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MATHEMATICAL MODELS IN FINANCE

Edited by S.D. Howison, F.P. Kelly, and P. Wilmott

A BOOK REVIEW

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The book consists of 13 papers and numerous discussions about the relation between applied mathematics and finance. It includes thorough reviews of research problems, which attract the attention of both academic people and practitioners. All papers follow two basic directions in mathematical finance. The first is the well-known "mean-variance" analysis of portfolio and the second one is the methodology used in the financial industry by Black-Scholes formula.

The content is as follows:

[1] R.C. Merton, Influence of mathematical models in finance on practice: past, present and future, 1-13.
[2] S.D. Howison, Applied mathematics and finance, 15-20.
[3] H. Follmer, Stock price fluctuation as a diffusion in a random environment, 21-33.
[4] M.H.A. Davis and J.M.C. Clark, A note on super-replicating strategies, 35-44.
[5] W.T. Ziemba and C.R. Hensel, Worldwide security market anomalies, 45-59.
[6] D. Harding, Making money from mathematical models, 61-65.
[7] J.N. Dewynne, A.E. Whalley and P. Wilmott, Path-dependent options and transaction costs, 67-79.
[8] A. Bensoussan, M. Crouhy and D. Galai, Stochastic equity volatility and the capital structure of the firm, 81-91.
[9] H.M. Markowitz, The general mean-variance portfolio selection problem, 93-99; General discussion, 101-104.
[10] S.R. Pliska and M.J.P. Selby, On a free boundary problem that arises in portfolio management, 105-111.
[11] R.H. Brown and S.M. Schaefer, Interest rate volatility and the shape of the term structure, 113-126.
[12] D. Duffie and R. Kan, Multi-factor term structure models, 127-136.
[13] S.D. Hodges, Dynamic asset allocation: insights from theory, 137-148.

Paper [1] surveys the history of the development of mathematical models in finance during the last 30 years.

In [2] and [6] the authors discuss the interaction of theoretical and practical economics and mathematics. In general, they outline future directions making even some comments on how to make money from mathematical models.

In [9] H. Markowitz presents a generalization of a portfolio problem, its solution, and a brief discussion on its use in practice. J. Plymen surveys new problems devoted to mathematicians interested in finance.

An application of Black-Scholes formula is discussed in [3], [4], [8], and [10]. The authors assume that the basic model for the price evolution of a financial asset is the geometric Brownian motion or any its extension. Various types of problems are considered: How the random environment can be generated by the interaction of a large set of agents modeled by Markov chains (see [3]) and how to approximate the equity volatility and to apply it to a firm financed with equity and debt (see [8]).

Such a challenging area as anomalies in security market takes place in [5]. The authors raise key questions in studying the anomalies and concentrate their attention on the turn-of-the-month effect and the results in worldwide markets.

The transaction costs are introduced in [4], [7], and [10]. In [4] the authors prove that the only possible candidates for super-replicating strategies are those that track the Black-Scholes portfolio closely by introducing suitable reflecting barriers, i.e., when the sell and buy barriers are too close. A model for pricing exotic options with transaction costs in terms of differential equations is described in [7]. The effect of transaction costs is discussed. The optimal management of a portfolio, when there are transaction costs proportional to a fixed fraction of the portfolio value, is modeled in [10].

The term *structure of interest rate* is the basic topic in [11] and [12]. In [11] the models are characterized by an affine relation between the drift and diffusion coefficients. In [12] the authors review stochastic models developed after the Black-Scholes option pricing model and the ideas of Merton. The models are applied to single-factor and multi-factor cases when the current term structure in a finite-dimensional state space is represented by Markov diffusion.

Finally, [13] surveys the theory of dynamic asset allocation. The author considers the key ideas in the area. Many examples enrich the exposition.

Future directions are presented in [1], [2] and [12]. The discussions at the end of the papers provide further developments and generate new problems. The modern directions of mathematical finance, like time series modeling and stable distributions, are included in the discussions as well as the suggestion to use the methods of mathematical finance in actuarial sciences.

The book will be helpful for everyone with interest in financial mathematics.

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