

Risk Management and Financial Institutions

Sixth Edition

John C. Hull

WILEY

Contents in Brief

Business Snapshots	xxiii
Preface	xxv
Chapter 1 Introduction: Risk-Return Trade-offs	1
Part 1: Financial Institutions	
Chapter 2 Banks	23
Chapter 3 Insurance Companies and Pension Plans	47
Chapter 4 Fund Managers	75
Part 2: Financial Markets	
Chapter 5 Financial Instruments	97
Chapter 6 The OTC Derivatives Market	99
Chapter 7 Securitization and the Global Financial Crisis	129
Chapter 8 Volatility	145
Chapter 9 Correlations and Copulas	163
Chapter 10 Valuation and Scenario Analysis	193
	217

Part 3: Market Risk		231
Chapter 11	Value at Risk and Expected Shortfall	233
Chapter 12	Historical Simulation and Extreme Value Theory	257
Chapter 13	Model-Building Approach	279
Chapter 14	Interest Rate Risk	293
Chapter 15	Derivatives Risk	319
Chapter 16	Scenario Analysis and Stress Testing	347
Part 4: Credit Risk		365
Chapter 17	Estimating Default Probabilities	367
Chapter 18	xVAs	393
Chapter 19	Credit Value at Risk	413
Part 5: Other Risks		429
Chapter 20	Operational Risk	431
Chapter 21	Liquidity Risk	449
Chapter 22	Model Risk Management	477
Chapter 23	Climate Risk, ESG, and Sustainability	497
Chapter 24	Enterprise Risk Management	513
Part 6: Regulation		531
Chapter 25	Basel I, Basel II, and Solvency II	533
Chapter 26	Basel II.5, Basel III, and Other Post-Crisis Changes	563
Chapter 27	Fundamental Review of the Trading Book	585
Chapter 28	Economic Capital and RAROC	599

Part 7: Other Topics	617
Chapter 29 Financial Innovation	619
Chapter 30 Risk Management Mistakes to Avoid	641
Part 8: Appendices	653
Appendix A Compounding Frequencies for Interest Rates	655
Appendix B Zero Rates, Forward Rates, and Zero-Coupon Yield Curves	659
Appendix C Valuing Forward and Futures Contracts	663
Appendix D Valuing Swaps	665
Appendix E Valuing European Options	669
Appendix F Valuing American Options	673
Appendix G Taylor Series Expansions	677
Appendix H Eigenvectors and Eigenvalues	681
Appendix I Principal Components Analysis	685
Appendix J Manipulation of Credit Transition Matrices	687
Appendix K Valuation of Credit Default Swaps	689
Appendix L Synthetic CDOs and Their Valuation	693
Appendix M SIMM	697
Answers to Questions and Problems	701
Glossary	743
RMFI Software	771
Table for $N(x)$ When $x \geq 0$	775
Table for $N(x)$ When $x \leq 0$	777
Index	779

Contents

Business Snapshots		xxiii
Preface		xxv
Chapter 1	Introduction: Risk-Return Trade-offs	1
	1.1 Risk vs. Return for Investors	2
	1.2 The Efficient Frontier	6
	1.3 The Capital Asset Pricing Model	8
	1.4 Arbitrage Pricing Theory	13
	1.5 Risk vs. Return for Companies	14
	1.6 Risk Management by Financial Institutions	18
	1.7 Credit Ratings	19
	Summary	20
	Further Reading	20
	Practice Questions and Problems (Answers at End of Book)	20
	Further Questions	21
	Part 1: Financial Institutions	23
Chapter 2	Banks	25
	2.1 Commercial Banking	26
	2.2 The Capital Requirements of a Small Commercial Bank	28
	2.3 Deposit Insurance	30
	2.4 Investment Banking	31

2.5	Securities Trading	37
2.6	Potential Conflicts of Interest in Banking	38
2.7	Today's Large Banks	39
2.8	The Risks Facing Banks	42
	Summary	43
	Further Reading	43
	Practice Questions and Problems (Answers at End of Book)	43
	Further Questions	44
Chapter 3	Insurance Companies and Pension Plans	47
3.1	Life Insurance	48
3.2	Annuity Contracts	51
3.3	Mortality Tables	53
3.4	Longevity and Mortality Risk	56
3.5	Property-Casualty Insurance	57
3.6	Health Insurance	60
3.7	Moral Hazard and Adverse Selection	61
3.8	Reinsurance	62
3.9	Capital Requirements	63
3.10	The Risks Facing Insurance Companies	64
3.11	Regulation	65
3.12	Pension Plans	66
	Summary	70
	Further Reading	71
	Practice Questions and Problems (Answers at End of Book)	71
	Further Questions	72
Chapter 4	Fund Managers	75
4.1	Mutual Funds	75
4.2	Exchange-Traded Funds	79
4.3	Active vs. Passive Management	80
4.4	Regulation	83
4.5	Hedge Funds	84
4.6	Hedge Fund Strategies	89
4.7	Hedge Fund Performance	93
	Summary	94
	Further Reading	95
	Practice Questions and Problems (Answers at End of Book)	95
	Further Questions	96

