

# Contents

**Advance Praise for *Fixed Income Securities* — v**

**Foreword — vii**

**Preface — ix**

**Acknowledgments — xi**

**Chapter 1: A Primer on the Time Value of Money — 1**

    Nominal and Effective Rates of Interest — 1

    Variables and Terms to Be Used and the Corresponding Symbols — 1

    The Concept of Simple Interest — 2

    The Concept of Compound Interest — 2

        Properties of Simple and Compound Interest — 4

    Effective Versus Nominal Rates of Interest — 5

        A Symbolic Derivation of the Relationship Between Effective and Nominal Rates of Interest — 5

    Computing Effective and Nominal Rates in Excel — 6

        Principle of Equivalency of Interest Rates — 7

        Continuous Compounding of Interest — 7

        Using Excel to Compute the Effective Rate with Continuous Compounding — 8

    Future Value of Cash Flows — 9

        Computing the Future Value Using Excel — 9

    Present Value of Cash Flows — 11

        Computing Present Values of Cash Flows Using Excel — 11

    The Internal Rate of Return of an Investment — 12

        Pure and Mixed Cash Flows — 13

        Descartes' Rule of Signs and the IRR — 13

    A Point About Effective Rates of Interest — 13

    Level Annuities — 14

        Present Value of a Level Annuity — 15

        Future Value of a Level Annuity — 16

        Relationship Between PVIFA and FVIFA for a Level Annuity — 16

    Level Annuities Due — 17

        Present Value of a Level Annuity Due — 17

        Computation in Excel of the Present Value of an Annuity Due — 18

        Future Value of an Annuity Due — 18

        Computation of the Future Value of an Annuity Due in Excel — 19

        Relationship Between PVIFA and FVIFA for Annuity Dues — 19

<b>Perpetuities — 19</b>
<b>The Amortization Method of Loan Repayment — 20</b>
<b>Obtaining the Amortization Schedule Using Excel — 22</b>
<b>The Rationale for Why IPMT and PPMT Can Be Used with Two Different Sets of Parameters — 23</b>
<b>Amortization with a Balloon Payment — 23</b>
<b>Handling the Balloon Using Excel — 23</b>
<b>A Growing Annuity — 24</b>
<b>Present Value of a Growing Annuity — 24</b>
<b>Future Value of a Growing Annuity — 25</b>
<b>Growing Perpetuity — 26</b>
<b>Growing Annuity Due — 26</b>
<b>Present Value of a Growing Annuity Due — 26</b>
<b>Future Value of a Growing Annuity Due — 28</b>
<b>Growing Perpetuity Due — 28</b>
<b>Chapter Summary — 29</b>
<b>Chapter 2: An Introduction to Bonds — 30</b>
<b>The Leverage Effect — 31</b>
<b>Tax Shield Due to Interest Payments — 31</b>
<b>Variables Influencing the Bond Price — 33</b>
<b>Face Value — 33</b>
<b>Term to Maturity — 33</b>
<b>Coupon — 34</b>
<b>Yield to Maturity — 34</b>
<b>Valuation of a Bond — 34</b>
<b>Par, Premium, and Discount Bonds — 35</b>
<b>Influence of Variables on the Bond Price — 36</b>
<b>The Pull to Par Effect — 37</b>
<b>An Interesting Result about Bond Prices — 38</b>
<b>Eurobonds and Foreign Bonds — 40</b>
<b>Coupon Dates and Coupon Frequencies — 41</b>
<b>Zero Coupon Bonds — 42</b>
<b>Creating a Synthetic Zero Coupon Bond — 42</b>
<b>Price Quotes for Bonds — 44</b>
<b>Computation of the Bond Price Using Excel — 44</b>
<b>Different Bond Types — 45</b>
<b>Amortizing Bonds — 45</b>
<b>Bonds with Step-Up Coupons and Step-Down Coupons — 47</b>
<b>Payment-In-Kind (PIK) Bonds — 47</b>
<b>Treasury Securities — 48</b>
<b>Treasury Auctions — 48</b>

