OPTIONS, FUTURES, AND OTHER DERIVATIVES

SIXTH EDITION

JOHN C. HULL

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To Michelle

TECHNICAL NOTES

Available on the Author's Website
www.rotman.utoronto.ca/~hull

1. Convexity Adjustments to Eurodollar Futures
2. Properties of the Lognormal Distribution
3. Warrant Valuation When Value of Equity plus Warrants Is Lognormal
4. Exact Procedure for Valuing American Calls on Stocks Paying a Single Dividend
5. Calculation of the Cumulative Probability in a Bivariate Normal Distribution
6. Differential Equation for Price of a Derivative on a Stock Paying a Known Dividend Yield
7. Differential Equation for Price of a Derivative on a Futures Price
8. Analytic Approximation for Valuing American Options
9. Generalized Tree-Building Procedure
10. The Cornish–Fisher Expansion to Estimate VaR
11. Manipulation of Credit Transition Matrices
12. Calculation of Cumulative Noncentral Chi-Square Distribution
13. Efficient Procedure for Valuing American-Style Lookback Options
14. The Hull–White Two-Factor Model
15. Valuing Options on Coupon-Bearing Bonds in a One-Factor Interest Rate Model
16. Construction of an Interest Rate Tree with Nonconstant Time Steps and Nonconstant Parameters
17. The Process for the Short Rate in an HJM Term Structure Model
18. Valuation of a Compounding Swap
19. Valuation of an Equity Swap
20. A Generalization of the Risk-Neutral Valuation Result

Preface

It is sometimes hard for me to believe that the first edition of this book was only 330 pages and 13 chapters long! Over the last 15 years I have had to expand and adapt the book to keep up with the fast pace of change in derivatives markets.

Like earlier editions, the book serves several markets. It is appropriate for graduate courses in business, economics, and financial engineering. It can be used on advanced undergraduate courses when students have good quantitative skills. Many practitioners involved in derivatives markets find the book useful. I am pleased that half the purchasers of the book have historically been analysts, traders, and other market practitioners.

One of the key decisions that must be made by an author who is writing in the area of derivatives concerns the use of mathematics. If the level of mathematical sophistication is too high, the material is likely to be inaccessible to many students and practitioners. If it is too low, some important issues will inevitably be treated in a rather superficial way. I have tried to be particularly careful about the way I use both mathematics and notation in the book. Nonessential mathematical material has been either eliminated or included in end-of-chapter appendices and in the technical notes on my website. Concepts that are likely to be new to many readers have been explained carefully, and many numerical examples have been included.

The book provides a comprehensive treatment of derivatives and risk management. It assumes that the reader has taken introductory courses in finance and in probability and statistics. No prior knowledge of options, futures contracts, swaps, or other derivative instruments is assumed. It is not therefore necessary for students to take an elective course in investments prior to taking a course based on this book.

There are many different ways *Options, Futures, and Other Derivatives* can be used in the classroom. Instructors teaching a first course in derivatives may wish to spend most time on the first half of the book; those teaching more advanced courses will find that many different combinations of chapters in the second half of the book can be used. I find the material in Chapter 32 works well at the end of either an introductory or an advanced course.

What's New?

Material has been updated and improved throughout the book. The changes in this edition include:

1. Complete rewrites of the chapters on credit risk and credit derivatives (Chapters 20 and 21) to reflect market developments in these important areas. The rewrites result in chapters that are up to date and easier to teach from than the corresponding chapters in the fifth edition.

2. The opening six chapters have been replaced by seven chapters that cover forward, futures, and swap contracts in a more student-friendly way. The chapter on hedging has been moved to Chapter 3. Chapter 4 is now devoted to understanding how interest rates are calculated and used. Chapter 5 covers the determination of futures and forward prices. Chapter 6 deals with interest rate futures, and Chapter 7 covers swaps.

3. Over 50 highlighted descriptions of real-world situations and interesting issues, referred to as *Business Snapshots*, illustrate points being made in the text.

4. There is more discussion of how models can be implemented with Excel (see, for example, Monte Carlo simulation in Chapter 17, GARCH models in Chapter 19, and the variance-gamma model in Chapter 24). Excel Spreadsheets illustrating model implementations are available from my website.

5. A series of Technical Notes are available from my website. This means that less purely technical material needs to be included in the book. As a result, the presentation is streamlined and more student friendly.

6. DerivaGem Version 1.51 is included. One change from the previous version of DerivaGem is that spreadsheets are now unlocked in the Calculator.

7. The binomial tree chapter (Chapter 11) and the swaps chapter (Chapter 7) have been extended so that there is a more complete coverage of these topics at one place in the book.

8. There is a new chapter on "Convexity, Timing, and Quanto Adjustments". Previously the material in this chapter was included in the chapters on "Martingales and Measures" and "Interest Rate Derivatives: The Standard Market Models".

9. Sequencing of chapters in the second half of the book has been changed to better meet the needs of students and instructors.

