B O O K   R E V I E W

Yuri Kabanov and Mher Safarin: Markets with transaction costs

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Classic financial models, such as the Black–Scholes one, rely on markets without frictions. It is well known that in complete markets without frictions, options can be priced by replication. However, trading in real markets can involve substantial costs. *Markets with Transaction Costs* provides the mathematical background for dealing with proportional transaction costs. It is the first book to compile the results from a substantial body of literature coherently in a single volume, and thus may be valuable to researchers looking for a theoretical foundation for their models. The book's sub-title, "Mathematical Theory," is important for it is a mathematically rigorous book. Therefore, the financial or economic generalist may gain little from the book apart from an in-depth discussion of Leland's (1985) seminal model. The book covers three major topics: the approximate replication of contingent claims, no-arbitrage pricing theory with transaction costs, and an optimal control problem.

In the first chapter, "Approximate Hedging," Kabanov and Safarin review the Le-land (1985) model and provide additional proofs. They discuss the problem of approximating the terminal payoff of options with a hedging strategy when transaction costs depend on the number of hedging portfolio revisions. Because of the practical relevance of the Leland (1985) model, this chapter may be of interest to a more general audience.

The second chapter is an exposition of discrete-time arbitrage theory in markets without frictions, which is extended to markets with transaction costs in the third chapter. Inspired by Schachermayer (2004), the authors investigate the fact that a straightforward extension of the fundamental theorem of asset pricing does not hold in general for infinite-state markets with frictions. They proceed to discuss alternative

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formulations and super-replicating portfolios for hedging American and European options.

The fourth chapter deals with Merton's (1971) seminal model of choice between consumption and investment when transaction costs are considered (Davis and Norman 1990). In this setting, the model becomes much more complex and the authors cover the theory of viscosity solutions first proposed by Shreve and Soner (1994).

Some of the original articles cited in this volume are 20 years old, but the authors have incorporated up-to-date results. Except for the last part of the book, most of the chapters can be read and understood as stand-alone pieces. The notation, exposition, and style of the book are typical of mathematical texts but, fortunately, intermediate steps are usually provided. The authors also provide additional comments and remarks, making the results much more accessible. The "Bibliographical Comments," where the authors relate the sections of the book to the original literature, are especially helpful. Personally, I would have preferred these to be incorporated into the main text and not as a separate section at the end of the book because, ultimately, it is this section that allows the reader to access the subject beyond the results selected by the authors. It is also evident that Kabanov and Safarin do some editorializing in the less mathematical sections when they present their own view of the field and how it has evolved. These parts are interesting, but the bread and butter of the text are the mathematical proofs. Hence, as is true of any text dealing with complex problems in mathematical finance, the reader needs to be acquainted with its foundations, such as martingale theory. Of some help in this regard is an appendix containing auxiliary results. By compiling the results and presenting them within a greater scope, Kabanov and Safarin have succeeded in creating the first book to summarize some of the major contributions in the mathematical finance literature on proportional transaction costs. They tackle a variety of problems but never lose focus. Because of the challenging nature of its topic, the book is obviously not aimed at an audience lacking a background in mathematical finance, but to those who have such knowledge, I recommend it as a stepping stone to the research field of transaction costs.

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