<b>Illustration of a Treasury Auction — 49</b>
<b>Security Identification — 50</b>
<b>Coupon Strips — 51</b>
<b>When Issued (WI) Trading — 53</b>
<b>Coupon Rolls — 53</b>
<b>Accounting for Bonds — 54</b>
Issue of Discount Bonds — 54
Issue of Premium Bonds — 56
<b>Risks Inherent in Bonds — 57</b>
Credit Risk — 57
Moody's Ratings Scale — 58
S&P's Rating Scale — 58
Fitch's Rating Scale — 59
Liquidity Risk — 61
Interest Rate Risk — 62
Inflation Risk — 62
Timing Risk — 63
Foreign Exchange Risk — 63
<b>Chapter Summary — 63</b>
<b>Chapter 3: Bonds: Advanced Concepts — 65</b>
Required Symbols for the Variables — 65
Day-Count Conventions — 66
The Actual/Actual Approach — 66
The Market Method for Bond Valuation — 67
The Treasury Method for Bond Valuation — 67
Accrued Interest — 68
The Impact of Time on the Dirty Price — 70
Computation of Price and Accrued Interest Using Excel — 71
Computation of the YTM Between Coupon Dates — 73
Other Day-Count Conventions — 73
The 30/360 NASD Approach — 73
30/360 European Convention — 75
Actual/365 Convention — 75
Actual/360 Convention — 76
Comparison of Day-Count Conventions — 76
Additional Coupon-Related Excel Functions — 77
Valuing a Bond in the Final Coupon Period — 78
Yield Measures: An Introduction — 79
Current Yield of a Bond — 79
Simple Yield to Maturity — 80
Yield to Maturity of a Bond — 81

**The Approximate Yield to Maturity Approach — 81**

**The Rationale for the AYM Approach — 81**

**The Realized Compound Yield — 87**

**The Horizon or Holding Period Return — 88**

**The Realized Compound Yield with Taxes — 89**

**Computing the YTM with Taxes — 90**

**The Portfolio Yield for Bonds — 90**

**The Taxable Equivalent Yield (TEY) — 92**

**Sinking Fund Provisions — 92**

**Serial Bonds — 93**

**Yield to Average Life — 94**

**Yield to Equivalent Life — 95**

**Chapter Summary — 96**

**Chapter 4: Yield Curves and the Term Structure — 97**

**Analyzing the Yield Curve — 97**

**Spot Rates of Interest — 98**

**The Relationship Between Spot Rates and the YTM — 98**

**Yield Curve versus the Term Structure — 99**

**Required Symbols — 100**

**Bootstrapping to Obtain Spot Rates — 100**

**Practical Difficulties with Bootstrapping — 101**

**Coupon Yield Curves and Par Bond Yield Curves — 102**

**Deducing a Par Bond Yield Curve — 103**

**Implied Forward Rates of Interest — 104**

**Fitting the Yield Curve — 105**

**Interpolation — 105**

**Polynomial Models of the Yield Curve — 106**

**Regression Models of the Yield Curve — 106**

**The Nelson-Siegel Model of the Yield Curve — 106**

**Interpretation of the Nelson-Siegel Model — 107**

**Theories of the Term Structure — 109**

**The Pure or Unbiased Expectations Hypothesis — 109**

**The Liquidity Preference Theory (LPT) — 110**

**The Expectations Hypothesis versus the LPT: A Mathematical Analysis — 111**

**The Money Substitute Hypothesis — 114**

**The Market Segmentation Hypothesis — 114**

**The Preferred Habitat Theory — 115**

**Features of the Debt Market and Theories of the Term Structure — 115**

**Chapter Summary — 117**

<b>Chapter 5: Duration, Convexity, and Immunization — 118</b>
A Mathematical Definition of Duration — 119
Duration of a Bond When the Settlement Date Is Between Two Coupon Dates — 120
A Concise Formula for the Duration on a Coupon Date — 120
The Case of a Par Bond — 121
Duration of a Level Annuity — 121
Duration of a Perpetuity — 122
The Rationale Behind Duration — 122
Factors Influencing Duration — 123
Term to Maturity — 123
Coupon — 125
Yield to Maturity — 126
Accrued Interest — 126
Coupon Frequency — 127
Percentage Price Change and Duration — 127
Duration of Annuities Due and Perpetuities Due — 128
Dollar Duration — 129
Computing Duration and Modified Duration with Excel — 129
Modified Duration — 129
Approximating Duration — 130
The Concept of Effective Duration — 130
Duration as a Center of Gravity — 131
Portfolio Duration — 131
Bond Convexity — 133
Approximating the Price Change of a Bond for a Given Change in Yield — 135
Dispersion of a Bond — 136
Convexity of a Zero Coupon Bond — 137
Dispersion as an Expected Value — 138
Portfolio Convexity and Dispersion — 138
Properties of Convexity — 139
The Impact of Duration — 139
The Irrelevance of the Face Value — 139
Dollar Convexity — 139
Approximate Convexity — 140
Convexity of Annuities and Perpetuities — 140
Perpetuities — 142
Immunization of a Bond Portfolio — 142
Chapter Summary — 144
Appendix 5.1: Derivation of a Concise Formula for Duration — 144
Appendix 5.2: Duration of Annuities and Perpetuities — 146
Appendix 5.3: Duration and Interest Rate Sensitivity — 148