10. Many new topics are included. For example, I cover the size of derivatives markets in Chapter 1, Basel II in Chapter 20, and the variance-gamma model in Chapter 24. Other topics are discussed in more depth than in the fifth edition. For example, there is more on convexity adjustments to Eurodollar futures (Chapter 5), copula models (Chapters 20 and 21), and executive stock options (Chapters 8 and 13).

11. One change has been made to the mathematical notation. δt, δx, etc., have been replaced by Δt, Δx, etc. (This reverses a change in the previous edition where I was trying to avoid overworking Δ—but found that the change was not popular!)

12. New end-of-chapter problems have been added.

The whole book (including end-of-chapter references) has been fully updated and many changes have been made to improve the presentation of material.

Software

Version 1.51 of DerivaGem is included with this book. This consists of two Excel applications: the *Options Calculator* and the *Applications Builder*. The Options Calculator consists of easy-to-use software for valuing a wide range of options. The worksheets are now unlocked. The Applications Builder consists of a number of Excel functions from which users can build their own applications. It includes a number of sample applications and enables students to explore the properties of options and

numerical procedures more easily. It also allows more interesting assignments to be designed.

The software is described more fully at the end of the book. Updates to the software can be downloaded from my website

www.rotman.utoronto.ca/~hull

Slides

Several hundred PowerPoint slides can be downloaded from my website. Instructors who adopt the text are welcome to adapt the slides to meet their own needs.

Solutions Manual

As in the fifth edition, end-of-chapter problems are divided into two groups: "Questions and Problems" and "Assignment Questions". Solutions to the Questions and Problems are in *Options, Futures, and Other Derivatives: Solutions Manual* (ISBN: 0-13-149906-8), which is published by Prentice Hall and can be purchased by students.

Technical Notes

A new feature of the sixth edition is the use of Technical Notes. These elaborate on points made in the text and can be downloaded from my website.

www.rotman.utoronto.ca/~hull

By not including the Technical Notes in the book, I was able to streamline the presentation of material so that it is more student friendly.

Online Training

In conjunction with Learning Dividends, Inc., I have developed e-Learning material entitled *Hull on Derivatives* to accompany the first half of the book. This consists of 14 modules with fully animated and narrated instruction. For more information visit

www.hullonderivatives.com

Acknowledgments

Many people have played a part in the production of this book. Academics, students, and practitioners who have made excellent and useful suggestions include Farhang Aslani, Jas Badyal, Emilio Barone, Giovanni Barone-Adesi, Alex Bergier, George Blazenko, Laurence Booth, Phelim Boyle, Peter Carr, Don Chance, J.-P. Chateau, Ren-Raw Chen, Dan Cline, George Constantinides, Michel Crouhy, Emanuel Derman, Brian Donaldson, Dieter Dorp, Scott Drabin, Jerome Duncan, Steinar Ekern, David Forfar, David Fowler, Louis Gagnon, Richard Goldfarb, Dajiang Guo, Jörgen Hallbeck, Ian Hawkins, Michael Hemler, Steve Heston, Bernie Hildebrandt, Michelle Hull, Andrew Karolyi, Kiyoshi Kato, Kevin Kneafsy, Iain MacDonald, Bill Margrabe, Eddie Mizzi, Izzy Nelkin, Neil Pearson, Paul Potvin, Shailendra Pandit, Eric Reiner, Richard Rendleman, Gordon Roberts, Chris Robinson, Cheryl Rosen, John Rumsey, Ani Sanyal, Klaus Schurger, Eduardo Schwartz, Michael Selby, Piet Sercu, Duane Stock, Edward Thorpe, Yisong Tian, Alan Tucker, P. V. Viswanath, George Wang, Jason Wei, Bob Whaley, Alan White, Hailiang Yang, Victor Zak, and Jozef Zemek.

I am particularly grateful to Eduardo Schwartz, who read the original manuscript for the first edition and made many comments that led to significant improvements, and to Richard Rendleman and George Constantinides, who made specific suggestions that led to improvements in more recent editions.

The first five editions of this book were very popular with practitioners and their comments and suggestions have led to many improvements in the book. I would particularly like to thank Dan Cline and David Forfar. The students in my elective courses on derivatives at the University of Toronto have also played a significant role the evolution of the book. Yves Noth from the University of St. Gallen provided excellent research assistance for this edition.

Alan White, a colleague at the University of Toronto, deserves a special acknowledgment. Alan and I have been carrying out joint research in the area of derivatives for the last 22 years. During that time we have spent countless hours discussing different issues concerning derivatives. Many of the new ideas in this book, and many of the new ways used to explain old ideas, are as much Alan's as mine. Alan read the original version of this book very carefully and made many excellent suggestions for improvement. He has also done most of the development work on the DerivaGem software.

Special thanks are due to many people at Prentice Hall for their enthusiasm, advice, and encouragement. I would particularly like to thank David Alexander, my editor, and Francesca Calogero, the finance assistant editor. I am also grateful to Scott Barr, Leah Jewell, Paul Donnelly, and Maureen Riopelle, who at different times have played key roles in the development of the book.

I welcome comments on the book from readers. My email address is:

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