Asset Prices	492
9.7.1	Assumptions	492
9.7.2	Government Debt	492
9.7.3	Ricardian Equivalence	493
9.7.4	Government Size and Asset Prices	494
9.8	Leverage and Volatility	495
9.8.1	Primitives	496
9.8.2	Equity Volatility and Leverage	497
9.8.3	Bankruptcy	498
9.9	Multiple Trees and the Cross-Section of Asset Returns	499
9.9.1	A Model of the Cross-Section of Expected Returns	499
9.9.2	Exogenous Aggregate Output and Habit Formation	504
9.9.3	Discussion: Predictability	506
9.9.4	Stochastic Strings	506

9.10	Prices, Quantities, and the Separation Hypothesis	508
9.10.1	Production Puzzles	509
9.10.2	Risk-Sensitive Models	510
9.10.3	Irrelevance	512
9.10.4	Preferences for Robustness and Detection Error Probabilities	513
9.11	Procyclicality and the Financial Accelerator Doctrine	515
9.11.1	Procyclicality	515
9.11.2	Introduction: Credit Rationing	517
9.11.3	Credit Cycles I: Propagation	518
9.11.4	Credit Cycles II: Amplification	524
9.11.5	Financial Intermediation and Business Cycles: Additional Mechanisms	529
9.11.6	The State of Current Research	537
9.A	Nonexpected Utility	538
9.B	Economies with Heterogeneous Agents	546
9.C	Knightian Uncertainty	553
9.D	Credit Rationing	554
	References	558
10	Information and Other Market Frictions	563
10.1	Introduction	563
10.2	Prelude: Imperfect Information in Macroeconomics	565
10.3	Informational Efficiency: A Road Map	568
10.4	Walrasian Equilibria as Informationally Inefficient Outcomes	569
10.5	Rational Expectations Equilibrium	571
10.6	Noisy Rational Expectations Equilibrium	574
10.6.1	Asymmetric Information: Information Transmission	575
10.6.2	Differential Information: Information Aggregation	582
10.6.3	Higher Order Beliefs and Beauty Contests	585
10.7	Dealers Markets: Introduction	587
10.7.1	Markets with Symmetric Information	588
10.7.2	With Asymmetric Information: Bid-Ask Spreads	589
10.7.3	Inventory Risk and Bid-Ask Spreads	592
10.7.4	Empirical Measures of Liquidity	594
10.8	Markets with Strategic Players	595
10.8.1	Kyle's Baseline Model	596
10.8.2	Markets with Multiple Traders and Dealers	598
10.8.3	Dynamic Markets	604
10.8.4	Gravitational Pull Problems	609
10.8.5	Mandatory Disclosure	611
10.9	Limits of Arbitrage and Further Frictions	614
10.9.1	A Simple Model of Risky Arbitrage	615
10.9.2	Funding and Early Liquidation Constraints	617
10.9.3	Market Segmentation and Bond Supply Shocks	622
10.9.4	Liquidity and Runs	625

- 10.10 Over-the-Counter Markets 630
 - 10.10.1 Background 630
 - 10.10.2 Search 631
 - 10.10.3 A Model with Symmetric Information 631
- 10.A The Projection Theorem 635
- 10.B Proof of Selected Results 636
- 10.C Market Segmentation 641
- 10.D Search 642
- 10.E Introduction to Pricing Behavior in Macroeconomics 643
- References 647

III Asset Pricing and Reality 651

- 11 Options and Volatility 653
 - 11.1 Introduction 653
 - 11.2 Forwards and Futures 655
 - 11.2.1 Forwards: Definition and Pricing in Frictionless Markets 656
 - 11.2.2 Forwards As a Means to Borrow Money, and Pricing Again 657
 - 11.2.3 Marking to Market 657
 - 11.2.4 Futures 657
 - 11.2.5 Backwardation and Contango 659
 - 11.3 Optionality and No-Arbitrage Bounds 663
 - 11.3.1 Model-Free Properties 664
 - 11.3.2 Limiting Behavior and Arbitrage Bounds 666
 - 11.3.3 Wasting Assets and Convexity 667
 - 11.3.4 Hedging 667
 - 11.3.5 A Case Study: Accumulators and Decumulators 669
 - 11.4 Classical Evaluation and Properties 670
 - 11.4.1 A Pricing Formula 670
 - 11.4.2 Black–Scholes 671
 - 11.4.3 Future Options and Black’s Formula 674
 - 11.4.4 Surprising Cancellations and “Preference-Free” Formulae 675
 - 11.4.5 Properties of Options in Diffusive Models 675
 - 11.5 Stochastic Volatility 678
 - 11.5.1 Statistical Models of Changing Volatility 678
 - 11.5.2 Implied Volatility, Smiles, and Skews 680
 - 11.5.3 Option Pricing under Stochastic Volatility 686
 - 11.6 Trading Volatility with Options 696
 - 11.6.1 Option Portfolios and a Taxonomy 696
 - 11.6.2 Delta-Neutral Portfolios 698
 - 11.6.3 Delta-Hedged Strategies and Variance Risk Premiums 702
 - 11.6.4 Perfect Hedging: Price Independence 707
 - 11.7 Local Volatility 708
 - 11.7.1 Issues 709
 - 11.7.2 Implied Binomial Trees 710