Appendix 5.4: Convexity of Annuities and Perpetuities — 149
Appendix 5.5: Proof of Single-Period Immunization — 149

**Chapter 6: The Money Market — 152**

Risk Factors in the Money Market — 153
Supervision of the Money Market — 154
Key Dates in Money Market Transactions — 155
Roll Conventions in the Event of Market Holidays — 155
The End/End Rule — 156
The Interbank Market — 156
Types of Loans in the Inter-bank Market — 157
LIBOR — 157
Interest Computation Methods — 158
Money Market Forward Rates — 159
Term Money Market Deposits — 160
Federal Funds — 161
Treasury Bills — 161
Re-openings of T-bills — 162
Discount Rates and T-bill Prices — 163
The Money Market Yield of a T-bill — 163
The Bond Equivalent Yield of a T-bill — 164
Holding Period Return for an Investor — 166
Concept of a Tail in a T-bill Transaction — 166
T-bill Related Computations Using Excel — 167
Repurchase Agreements — 169
Repo Rates — 170
Margins in Repo Transactions — 170
The Federal Reserve and Repos — 172
Negotiable Certificates of Deposit (CDs) — 173
Required Symbols — 173
Term Certificates of Deposit — 174
NCDs vs. Money Market Time Deposits — 176
The Effective Cost of a CD — 177
Commercial Paper — 177
Letters of Credit (LCs) — 178
Yankee Paper — 178
Credit Rating — 179
Moody's Rating Scale — 179
S&P's Rating Scale — 179
Fitch's Rating Scale — 180
Bills of Exchange — 180
Chapter Summary — 182