Part 2: Financial Markets		97
Chapter 5	Financial Instruments	99
	5.1 Long and Short Positions in Assets	99
	5.2 Derivatives Markets	102
	5.3 Plain Vanilla Derivatives	103
	5.4 Non-Traditional Derivatives	115
	5.5 Exotic Options and Structured Products	119
	5.6 Risk Management Challenges	123
	Summary	123
	Further Reading	123
	Practice Questions and Problems (Answers at End of Book)	124
	Further Questions	126
Chapter 6	The OTC Derivatives Market	129
	6.1 A Reference Point: Exchange-Traded Markets	129
	6.2 Clearing in OTC Derivatives Markets	131
	6.3 Post-Crisis Regulatory Changes	136
	6.4 Impact of the Changes	138
	6.5 CCPs and Bankruptcy	141
	Summary	142
	Further Reading	142
	Practice Questions and Problems (Answers at End of Book)	143
	Further Questions	143
Chapter 7	Securitization and the Global Financial Crisis	145
	7.1 The U.S. Housing Market	146
	7.2 Securitization	149
	7.3 The Losses	155
	7.4 What Went Wrong?	156
	7.5 Lessons from the Global Financial Crisis	158
	Summary	159
	Further Reading	160
	Practice Questions and Problems (Answers at End of Book)	160
	Further Questions	161
Chapter 8	Volatility	163
	8.1 Definition of Volatility	163
	8.2 Implied Volatilities	165
	8.3 Are Daily Percentage Changes in Financial Variables Normal?	167

8.4	The Power Law	170
8.5	Monitoring Daily Volatility	172
8.6	The Exponentially Weighted Moving Average Model	175
8.7	The GARCH(1,1) Model	177
8.8	Choosing between the Models	179
8.9	Maximum Likelihood Methods	179
8.10	Using GARCH(1,1) to Forecast Future Volatility	185
	Summary	189
	Further Reading	189
	Practice Questions and Problems (Answers at End of Book)	190
	Further Questions	191
Chapter 9	Correlations and Copulas	193
9.1	Definition of Correlation	193
9.2	Monitoring Correlation	195
9.3	Correlation and Covariance Matrices	198
9.4	Multivariate Normal Distributions	199
9.5	Copulas	202
9.6	Application to Loan Portfolios: Vasicek's Model	208
	Summary	213
	Further Reading	213
	Practice Questions and Problems (Answers at End of Book)	214
	Further Questions	215
Chapter 10	Valuation and Scenario Analysis	217
10.1	Volatility and Asset Prices	218
10.2	Risk-Neutral Valuation	219
10.3	Scenario Analysis	224
10.4	When Both Worlds Have to Be Used	224
10.5	The Calculations in Practice	225
	Summary	227
	Further Reading	228
	Practice Questions and Problems (Answers at End of Book)	228
	Further Questions	229
Part 3: Market Risk		231
Chapter 11	Value at Risk and Expected Shortfall	233
11.1	Definition of VaR	233
11.2	Examples of the Calculation of VaR	235
11.3	A Drawback of VaR	237

11.4	Expected Shortfall	238
11.5	Coherent Risk Measures	238
11.6	Choice of Parameters for VaR and ES	242
11.7	Marginal, Incremental, and Component Measures	247
11.8	Euler's Theorem	248
11.9	Aggregating VaRs and ESs	249
11.10	Back-Testing	249
	Summary	253
	Further Reading	253
	Practice Questions and Problems (Answers at End of Book)	254
	Further Questions	255
Chapter 12	Historical Simulation and Extreme Value Theory	257
12.1	The Methodology	257
12.2	Accuracy of VaR	263
12.3	Extensions	265
12.4	Computational Issues	270
12.5	Extreme Value Theory	270
12.6	Applications of EVT	273
	Summary	276
	Further Reading	276
	Practice Questions and Problems (Answers at End of Book)	277
	Further Questions	278
Chapter 13	Model-Building Approach	279
13.1	The Basic Methodology	280
13.2	Generalization	282
13.3	The Four-Index Example Revisited	284
13.4	Extensions of the Basic Procedure	286
13.5	Risk Weights and Weighted Sensitivities	287
13.6	Non-Linearity	288
13.7	Model-Building vs. Historical Simulation	288
	Summary	289
	Further Reading	289
	Practice Questions and Problems (Answers at End of Book)	289
	Further Questions	290
Chapter 14	Interest Rate Risk	293
14.1	Types of Rates	294
14.2	Calculating Risk Measures	296

