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EDITORIAL

Data-driven optimization in management

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Original articles

(1) CMSC-D-17-00014_R5: Gabriele Torri, Rosella Giacometti and Sandra Paterlini: Sparse Precision Matrices for Minimum Variance Portfolios.
Length 30 pages space 1

(2) CMSC-D-17-00018_R3: Margherita Giuzio and Sandra Paterlini: Undiversifying during crises: is it a good idea?
Length 30 pages space 1

(3) CMSC-D-17-00019_R2: Diana Barro, Elio Canestrelli and Giorgio Consigli: Volatility vs downside risk: performance protection in dynamic portfolio strategies.
Length 48 pages space 1
Tutorial

(4) CMSC-D-17-00012_R2: Algo Carè, Simone Garatti and Marco C. Campi: The Wait-and-Judge Scenario Approach Applied to Antenna Array Design.
Length 20 pages space 1

Editorial

This featured cluster includes a selected set of articles submitted to CMS following a research cooperation focused on optimization and computational methods in management between the *School of Industrial and Systems Engineering (ISyE)* at the Georgia Institute of Technology and the *Department of Management, Economics and Quantitative Methods* at the University of Bergamo. As Guest Editors of CMS, when proposing this cluster, we aimed at collecting contributions that address the use of data to pose and solve management optimization problems common in operational contexts. The area of data-driven optimization continues to attract interest not only in finance but in several other subject areas, such as energy, transportation, supply chain management, and logistics.

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In this featured cluster we include three original articles, all on the subject of finance, and one paper that presents a tutorial on the wait-and-judge approach. The content of the three finance articles is clearly influenced by the persistent condition of financial instability and high volatility experienced by global markets in the aftermath of the 2008 crisis. They are ordered within the cluster considering first two contributions relying on static optimization methods, the first of which by Torri et al. with a relevant methodological content and the second by Giuzio and Paterlini addressing directly the implications of high market correlations for portfolio managers, and then the article by Barro et al. employing a dynamic optimization approach again in the presence of alternative volatility regimes.

As fourth contribution we present the tutorial by Carè et al. on the application of the wait-and-judge approach. The wait-and-judge approach is a general-purpose approach to evaluate the risk of constraint violation of a scenario-driven solution, based on the number of scenarios that the solution depends on. The paper demonstrates the application of the wait-and-judge approach on an antenna array design problem.

The article on Sparse Precision Matrices for Minimum Variance Portfolios by Torri, Giacometti and Paterlini focuses on regularization methods used in the estimation of the precision matrix, an essential input in mean–variance optimization and here considered for minimum variance portfolios. This is still considered in practice the reference model for risk minimization in equity markets, due to its simplicity in the optimization as well as its need for just one input, namely the inverse of the covariance estimate, or precision matrix. Two regularization methods are considered, glasso and tlasso, that provide sparse estimates of the precision matrix by penalizing its L1-norm. Glasso and tlasso rely on assumptions that the asset returns are respectively Gaussian or Student-t distributed. Torri et al. present simulation and real-world results supporting the proposed methods compared to state-of-the-art approaches, such as random matrix and Ledoit-Wolf shrinkage. The article by Giuzio and Paterlini also addresses a key issue for portfolio managers when faced by the risk of extreme losses, as during financial crises. In such situations, investing in few assets might be a better choice than holding diversified portfolios. Giuzio and Paterlini show that constraining the sparse lq-norm of portfolio weights automatically controls diversification and selects portfolios with a small number of active weights and low risk, in presence of high correlation and volatility. An interesting comparison is developed between minimum variance portfolios, risk budgeting strategies, and diversification-constrained portfolios. Giuzio and Paterlini complete their analysis by showing empirically that the lq-strategy can successfully cope with bear markets by shrinking portfolio weights and total amount of shorting.

The third article by Barro et al. still focusing on a portfolio management problem develops an interesting decision model based first on the definition of a volatility-based early warning signal and then on the derivation of the more appropriate risk control approach. Volatility-based and volatility targeting approaches have indeed become popular among equity fund managers after the introduction in 1993 of the VIX, the implied volatility index on the SP500 followed, in 2004, by futures and option contracts on the VIX: since then we have assisted to an increasing interest in risk control strategies based on market signals. As a result, specifically in the US, portfolio strategies based on combinations of market indices and derivatives have been

proposed by Stock Exchanges and investment banks. While rather effective in reducing the downside risk, those index-based portfolio approaches do not allow an optimal risk-reward trade-off and may not be sufficient to control financial risk originated by extreme market drops. Barro et al. propose a linear programming model, based on mean-absolute deviation functions, to portfolio management jointly focusing on volatility and tail risk controls and able to accommodate effectively the return payoffs associated with option strategies, whose cost as market volatility increases may become excessive. The results presented span two decades and include several financial crises: they confirm that optimal volatility controls produce better risk-adjusted returns if compared with rule-based approaches. Moreover the portfolio return distribution is dynamically shaped depending on the adopted risk management approach.

The fourth and final contribution considers the scenario-driven optimisation approach. This is a methodology for finding solutions to uncertain optimization problems by using data or scenarios. An important performance metric of such a solution is its risk, defined as the probability that an empirical cost threshold will be exceeded when the scenario-based solution is adopted. While standard theory of scenario optimisation has related the risk of the scenario-based solution to the number of optimisation variables, a more recent approach, called the wait-and-judge approach, enables the user to assess the risk of the solution in a data-dependent way, based on the number of decisive scenarios ("support scenarios"). The tutorial demonstrates the application of the wait-and-judge approach using an antenna array design problem. The main concepts of antenna array design are introduced in the first part of the article along with a numerical instance of the problem. This problem is used as an ongoing example throughout the paper to demonstrate the application of the wait-and-judge approach on practical problems.

By completing this featured cluster on Data-driven Optimization for CMS, we would like to thank Ruediger Schultz, Editor-in-Chief of Computational Management Science, for his continuous support.

Guest Editors Anton Kleywegt and Giorgio Consigli, ISyE, GeorgiaTech and DMEQM, UniBG, April 2019

Note added by Editor-in-Chief

The present issue is completed by two papers on decision making under uncertainty, To handle complex hydro-valleys and highly constrained reservoirs. Alexia Marchand, Michel Gendreau, Marko Blais, and Jonathan Giudi propose a new form of operating rules, and a solution approach to solve the short-term planning problem directly in the space of rules. Their computational tests on real instances from Hydro-Québec show that the new approach is able to find good stochastic solutions while respecting the operational timing. Didem Sarı Ay and Sarah M. Ryan propose two approaches for assessment of scenario generation methods using past instances that do not require solving stochastic programing (SP) instances.Instead of comparing scenarios to observations directly, the impact of each scenario in the SP problemi is made the basis for

comparison. Computational tests are run for SP models of server location and unit commitment.