**Chapter 7: Floating Rate Bonds — 183**

Call and Put Provisions in Floating Rate Bonds — 183

Caps and Floors for the Coupon Rate — 184

Valuation of a Floating Rate Bond — 184

Variations on the Floating Rate Feature — 185

Inverse Floating Rate Bonds — 185

Deleveraged Floating Rate Bonds — 186

Dual-Indexed Floating Rate Bonds — 187

Range Notes — 187

Variations on the Principal Repayment Feature — 187

Floater, Inverse Floaters, and Plain Vanilla Bonds — 187

A More General Relationship for an Inverse Floater — 188

Duration of a Floating Rate Bond — 188

Convexity of a Risk-Free Floating Rate Bond — 189

Comparison with a Zero Coupon Bond — 189

Margin Measures for Floaters — 189

Simple Margin — 190

Adjusted Simple Margin — 190

Adjusted Total Margin — 191

The Discount Margin — 192

Inflation Indexed Bonds — 193

Principal Linkers or P-Linkers — 193

Analysis — 194

Coupon Linkers or C-Linkers — 195

Valuing a Risky Floater — 195

Duration of a Risky Floater — 199

Chapter Summary — 200

Appendix 7.1: Duration of a Risky Floater — 201

Appendix 7.2: Duration of a Risky Perpetual Floater — 202

**Chapter 8: Mortgage Loans — 203**

Important Mortgage-Related Terms — 203

Risks in Mortgage Lending — 203

Default Risk — 204

Liquidity Risk — 204

Interest Rate Risk — 204

Prepayment Risk — 204

The Role of the Mortgage Rate in Prepayments — 206

Negative Amortization — 207

Other Mortgage Structures — 208

Adjustable Rate Mortgages (ARMs) — 208

Option to Change the Maturity — 210

Features of ARMs — 210	
Variations on the ARM Structure — 210	
Interest Rate Caps — 212	
Example of Interest Rate Caps — 212	
Payment Caps — 213	
Graduated Payment Mortgages — 213	
Growing Equity Mortgages — 214	
A Comparison of the Three Mortgage Structures — 214	
Mortgage Servicing — 218	
Income for the Servicer — 219	
Mortgage Insurance — 221	
Sale of Mortgage Loans — 221	
The Average Life of a Mortgage Loan — 222	
Prepayments of Principal — 223	
Single Month Mortality (SMM) — 223	
Analysis of a Loan with Prepayments — 224	
Relationship between Cash Flows with and without Prepayments — 225	
Conditional Prepayment Rate (CPR) — 227	
An Equal Principal Repayment Loan — 228	
Weighted Average Coupon (WAC) and Weighted Average Maturity (WAM) — 228	
Chapter Summary — 229	
Appendix 8.1 — 229	
<b>Chapter 9: Mortgage-Backed Securities — 233</b>	
Cash Flows for a Pass-Through Security — 234	
Cash Flow Yield of a Pass-Through Security — 237	
Symbols Required for the Exposition — 237	
Collateralized Mortgage Obligations — 238	
Extension Risk and Contraction Risk for Mortgage-backed Securities — 242	
Accrual Bonds — 243	
Creating Floating Rate Tranches — 247	
Notional Interest-Only Tranches — 248	
Interest-Only and Principal-Only Strips — 249	
Planned Amortization Class (PAC) Bonds — 249	
Analysis of the SMM = 15% Scenario — 253	
Chapter Summary — 254	
Appendix 9.1 — 254	
<b>Chapter 10: A Primer on Derivatives — 258</b>	
Futures and Forwards: Comparisons and Contrasts — 258	
The Role of the Clearinghouse in a Futures Trade — 260	
Margins for Futures Trades — 261	

<b>Marking to Market of Futures Contracts — 261</b>
The Settlement Price for Futures Contracts — 264
Movements in the Margin Account — 264
<b>Offsetting of Futures Contracts — 265</b>
<b>Spot-Futures Convergence of Prices — 266</b>
<b>Delivery in the Case of Futures Contracts — 267</b>
<b>Cash Settlement of Futures Contracts — 269</b>
<b>Valuation of Futures and Forwards — 269</b>
<b>The Case of Assets Making Payouts — 272</b>
<b>Conversion Factors When There Are Multiple Deliverable Grades — 273</b>
Multiplicative Adjustment of the Futures Price — 273
Additive Adjustment of the Futures Price — 274
<b>Hedging Using Futures Contracts — 275</b>
<b>Hedging and Ex-Post Regret — 276</b>
<b>Hedging and the Case of Cash-Settled Contracts — 277</b>
<b>Perfect Hedges Using Futures Contracts — 278</b>
The Importance of Terminating the Hedge on the Expiration Date — 279
The Importance of Hedging an Integer Multiple of the Contract Size — 280
<b>Choosing an Expiration Month for Hedging — 281</b>
<b>Speculation Using Futures Contracts — 281</b>
<b>Introduction to Options — 283</b>
<b>Common Terms Associated with Options — 284</b>
Exercise Price — 284
Expiration Date — 285
Option Premium — 285
<b>Notation — 286</b>
<b>Exercising Call and Put Options — 286</b>
Payoffs and Profits: A Symbolic Representation — 287
<b>Moneyness of the Option — 288</b>
Call Options — 288
Put Options — 288
<b>Intrinsic Value and Time Value of Options — 289</b>
<b>The Absence of Arbitrage and Its Implications for Option Prices — 289</b>
Non-Negative Option Premia — 290
Non-Negative Time Value of American Options — 290
<b>Lower Bound for Call Options — 291</b>
<b>Lower Bound for Put Options — 291</b>
<b>Put-Call Parity for European Options — 292</b>
<b>Option Premia at Expiration — 292</b>
Proof — 292
<b>Variables of Interest for Option Valuation — 293</b>
The Current Stock Price — 293

<b>Chapter 12: Interest Rate Forwards and Futures — 341</b>
Forward Rate Agreements (FRAs) — 341
Determining the Contract Rate — 343
Using Short Rates to Determine the FRA Rate — 345
Eurodollar Futures — 348
Calculating Profits and Losses on ED Futures — 348
Locking in a Borrowing Rate — 349
Locking in a Lending Rate — 351
Cash-and-Carry Arbitrage — 352
Reverse Cash-and-Carry Arbitrage — 353
The No-Arbitrage Pricing Equation — 353
Hedging an <i>N</i> -day Loan Using ED Futures — 354
A More General Argument — 356
Using ED Futures to Create a Fixed Rate Loan — 357
Stack and Strip Hedges — 358
FRAs vs. ED Futures: An Important Point — 360
Federal Funds — 360
Fed Funds Futures — 363
T-Note and T-Bond Futures — 363
T-Bond Contracts — 364
Conversion Factors — 364
Calculating the Invoice Price for a T-Bond — 366
The Cheapest-to-Deliver (CTD) Bond — 367
The Cheapest-to-Deliver Bond Prior to Expiration — 368
Risk in an Arbitrage Strategy Due to Multiple Deliverable Grades — 370
Seller's Options — 373
The Delivery Process — 373
The Wild Card Option — 374
The Quality Option — 377
The End-of-Month Option — 377
Hedging — 378
Hedging the Cheapest-to-Deliver Bond: A Naive Approach — 378
The Conversion Factor Approach — 379
Hedging a Portfolio Other Than the CTD Bond — 380
Changing the Duration of a Portfolio of Bonds — 381
Chapter Summary — 382
Appendix 12.1: Duration-Based Hedge Ratio — 382
Appendix 12.2: Required Number of Contracts to Change the Duration — 383
<b>Chapter 13: Bonds with Embedded Options — 385</b>
Callable Bonds — 385
Yield to Call — 386

