Preface

**Marida Bertocchi · Georg C. Pflug ·
Hercules Vladimirov**

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Since Markowitz's seminal work on portfolio optimization in the 1950s the interplay between the disciplines of finance and operations research has remained strong and mutually beneficial. The area of finance has been a continuous source of challenging problems that have influenced research efforts on analytical and numerical solution methods for complex decision problems. Important problems in finance provided the impetus for the development of advanced modelling approaches in stochastics, mathematical programming, simulation of complex stochastic and dynamic systems, game theoretic approaches for decision support in competitive environments, etc. As a result, modelling, methodological, and algorithmic advancements in operations research can address diverse financial planning problems of great practical significance. Notable contributions have been made in a wide range of topics: pricing of complex securities, valuation techniques for dynamic multistage decision problems, risk measurement and control, portfolio and asset-liability management, risk management, design of innovative financial products, etc.

Quantitative financial planning problems are commonly governed by various uncertain factors such as interest rates, exchange rates, stock market fluctuations, credit rating migrations, reactions of competitors, etc. Accounting for the impact of various random factors and their interactions is essential in solving practical financial decision problems. The trends of globalization and liberalization are reshaping the competitive business environments and create new opportunities as well as new challenges. The competitive pressures in these environments, as well as new regulatory frameworks (e.g., the Basel II Accord governing risk monitoring and control in the banking sector) that are revised in response to severe financial

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M. Bertocchi
University of Bergamo, Bergamo, Italy

G.C. Pflug (✉)
University of Vienna, Vienna, Austria
e-mail: georg.pflug@univie.ac.at

H. Vladimirov
University of Cyprus, Nicosia, Cyprus

failures in previous years, make the development, implementation, and practical adoption of sophisticated decision support tools an imperative necessity in the financial sector. Operations research methods can play an important role in this respect.

The paradigm of stochastic programming provides an effective framework to model and analyze financial decision making problems under uncertainty. Stochastic programming models can accommodate alternative representations of uncertainty by means of scenario trees that are not restricted to specific distributional assumptions. Discrete approximations can capture asymmetric and leptokurtic distributions of random financial variables that are observed in market data. Regulatory requirements, managerial guidelines, operational issues, and other practical concerns (e.g., transaction costs) can be incorporated in stochastic optimization programs with appropriate constraints. Moreover, appropriate model features can be employed to capture the decision maker's risk bearing attitudes. Thus, stochastic programming models can be flexibly tailored to suit various practical decision settings. The flexibility of stochastic programs attracts the interest of researchers and practitioners alike, and notable applications have been developed for challenging financial problems in recent years.

Motivated by the current vigorous activity in the operations research community aimed towards the development of advanced methods and practical decision support tools for financial applications, we organized a series of international workshops with the overall theme "*Mathematical Optimization Models for Financial Institutions*." Three workshops were organized in the context of the program *EUMOptFin* with funding from the European Commission and covered the respective topics: *The technology of asset and liability modelling* (Semmering, Austria, January 2003); *Asset and liability modelling for financial institutions* (Agia Napa, Cyprus, November 2003); *The drivers of performance of financial institutions* (Bergamo, Italy, May 2004).

Each workshop was a five-day event and provided a forum for scientific discussions and exchanges of experiences between senior researchers, practitioners, and young scientists. Teams of guest speakers from academia and industry delivered tutorials on state-of-the-art methods and practical applications. Groups of about 40 young researchers (junior faculty, post-doctoral fellows, and PhD students) participated in each workshop and had the opportunity to present their work and receive feedback from the peers. A wide range of related topics were discussed during the workshops: such as multistage stochastic programming models, scenario generation methods for dynamic processes of stochastic financial factors, modelling of extreme events, risk and performance measures, algorithmic approaches to efficiently solve large-scale optimization programs by capitalizing on special program structures, drivers of performance in financial institutions, means for comparative assessment of performance, efficiency and effectiveness of financial units, as well as applications in managing asset and liability portfolios (e.g., pension funds, insurance products), hedging financial risks, etc. The current volume is essentially a product of the *EUMOptFin* program.

