



Optimization

Special Issue

Continuous Optimization in Finance

Dedicated to our dear teacher and friend
Prof. Dr. Hayri Körezlioğlu (1930-2006)

Editorial

Optimization publishes a small special issue on *Continuous Optimization in Finance*, a topic that is also one of the new research areas which in these years *EURO Working Group on Continuous Optimization (EUROPT)*; cf. <http://www.iam.metu.edu.tr/EUROPT/>) is strongly supporting. Indeed, continuous optimization has become a key technology in the entire financial sector which, reversely, poses new problems and research projects to optimization.

The special issue is concentrating on topics that are equally important in both financial mathematics and optimization theory. It (i) provides an overview of, and (ii) presents some important recent developments in *continuous optimization* regarding the analysis and prediction of *financial* processes focusing on theory, methodology, and applications.

The topics of the special issue include: (a) Financial Risk Management with Continuous Optimization, (b) Portfolio Optimization, (c) Regression Problems in Finance, and (d) Stochastic Optimization and Control in Finance.

This special issue would not have become possible with the encouragement, foresight and continuous guidance at each moment of preparation of the special issue given by **Prof. Dr. Juan Enrique Martínez-Legaz**, Editor in Chief of *Optimization*. Cordial gratitude to him by EUROPT and by the guest editor!

Let the contents of the articles shortly be summarized:

In the paper *DC Programming Approach for Portfolio Optimization under Step Increasing Transaction Costs*, Hoai An Le Thi, Mahdi Moeini and Tao Pham Dinh study the class of portfolio optimization problems under step increasing transaction; these problems are hard-to-solve. Step increasing functions are approximated arbitrarily fine by a differences of polyhedral convex functions yielding polyhedral DC programs. To these programs, the authors employ Difference of Convex functions Algorithm (DCA). They test the efficiency of DCA showing that DCA gives a very good approximation of the optimal solution within a short time, and rigorously compare it with CPLEX and the branch and bound algorithm of H. Konno et al..

Ralf Korn and Serkan Zeytun in their contribution *Solving Optimal Investment Problems with Structured Products under CVaR Constraints* consider a simple investment problem where besides stocks and bonds the investor can also include options into the investment portfolio. They

introduce into the problems related with such structured products. The aim of the investor is to maximize the expected return under a conditional value-at-risk (CVaR) constraint. Due to possible intermediate payments, the authors deal with a reinvestment problem which turns the originally one-period problem into a multi-period one. For solving this problem, they present an iterative scheme based on linear optimization.

The paper *An Exact Algorithm for Factor Models in Portfolio Selection with Roundlot Constraints* by Xiaoling L. Sun, S.F. Niu and D. Li is concerned with a portfolio selection problem posed by H. Markowitz. It studies a factor model with roundlot constraints. This mathematical model leads to a quadratic integer programming problem. The authors exploit the separable structure of the model in order to derive Lagrangian bounds. A branch-and-bound algorithm based on the Lagrangian relaxation and continuous relaxation is then developed for solving this model. Computational results are reported for test problems with up to 150 securities.

Static hedging strategies for barrier options have been the focus of various studies, with the primal optimization problem being well understood but the form of dual of the static hedging problem having been unknown before. The paper *Duality in Static Hedging of Barrier Options* of Jan H. Maruhn closes this gap by exploiting a linear semi-infinite reformulation of the static super-replication problem in the Black-Scholes model. The feasible set of the dual problem turns out to consist of all measures which are price-consistent with the calls in the hedge portfolio. Moreover, the author proves the existence of an optimal measure solving the dual problem and analyzes the duality result from a financial point of view. Careful interpretations are provided throughout the paper.

R. Cont recently proposed two measures of model uncertainty in the context of derivative pricing: one measure based on a coherent risk measure compatible with market prices of derivatives, and another measure based on convex risk measures. In his paper *Measures of Model Uncertainty and Calibrated Option Bounds*, Mustafa Ç. Pınar shows in a discrete time, finite state probability setting that the two measures introduced by Cont are closely related to calibrated option bounds studied recently by A. King et al.. The precise relationship is established through convex programming duality, so that the model uncertainty measures can be computed efficiently by solving convex programming or LPs. Numerical results are provided.

In their paper *Robust Mid Term Power Generation Management*, Vincent Guigues, René Aid, Papa Momar Ndiaye, François Oustry and François Romanet consider robust formulations of the mid-term optimal power management problem. For this type of problems, classical approaches minimize the expected generation cost over a horizon of 1 year, and model the uncertain future by scenario trees. In the authors' setting, when an extreme event occurs, strategies devised with the classical approach can result in significant financial losses. They consider two robust formulations preserving the separable structure of the original problem. Numerical results assess the validity of the approaches.

For pricing of interest rate derivatives, various stochastic interest rate models of different shapes are used. In Martin Reiner's paper *Calibration of Stochastic Models for Interest Rate Derivatives*, calibration of the state of a given stochastic model to some target state implies a continuous optimization of the model parameters, delivering a global minimum of the distance between target and model state. A new algorithm is presented which operates in the model parameter space on an adaptive lattice, allowing a considerable performance gain achieved. Indeed, comparisons with algorithms that employ nonadaptive lattices and with other nonlinear

regression methods as well as a numerical example show the advances given by the new algorithm.

The guest editor is convinced that all papers selected for this special issue constitute valuable contributions to many different areas in Financial Mathematics employing methods from Continuous Optimization and related fields, herewith representing *Optimization* as a premium journal in important and challenging areas of optimization theory and Operations Research. He thanks to the 23 referees who served with their rigorous referee reports and to all colleagues who participated in this exciting endeavor with care and vision, for their highly appreciated help.

This special issue is accompanied by 3 further articles which are going to appear in regular issues of *Optimization*: *Robustness Properties of Mean-Variance Portfolios* by Katrin Schöttle and Ralf Werner, *Discrete Control and Algorithms for Solving Antagonistic Dynamic Games on Networks* by Dmitrii Lozovanu and Stefan Pickl, and *Pricing American Contingent Claims by Stochastic Linear Programming* by Ahmet Camcı and Mustafa Ç. Pınar. These three papers were carefully evaluated by nine referees. The 10 contributions - the ones in the special issue and the ones in regular issues – altogether amount to our endeavor on continuous optimization in finance!.

When the first submissions to this special issue were made, *Prof. Dr. Hayri Körezlioğlu* passed way. He was the founder of the first Department of Financial Mathematics in Turkey; it is part of Institute of Applied Mathematics of Middle East Technical University in Ankara. Professor Körezlioğlu supported this special issue from the early days of its pre-consideration, and numerous authors and referees did their creative and responsible work in his commemoration.

Gerhard-Wilhelm Weber

(Guest Editor)

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