The Exercise Price — 293
Dividends — 293
Volatility — 293
Time to Maturity — 294
Riskless Rate of Interest — 294
<b>The Binomial Model of Option Valuation — 295</b>
The One Period Binomial Model — 295
The Two-Period Case — 297
The Binomial Model for European Puts — 299
<b>Using the Binomial Model: The Case of European vs. American Puts — 299</b>
Valuing a European Put Using the Binomial Model — 299
Valuing an American Put Using the Binomial Model — 300
<b>The Black-Scholes Formula for Valuing Options — 301</b>
Put-Call Parity and Option Pricing Models — 302
Interpretation of $N(d_1)$ and $N(d_2)$ — 303
Chapter Summary — 303
 <b>Chapter 11: The Valuation of Interest Rate Options — 305</b>
Short Rates — 305
Issues in the Valuation of Interest Rate Derivatives — 305
Equilibrium Models of the Term Structure — 306
Arbitrage-Free Term Structure Models — 306
The Ho-Lee Model — 307
The Hull-White Model — 307
The Black-Derman-Toy Model — 307
The Binomial Tree Approach to the Term Structure — 307
Some Insights into the Ho-Lee Model — 309
Calibrating the Ho-Lee Model — 311
Arrow-Debreu Securities — 312
Calibrating the Black-Derman-Toy Model — 319
An Issue with Recombination — 320
An Issue with Calibration — 324
Valuation of a Plain Vanilla Bond — 326
Valuation of a Zero Coupon Bond — 327
Valuing a European Call — 330
Valuing an American Put — 330
Caps, Floors, and Collars — 331
Caps and Floors: A Detailed Perspective — 333
Interest Rate Collars — 336
Captions and Floortions — 339
Chapter Summary — 340

Relationship between the Yield to Call and the Yield to Maturity — 387
The Approximate Yield to Call Approach — 388
Reinvestment Assumption — 389
Concept of the Yield to Worst — 389
Valuation of a Callable Bond — 390
Putable Bonds — 394
Valuation of a Putable Bond — 395
Pricing the Callable and Putable Bonds Using the BDT Model — 397
The Callable Bond and the BDT Model — 398
Valuation of the Putable Bond — 399
Yield Spreads for Callable Bonds — 401
The Traditional Yield Spread — 401
The Static Spread — 402
The Option-Adjusted Spread — 402
Convertible Bonds — 405
Changes in the Conversion Ratio — 407
Pros and Cons of a Convertible Issue: The Issuer's Perspective — 409
Concept of Break-Even — 409
Liquid Yield Option Notes (LYONs) — 410
Exchangeable Bonds — 411
Valuing a Convertible Bond with Built-in Call and Put Options — 411
Chapter Summary — 414
<b>Chapter 14: Interest Rate Swaps and Credit Default Swaps — 416</b>
Interest Rate Swaps — 416
Contract Terms — 416
Key Dates in a Swap Contract — 420
The Swap Rate — 420
Risk — 421
Quoted Swap Rates — 421
Comparative Advantage and Credit Arbitrage — 422
The Role of Banks in the Swap Market — 423
Valuing an Interest Rate Swap — 423
Valuing a Swap at an Intermediate Stage — 425
Terminating a Swap — 426
Motives for the Swap — 427
Speculation — 427
Hedging a Liability — 427
Hedging an Asset — 428
Equivalence with FRAs — 431
Determining the Fixed Rate — 431
Forward-Start Swaps — 434

<b>Amortizing Swaps — 435</b>
<b>In-Arrears Swaps — 436</b>
<b>Extendable and Cancelable Swaps — 436</b>
<b>Swaptions — 437</b>
<b>Credit Default Swaps — 438</b>
<b>Valuation of a CDS — 440</b>
<b>Using Default Probabilities to Determine the Swap Rate — 441</b>
<b>Chapter Summary — 443</b>
<b>Appendix A — 444</b>
<b>Goal Seek — 444</b>
<b>Solver — 445</b>
<b>Bibliography — 446</b>
<b>Index — 448</b>