14.3	Principal Components Analysis	299
14.4	The Management of Net Interest Income	303
14.5	Duration	305
14.6	Convexity	308
14.7	Generalization	310
14.8	Nonparallel Yield Curve Shifts	312
	Summary	315
	Further Reading	316
	Practice Questions and Problems (Answers at End of Book)	316
	Further Questions	317
Chapter 15	Derivatives Risk	319
15.1	Delta	319
15.2	Gamma	327
15.3	Vega	329
15.4	Theta	331
15.5	Rho	332
15.6	Calculating Greek Letters	332
15.7	Taylor Series Expansions	333
15.8	The Realities of Hedging Derivatives	335
15.9	Hedging Exotic Options	336
15.10	Scenario Analysis	338
15.11	Approximate Analytical Results	339
	Summary	343
	Further Reading	344
	Practice Questions and Problems (Answers at End of Book)	344
	Further Questions	345
Chapter 16	Scenario Analysis and Stress Testing	347
16.1	Generating the Scenarios	347
16.2	Regulation	354
16.3	What to Do with the Results	358
	Summary	361
	Further Reading	361
	Practice Questions and Problems (Answers at End of Book)	362
	Further Questions	363
	Part 4: Credit Risk	365
Chapter 17	Estimating Default Probabilities	367
17.1	Credit Ratings	367
17.2	Historical Default Probabilities	369

17.3	Recovery Rates	371
17.4	Credit Default Swaps	372
17.5	Credit Spreads	377
17.6	Estimating Default Probabilities from Credit Spreads	380
17.7	Comparison of Default Probability Estimates	382
17.8	Using Equity Prices to Estimate Default Probabilities	386
	Summary	388
	Further Reading	389
	Practice Questions and Problems (Answers at End of Book)	390
	Further Questions	391
Chapter 18	xVAs	393
18.1	Credit Exposure on Derivatives	394
18.2	CVA	395
18.3	The Impact of a New Transaction	399
18.4	CVA Risk	400
18.5	Wrong-Way Risk	401
18.6	DVA	402
18.7	Some Simple Examples	403
18.8	Other xVAs	407
	Summary	408
	Further Reading	409
	Practice Questions and Problems (Answers at End of Book)	409
	Further Questions	410
Chapter 19	Credit Value at Risk	413
19.1	Ratings Transition Matrices	414
19.2	Vasicek's Model	416
19.3	Credit Risk Plus	417
19.4	Creditmetrics	420
19.5	Credit Spread Risk	423
	Summary	425
	Further Reading	426
	Practice Questions and Problems (Answers at End of Book)	426
	Further Questions	427
Part 5: Other Risks		429
Chapter 20	Operational Risk	431
20.1	Defining Operational Risk	433
20.2	Types of Operational Risk	434
20.3	Loss Severity and Loss Frequency	434

20.4	The Standardized Measurement Approach	439
20.5	Preventing Operational Risk Losses	441
20.6	Allocation of Operational Risk Capital	442
20.7	Use of Power Law	443
20.8	Insurance	443
20.9	Sarbanes–Oxley	445
	Summary	446
	Further Reading	446
	Practice Questions and Problems (Answers at End of Book)	447
	Further Questions	448
Chapter 21	Liquidity Risk	449
21.1	Liquidity Trading Risk	450
21.2	Liquidity Funding Risk	457
21.3	Liquidity Black Holes	466
	Summary	472
	Further Reading	473
	Practice Questions and Problems (Answers at End of Book)	474
	Further Questions	475
Chapter 22	Model Risk Management	477
22.1	Regulatory Guidance	478
22.2	Models in Physics and Finance	484
22.3	Simple Models: Expensive Mistakes	484
22.4	Models for Pricing Actively Traded Products	487
22.5	Models for Less Actively Traded Products	490
22.6	Accounting	492
22.7	What Makes a Successful Pricing Model?	492
22.8	Model-Building Missteps	493
	Summary	494
	Further Reading	495
	Practice Questions and Problems (Answers at End of Book)	495
	Further Questions	496
Chapter 23	Climate Risk, ESG, and Sustainability	497
23.1	Climate Risk	497
23.2	ESG	507
23.3	Sustainability	508
23.4	Greenwashing	509
	Summary	510
	Further Reading	510

