Preface

It has been our pleasure to have been invited by René Carmona and Nizar Touzi to edit this 5th volume of the Paris-Princeton Lectures on Mathematical Finance. The present volume contains four chapters touching on some of the most important and modern areas of research in mathematical finance: asset price bubbles; energy markets; investment under transaction costs; and numerical methods for solving stochastic equations.

In the first chapter, Philip Protter presents a comprehensive survey of the Mathematical Theory of Financial Bubbles. Understanding, defining, and detecting a bubble from observed prices is a long-standing challenge spanning ideas from economics, stochastic analysis, mathematical finance, and statistics. This chapter presents a broad review of the history and literature of the problem as well as the mathematics and an empirical analysis of some recent data.

The second chapter, by Fred Espen Benth, concerns analysis and models for energy markets, particularly electricity (or power) prices. Here, short-term spikes are of paramount importance and the author describes using Lévy processes to try and capture this. In particular, he focuses on introducing stochastic volatility effects and on valuation of energy derivatives such as forwards and cross-commodity spread options. This covers part of a growing area as energy markets become more financialized and a greater part of the financial economy.

In the third chapter, by Paolo Guasoni and Johannes Muhle-Karbe, the problem of investment choice in the presence of transaction costs is surveyed in the form of a User's Guide. The problem has a long history and brings interesting problems in singular stochastic control when analyzed in the typical framework of continuous time models. Recently there have been some important breakthroughs, involving the so-called shadow prices, that have led to a burst of activity in understanding how to optimally invest under this friction. The authors bring us up to date on this progress and list some open problems.

The final chapter, by Crisan, Manolarakis and Nee, discusses numerical methods for solving stochastic differential equations (SDEs) based on cubature. The theory and analysis, including tools from Malliavian calculus, are introduced from scratch, and some financial applications are studied. The fourth section also develops cubature methods for backward SDEs, including numerical examples demonstrating the impressive performance.

We thank the authors for their outstanding contributions, as well as those we enlisted as anonymous referees for their hard work and valuable suggestions that improved the chapters.

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