Preface

This book was developed during many years of teaching derivatives to doctoral students in financial economics. The aim in writing it was to help fill the gap between books that offer a theoretical treatment without much application and those that simply present the pricing formulas without deriving them. The project was guided by the beliefs that understanding is not complete without practice at application and that applying results one doesn't understand is risky and unsatisfying. This book presents the theory but directs it toward the goals of producing practical pricing formulas for derivative assets and of implementing them empirically.

Teaching the theory of derivatives to Ph.D. students in economics or to doctoral finance students in business requires teaching some math along the way. I have tried to make the book self-contained in this regard by presenting the required basics of analysis, general probability theory, and stochastic processes. This development starts with chapter 2, which presents (and is devoted entirely to) the general mathematical background needed throughout the book. It continues in chapter 3 with the specific tools required for continuous-time finance, including the special theory needed to handle processes with discontinuous sample paths. Since teaching math is not the book's main purpose, the treatment is necessarily brief and emphasizes examples rather than proofs. Because appendices (like prefaces) tend to be ignored by students, I have chosen to present this background in the main text. Paging through chapters 2 and 3 will serve as a refresher to those who have had the required math. For those who have not, the material is there for more careful thought, as a guide to the mathematical literature, and as a reference to be consulted in the later chapters. The math-prep chapters and the general overview in chapter 1 comprise Part I: Preliminaries.

The book has two distinctive features besides the math lessons. First, the chapters in Part II: Pricing Theory, are organized around the assumptions made about the dynamics of underlying assets on which the derivatives depend. This allows us to progress from the relatively simple models that require little mathematical sophistication to the more complex ones that require a great deal. Thus, chapter 4 begins with pricing bounds and relations such as European put-call parity that apply very generally and are derived from simple static-replication arguments. Chapter 5 progresses to Bernoulli dynamics and the associated binomial approach to pricing in discrete time. Modeling the evolution of prices in continuous time begins in chapter 6 with the basic Black-Scholes theory for pricing European-style derivatives under geometric Brownian motion. Chapter 7 applies the same dynamic framework to American options and some of the many "exotic" varieties of contingent claims. Chapters 8 and 9 deal with more elaborate models based on diffusions with *ex ante* uncertain volatility and with discontinuous processes, respectively. Much of this material comes from very recent research literature. Finally, chapter 10 brings in stochastic models for interest rates and introduces readers to the literature on pricing interest-sensitive instruments.

The book's second distinctive feature is its detailed treatment of empirical and numerical methods for implementing the pricing procedures. This material is presented in Part III: Computational Methods, which comprises chapters on simulation, on the numerical solution of partial differential equations, and on computation. The last chapter is a summary list of FORTRAN, C++, and VBA programs on the accompanying CDROM that implement many of the basic pricing procedures discussed in the text: binomial pricing, Black-Scholes, the constant-elasticity-of-variance model, options on assets following mixed jump-diffusions, and others. There are also basic routines for generating pseudorandom numbers, for testing for randomness and adherence to specific distributional forms, for numerical integration and Fourier inversion, and for solving p.d.e.s numerically. The FORTRAN and C++ programs are presented in source form in order to guide readers in producing their own applications. Code for many of the Visual Basic for Applications routines can be viewed as macros within the spreadsheets that facilitate the input and output.

I have tried to supply enough detail in the derivations of pricing formulas to enable readers to follow the development without having to puzzle over each line. The amount of such detail declines as we move along, in

the expectation that readers are acquiring a mastery of technique as they progress.

The second edition is a complete revision of the first and adds several topics from recent research in the field. The chapter on fixed-income derivatives has been significantly expanded to include sections on the LIBOR market model and default risk. The chapter on discontinuous processes now includes two new models, one that allows jumps in volatility as well as price and another that accommodates stochastic variation in the mean frequency of price breaks. A new section on regime-change models opens up a number of flexible and computationally attractive strategies for parsimonious modeling of noisy processes. The chapter on stochastic volatility models presents a new and very fast technique for pricing European-style derivatives off the underlying characteristic function. Finally, the chapter on simulation now includes a detailed treatment of its application to American-style derivatives. Both to save space and to facilitate their use, the computer routines included in the first edition have been placed on an accompanying CDROM. An outline and general description still appears as chapter 13.

Besides graduate students in economics and doctoral students in business, others who should find this book useful include masters students or upper-level undergraduates in applied math courses, students in masters-level computational finance and financial engineering programs, those with prior math background who are being trained as practitioners, and non-specialist researchers who are trying to acquire some familiarity with the field of derivatives. Whether this book does help to fill the gap between the too-theoretical and the too-applied, I leave to the market to decide!

I am grateful to the many students who have commented on and corrected the course notes from which this book evolved; to Hua Fang and, especially, to Todd Williams, who proofed and gave detailed comments on several chapters in the first edition; and to Michael Nahas, who painstakingly translated my FORTRAN code into C++. The second edition owes much to Ubbo Wiersema, who suggested several additions, provided detailed comments on one of the chapters, and assisted in developing the VBA programs. For his capable work in producing these, I thank Ben Koulibali. Finally, I am indebted to my wife Mary Lee for her bounteous support, advice, and editorial assistance.

Queries about the book or reports of errors in the text or in the computer codes should be directed to twe@virginia.edu. Please include the initials "PDS" in the subject field. A current list of errata will be maintained at http://www.worldscibooks.com/economics/6243.html.