	Practice Questions and Problems (Answers at End of Book)	511
	Further Questions	511
Chapter 24	Enterprise Risk Management	513
	24.1 Risk Appetite	514
	24.2 Risk Culture	520
	24.3 Identifying Major Risks	523
	24.4 Strategic Risk Management	526
	Summary	527
	Further Reading	528
	Practice Questions and Problems (Answers at End of Book)	528
	Further Questions	529
	Part 6: Regulation	531
Chapter 25	Basel I, Basel II, and Solvency II	533
	25.1 The Reasons for Regulating Banks	533
	25.2 Bank Regulation Pre-1988	535
	25.3 The 1988 BIS Accord	536
	25.4 The G-30 Policy Recommendations	539
	25.5 Netting	540
	25.6 The 1996 Amendment	542
	25.7 Basel II	545
	25.8 Credit Risk Capital Under Basel II	546
	25.9 Operational Risk Capital Under Basel II	555
	25.10 Pillar 2: Supervisory Review	556
	25.11 Pillar 3: Market Discipline	556
	25.12 Solvency II	557
	Summary	558
	Further Reading	559
	Practice Questions and Problems (Answers at End of Book)	559
	Further Questions	561
Chapter 26	Basel II.5, Basel III, and Other Post-Crisis Changes	563
	26.1 Basel II.5	564
	26.2 Basel III	567
	26.3 Contingent Convertible Bonds	576
	26.4 Use of Standardized Approaches and SA-CCR	576
	26.5 Dodd-Frank Act	578
	26.6 Legislation in Other Countries	580
	Summary	582
	Further Reading	582

	Practice Questions and Problems (Answers at End of Book)	583
	Further Questions	583
Chapter 27	Fundamental Review of the Trading Book	585
	27.1 Background	586
	27.2 Standardized Approach	588
	27.3 Internal Models Approach	591
	27.4 Trading Book vs. Banking Book	595
	Summary	596
	Further Reading	596
	Practice Questions and Problems (Answers at End of Book)	596
	Further Question	597
Chapter 28	Economic Capital and RAROC	599
	28.1 Definition of Economic Capital	600
	28.2 Components of Economic Capital	602
	28.3 Shapes of the Loss Distributions	604
	28.4 Relative Importance of Risks	605
	28.5 Aggregating Economic Capital	606
	28.6 Allocation of Economic Capital	610
	28.7 Deutsche Bank's Economic Capital	611
	28.8 RAROC	612
	Summary	613
	Further Reading	614
	Practice Questions and Problems (Answers at End of Book)	614
	Further Questions	615
	Part 7: Other Topics	617
Chapter 29	Financial Innovation	619
	29.1 Technological Advances	620
	29.2 Payment Systems	624
	29.3 Open Banking	628
	29.4 Lending	629
	29.5 Wealth Management	631
	29.6 InsurTech	632
	29.7 Regulation and Compliance	634
	29.8 How Should Financial Institutions Respond?	636
	Summary	639
	Further Reading	640

	Practice Questions and Problems (Answers at End of Book)	640
	Further Questions	640
Chapter 30	Risk Management Mistakes to Avoid	641
	30.1 Risk Limits	643
	30.2 Managing the Trading Room	645
	30.3 Liquidity Risk	647
	30.4 Lessons for Nonfinancial Corporations	650
	30.5 A Final Point	651
	Further Reading	652
Part 8: Appendices		653
Appendix A	Compounding Frequencies for Interest Rates	655
Appendix B	Zero Rates, Forward Rates, and Zero-Coupon Yield Curves	659
Appendix C	Valuing Forward and Futures Contracts	663
Appendix D	Valuing Swaps	665
Appendix E	Valuing European Options	669
Appendix F	Valuing American Options	673
Appendix G	Taylor Series Expansions	677
Appendix H	Eigenvectors and Eigenvalues	681
Appendix I	Principal Components Analysis	685
Appendix J	Manipulation of Credit Transition Matrices	687
Appendix K	Valuation of Credit Default Swaps	689
Appendix L	Synthetic CDOs and Their Valuation	693
Appendix M	SIMM	697
	Answers to Questions and Problems	701
	Glossary	743
	RMFI Software	771
	Table for $N(x)$ When $x \geq 0$	775
	Table for $N(x)$ When $x \leq 0$	777
	Index	779