

Preface

Whether you work in fund management, a business school, or a university economics or mathematics department, the title of this book, *Optimal Investment*, promises to be of interest to you. Yet its contents are, I guess, not as you would expect. Is it about the practical issues of portfolio selection in the real world? No; though it does not ignore those issues. Is it a theoretical treatment? Yes; though often issues of completeness and rigour are suppressed to allow for a more engaging account. The general plan of the book is to set out the most basic problem in continuous-time portfolio selection, due in its original form to Robert Merton. The first chapter presents this problem and some variants, along with a range of methods that can be used for its solution, and the treatment here is quite careful and thorough. There is even a complete verification of the solution of the Merton problem! But the theorem/proof style of academic mathematical finance quickly palls, and anyone with a lively imagination will find this too slow-moving to hold the attention.¹ So in the second chapter, we allow ourselves to run ahead of proof, and present a large number of quite concrete and fascinating examples, all inspired by the basic Merton problem, which rested on some overly specific assumptions. We ask what happens if we take the Merton problem, and change the assumptions in various ways: How does the solution change if there are transaction costs? If the agent's preferences are different? If the agent is subject to various kinds of constraint? If the agent is uncertain about model parameters? If the underlying asset dynamics are more general? This is a chapter of variations on the basic theme, and many of the individual topics could be, have been, or will be turned into full-scale academic papers, with a lengthy literature survey, a careful specification of all the spaces in which the processes and variables take values, a detailed and thorough verification proof, maybe even some study of data to explore how well the new story accounts from some phenomenon. Indeed, this is very much the pattern of the subject, and is something I hope this book will help to put

¹ ... but anyone who wants to get to grips with the details will find exemplary presentations in [30] or [21], for example.

in its proper place. Once the reader has finished with [Chapter 2](#), it should be abundantly clear that in all of these examples we can very quickly write down the equations governing the solution; we can very rarely solve them in closed form; so at that point we either have to stop or do some numerics. What remains constitutes the conventional steps of a formal academic dance. So the treatment of the examples emphasizes the essentials—the formulation of the equations for the solution, any reduction or analysis which can make them easier to tackle, and then numerically calculating the answer so that we can *see* what features it has—and leaves the rest for later. There follows a brief chapter discussing numerical methods for solving the problems. There is likely little here that would surprise an expert in numerical analysis, but discussions with colleagues would indicate that the Hamilton-Jacobi-Bellman equations of stochastic optimal control are perhaps not as extensively studied within PDE as other important areas. And the final chapter takes a look at some actual data, and tries to assess just how useful the preceding chapters may be in practice.

As with most books, there are many people to thank for providing support, encouragement, and guilt. Much of the material herein has been given as a graduate course in Cambridge for a number of years, and each year by about the third lecture of the course students will come up to me afterwards and ask whether there is any book that deals with the material of the course—we all know what that signifies. At last I will be able to answer cheerfully and confidently that there is indeed a book which follows closely the content and style of the lectures! But this book would not have happened were it not for the invitations to give various short courses over the years: I am more grateful than I can say to Damir Filipovic; Anton Bovier; Tom Hurd and Matheus Grasselli; Masaaki Kijima, Yukio Muromachi, Hidetaka Nakaoka, and Keiichi Tanaka; and Ralf Korn for the opportunities their invitations gave me to spend time thinking through the problems explained in this book. I am indebted to Arie Iserles who kindly provided me with numerous comments on the chapter on numerical methods; and I am likewise most grateful to my students over the years for their inputs and comments on various versions of the course, which have greatly improved what follows. And last but not least it is a pleasure to thank my colleagues at Cantab Capital Partners for allowing me to come and find out what the issues in fund management really are, and why none of what you will read in this book will actually help you if that is your goal.

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Chris Rogers

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Rogers, L.C.G.

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