Dupacova and Polivka consider a multistage stochastic programming model for managing a defined contribution pension fund. Incorporating the model specific statutory requirements of pension funds in the Czech Republic, they explore scenario generation methods to project plausible asset and liability values over the fund's planning horizon that account for the lack of historical data. They employ output analysis to assess the scenario generation procedures. Their numerical tests reveal that the initial composition of the fund plays an important role in its subsequent performance because of the influence of the statutory requirements on capital allocation policies.

In multistage stochastic programming models decisions are taken at pre-specified points in time. Moreover, in these models the stochastic evolution of random input parameters

is represented by discrete approximations (often sparse for computational reasons) of the underlying distributions. *Smid* studies the expected loss that is associated with the solution of the approximating stochastic program. Under certain assumptions he derives an upper bound and an estimate of the convergence rate of the expected loss with respect to the discretization of the distribution.

Barro and *Canestrelli* employ a multistage stochastic program to track a benchmark in a dynamic setting. Their model aims to select portfolios with a limited set of assets so as to closely replicate the performance of a broadly defined index. They discuss the suitability of different tracking error measures when the model is extended to a dynamic decision setting that incorporates rebalancing decisions, transaction costs, and liquidity considerations. Through empirical tests they demonstrate that the dynamically optimized tracking portfolios replicate a market index more closely than static tracking strategies.

Krzemienowski examines a conditional average risk measure that may potentially be applied to general distributions and discusses its relation to the familiar measures of value-at-risk (VaR) and conditional value-at-risk (CVaR). He shows that the preference structure introduced by the conditional average measure corresponds to the preference structure induced by dual prospect stochastic dominance. He illustrates optimization models with the conditional average risk measure, in general, using the conditional average measure as objective results in a non-convex quadratic program. In the case of a probability distribution with a finite support it leads to a mixed integer program. The author experiments with the risk measure in an empirical analysis using market data.

The computation of the value-at-risk (VaR) measure requires the specification, or the empirical estimation, of the profit-loss distribution. Empirical evidence shows that this distribution is often asymmetric and leptokurtic, as is the case for portfolios of derivative securities or contingent claims. *Iaquinta*, *Lamantia*, *Messabo*, and *Ortobelli* describe and apply an estimating function methodology to determine percentiles (value the risk) of skewed distributions with fat tails. Their semi-parametric approach utilizes information on the first few moments of the return distributions. It is more flexible than parametric approaches that depend on restrictive assumptions regarding the profit-loss distribution and is computationally more efficient than a Monte Carlo approach.

Bellalah and *Wu* examine the effects of information costs, currency exchange risk, taxes, and diversification of operational cashflows on corporate decisions for international capital investments. They present a dynamic portfolio model that accounts for these as stochastic environmental factors. They use their model to investigate the impact of information costs, taxes and exchange risk, as well as their correlations, on corporate international investments. They find that real exchange risk and diversification motives are among the primary determinants of corporate international investment decisions in a setting of incomplete information.

Flaam views the exchange of risks as a transferable utility among risk averse economic agents in a cooperative game. He advocates that a risk cannot be properly priced in isolation (i.e., based only on its marginal distribution). He takes a game theoretic approach to pricing pooled risks in terms of a convolution of individual preferences, placing emphasis on the role of prices and incompleteness. Based on principles of Lagrangian duality he discusses questions of existence, uniqueness, and computation of equilibrium solutions.

De Palma and *Prigent* investigate the losses incurred by investors (in terms of expected utility) as a result of choosing from a limited set of standardized portfolios offered by financial institutions instead of following a customized investment strategy tailored to the investor's risk tolerance, planning horizon, and other individual considerations. They demonstrate a method to determine the optimal (customized) portfolio of the investor in an intertemporal setting. They compute, for a number of utility functions, the losses associated

with the limited choice of standardized portfolios compared to the optimal customized portfolio; and they demonstrate that these losses may be substantial.

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