11.7.3	The Perfect Fit in Continuous Time	713
11.7.4	Relations with Implied Volatility	715
11.8	The Price of (Equity) Volatility	717
11.8.1	One Introductory Example: Range-Based Volatility	717
11.8.2	“Fear Gauge” Contracts	719
11.8.3	Hedging Variance Swaps	723
11.8.4	Forward Volatility Trading	724
11.8.5	Marking to Market	725
11.8.6	Stochastic Interest Rates	726
11.8.7	A Digression on Skewness	726
11.9	VIX Derivatives	728
11.9.1	Model-Free Future Pricing	728
11.9.2	A Simple VIX Future Pricing Model	730
11.9.3	Options and the Volatility of Volatility	732
11.9.4	Replicating Variance Futures	733
11.10	Endogenous Risk and Market Dysfunctionalities	735
11.10.1	Cyclical Hedging	737
11.10.2	Market Crashes	738
11.A	The Original Formulation of Black–Scholes	746
11.B	Black 1976	746
11.C	Stochastic Volatility	747
11.D	Local Volatility	750
11.E	Spanning and Variance Contracts	752
	References	755
12	Engineering of Fixed Income Securities	759
12.1	Introduction	759
12.1.1	No-Arbitrage Models	760
12.1.2	Relative Pricing in Fixed Income Markets	760
12.1.3	Many Evaluation Paradigms	761
12.1.4	Plan of the Chapter	762
12.2	Markets and Interest Rate Conventions	762
12.2.1	Markets for Interest Rates	762
12.2.2	Mathematical Definitions of Interest Rates	765
12.2.3	Yields to Maturity on Coupon-Bearing Bonds	767
12.2.4	Accruals, Invoice, and Clean Prices on Coupon-Bearing Bonds	768
12.3	Duration, Convexity Hedging, and Trading	770
12.3.1	Duration	770
12.3.2	Convexity	772
12.3.3	Asset-Liability Management	772
12.4	Foundational Issues in Interest Rate Modeling	781
12.4.1	Tree Representation of the Short-Term Rate	782
12.4.2	Tree Pricing	787
12.4.3	Introduction to Calibration	788
12.4.4	Calibrating Probabilities Through Derivative Data	800
12.4.5	Extensions to Trinomial Trees	807

12.5	The Ho–Lee Model	807
12.5.1	The Tree	808
12.5.2	Price Movements and the Martingale Restriction	809
12.5.3	The Recombining Condition and Interest Rate Volatility	810
12.5.4	Model Solution	811
12.5.5	Model Calibration	813
12.5.6	An Example	813
12.5.7	Continuous Time Approximations with an Application to Barbell Trading	816
12.6	Beyond Ho–Lee: Calibration Through Arrow-Debreu Securities	821
12.6.1	Extracting Arrow-Debreu Securities from the Yield Curve	822
12.6.2	Implementation with Two Model Examples	825
12.6.3	Numerical Examples	827
12.7	Callables, Puttables, and Convertibles with Trees	835
12.7.1	Foundational Issues	835
12.7.2	Callable Bonds	838
12.7.3	Convertible Bonds	842
12.8	Probabilities of Fed Funds Target Changes	845
12.A	Bootstrapping and No-Arbitrage Restrictions	847
12.B	Bond Sharpe Ratios	852
12.C	Ho-Lee Representations	853
	References	855
13	Interest Rates	857
13.1	Introduction	857
13.2	Bond Prices and Interest Rates	859
13.2.1	A First Representation of Bond Prices	859
13.2.2	Forward Rates	861
13.2.3	A Second Representation of Bond Prices	862
13.3	Stylized Facts	862
13.3.1	The Expectation Hypothesis	862
13.3.2	Bond Returns Predictability	864
13.3.3	The Yield Curve and the Business Cycle	865
13.3.4	Additional Stylized Facts about the US Yield Curve	868
13.3.5	Common Factors Affecting the Yield Curve	868
13.4	Models of the Short-Term Rate: Introduction	872
13.4.1	Models versus Representations	873
13.4.2	The Bond Pricing Equation	874
13.4.3	Stochastic Duration	878
13.4.4	Some Famous Models	879
13.4.5	Interest Rate Volatility and the Business Cycle	887
13.4.6	Jumps, Volatility, and Default	890
13.5	Multifactor Models of the Short-Term Rate	896
13.5.1	Stochastic Volatility	896
13.5.2	Three-Factor Models	901

13.5.3	Affine and Quadratic Term Structure Models	902
13.5.4	Unspanned Stochastic Volatility	904
13.5.5	Topics Regarding Estimation and Trading Strategies	905
13.6	No-Arbitrage Models: Early Formulations	908
13.6.1	Fitting the Yield-Curve, Perfectly	908
13.6.2	Ho and Lee	909
13.6.3	Hull and White	910
13.7	The Heath-Jarrow-Morton Framework	911
13.7.1	The Framework	911
13.7.2	The Model	913
13.7.3	The Dynamics of the Short-Term Rate	913
13.7.4	Embedding	914
13.7.5	Stochastic String Shocks Models	915
13.8	Interest Rate Derivatives	918
13.8.1	Persistence and Volatility in Fixed Income Markets	918
13.8.2	Hypothetical Continuous Payoffs	921
13.8.3	Forward Martingale Probabilities	922
13.8.4	European Options on Bonds	923
13.8.5	Callable Bonds and Convexity Risks	926
13.8.6	Options on Fixed Coupon Bonds	932
13.8.7	Interest Rate Swaps	934
13.8.8	Caps and Floors	938
13.8.9	Swaptions	939
13.9	Market Models	940
13.9.1	Models and Market Practice	940
13.9.2	No-Arbitrage Restrictions	941
13.9.3	Applications to Derivatives Evaluation	943
13.9.4	Multiple Curves	947
13.10	Volatility Surfaces	950
13.10.1	Implied Volatilities	950
13.10.2	Local Volatilities and SABR Models	951
13.A	Bond Prices and Arbitrage Restrictions	954
13.B	Forward Probabilities	955
13.C	Factors and Components	957
13.D	Jumps	958
13.E	Exponential-Affine Models	961
13.F	Expectation Theory and Embedding	963
13.G	Strings	965
13.H	Changes of Numéraire	965
13.I	Convexity Risks in Gaussian Markets	966
	References	967
14	Risky Debt and Credit Derivatives	973
14.1	Introduction	973
14.1.1	A Brief History of Credit Risk and Financial Innovation	973
14.1.2	Plan of the Chapter	976

- 14.2 Conceptual Approaches to the Evaluation of Defaultable Securities 977
 - 14.2.1 Firm Value, or Structural, Approach 977
 - 14.2.2 The Structural Approach in Theory: Strategic Defaulting 989
 - 14.2.3 In Practice: The Pricing of Convertible Bonds 994
 - 14.2.4 Sovereign Risk 997
 - 14.2.5 Reduced Form Approaches: Rare Events or Intensity Models 1001
 - 14.2.6 Ratings 1006
- 14.3 Credit Derivatives and Structured Products Based Thereon 1011
 - 14.3.1 Options and Spreads 1011
 - 14.3.2 Credit Default Swaps 1012
 - 14.3.3 Evaluation with Random Intensity Rates 1018
 - 14.3.4 The Pricing of Credit Products 1025
 - 14.3.5 Collateralized Debt Obligations 1031
- 14.4 Managing Loan Losses 1045
 - 14.4.1 Regulatory Framework 1045
 - 14.4.2 Foundations of Risk Management 1048
 - 14.4.3 Measures of Systemic Risk 1053
 - 14.4.4 Credit Risk, Correlation, and Loss Probabilities 1055
- 14.5 The Global Financial Crisis of the Late 2000s 1059
 - 14.5.1 Credit Bubbles, Procyclicality, and “Quantitative Easing” 1059
 - 14.5.2 The 2007 Subprime Crisis 1062
 - 14.5.3 Procyclicality 1067
 - 14.5.4 Credit Crunches and Quantitative Easing 1074
 - 14.5.5 Where Did Quantitative Easing go? 1077
- 14.A Strategic Defaulting 1081
- 14.B Proof of Selected Results 1082
- 14.C Transition Probability Matrices and Pricing 1083
- 14.D Stochastic Default Intensity and Bond Spreads 1084
- 14.E Bond and Credit Default Swap spreads 1085
- 14.F Conditional Probabilities of Survival 1086
- 14.G CDS Index Swaps and Swaptions 1086
- 14.H Copulae 1089
- 14.I Pricing CDOs with Imperfect Correlation 1091
- References 1092

- Index** 1095