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EDITORIAL

Financial Optimization: optimization paradigms and financial planning under uncertainty

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This special issue provides a collection of research articles addressing different financial management and valuation problems arising in modern financial markets. When this issue was first proposed to the Journal Editor, our initial goal was to collect a set of articles considering similar financial optimization problems, but relying on different methodological approaches and alternative underlying statistical assumptions on market stochastics. As guest editors we are currently also completing a companion volume with Springer—as part of its International Series in Operations Research and Management Science, titled *Optimal Financial Decision Making under Uncertainty* —which is expected to be published by the end of 2015, and whose content is complementary to the one presented in this special issue.

Jointly, the two publications offer an extensive overview of different modeling frameworks and mathematical approaches currently adopted in a wide range of financial domains.

At the end of this editorial effort, some relevant features of the articles included in this issue are worth mentioning:

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- The substantial relaxation of what we may refer to as *mainstream* finance assumptions on both portfolio selection and derivatives valuation, leading to a set of new models, consistent with stylized facts observed in real markets, and relying on the concept of model risk or ambiguity.
- The adoption of novel and more realistic assumptions on the stochastic behavior of underlying returns in the contributions focusing on portfolio selection and asset–liability management problems.
- The attention devoted to an accurate formulation of optimal controls in dynamic programs based on discrete or continuous time models and combinations thereof, offering a new set of results on time consistency and modeling formulations, particularly effective for long-term financial planning problems.
- The methodological challenges brought about by increasingly realistic modeling frameworks in the different application domains.

All the articles included in the special issue not only document the progress in the state-of-the-art in the respective application and methodological fields, but also carry a relevant underlying motivation to remove unrealistic assumptions that have previously limited the practical applicability of those methodological approaches. Stylized evidence that has emerged in the recent financial history often provides starting points of the analyses and is called upon to motivate a given mathematical formulation.

Reading through the articles and sharing the final ordering of the collected articles—a subset of the many submissions we have received—an interesting partition can be proposed taking into account different perspectives. Focusing on the problems' mathematical formulation, the following details are relevant:

– New results on stochastic calculus, specifically in continuous time and space models, can be traced in articles Davis and Lleo (2015), Desmettre et al. (2015), Driouchi et al. (2015), Pagliarani and Vargiolu (2015) and, from a certain perspective, in Konicz et al. (2015).
– Discrete-time optimization and modeling frameworks characterize the contributions Bruni et al. (2015); Kopa and Post (2015); Dupacova and Kozmik (2015); Konicz et al. (2015): here, decision processes are defined in discrete time despite an underlying continuous time evolution, and the statistical characterization leads to highly realistic problem formulations, due to a positive trade-off between formulation realism and numerical complexity.
– Discontinuous stochastic dynamics in the market, Choquet uncertainty and Knightian ambiguity underlie and characterize the modeling framework in articles Davis and Lleo (2015), Desmettre et al. (2015), Driouchi et al. (2015), and Pagliarani and Vargiolu (2015).
– Stochastic dominance and dynamic time consistency of decision processes within optimization problems are key concepts in articles Konicz et al. (2015), Thiele and Cetinkaya (2015), Dupacova and Kozmik (2015), and Kopa and Post (2015).
– Article Dupacova and Kozmik (2015) has a strong dynamic stochastic programming flavor, while article Konicz et al. (2015) combines a stochastic programming with a stochastic control modeling framework. The latter is a key ingredient to the comprehension of articles Davis and Lleo (2015), Desmettre et al. (2015) and Pagliarani and Vargiolu (2015).

From the viewpoint of a financial characterization of the problem, the following subsets are of interest:

- Articles Dupacova and Kozmik (2015), Konicz et al. (2015), Davis and Lleo (2015), Desmettre et al. (2015) and Pagliarani and Vargiolu (2015) focus, under alternative modeling approaches, on dynamic portfolio selection problems, leading to closed-form solutions or qualified characterizations of optimal policies.
- Articles Bruni et al. (2015) and Thiele and Cetinkaya (2015) address static portfolio selection problems within a rather general set of assumption on market returns and decision criteria. Article Kopa and Post (2015) addresses stochastic dominance tests and presents a very general procedure to validate optimal portfolio choices under second-order stochastic dominance rules.
- Articles Konicz et al. (2015) and Driouchi et al. (2015) deal with relevant financial engineering applications.

For more details, below we summarize the key contributions of each article included in the special issue:

- Dupacova and Kozmik (2015): Extensions of *time-consistent risk measures* are studied within multistage stochastic programs, and a *stochastic dual dynamic programming* approach is proposed for their solution, exploiting the properties of coherent or polyhedral risk measures, as well as a decomposition into a sequence of sub-problems.
- Konicz et al. (2015): A combined model philosophy is proposed: a *multistage stochastic programming* is adopted from time 0 to T, whereas dynamic programming-based *stochastic control* is adopted from time T until a fixed life (assumed 85 years). Detailed constraints are included only during the first portion of the time horizon, whereas the second portion deals with end effects, and it leads to stationary strategies.
- Pagliarani and Vargiolu (2015): The key contribution here is related to the *characterization of the optimal control in terms of risky assets which depend only on time and a defaultable state but not on prices and wealth levels*. This is achieved by an underlying model in which the returns are discontinuous (defaultable exponential additive processes) and their coefficients are state dependent.
- Davis and Lleo (2015): The *stochastic control methodology is extended to address an ALM problem* which does not admit an analytical solution: it is shown, however, that the problem has a classical solution under two different sets of assumptions and *jump-diffusion uncertainty* on both assets and liabilities. It is also shown that *fund separation* still holds with up to six funds under a complex modeling framework.
- Desmettre et al. (2015): These authors study another *optimal portfolio allocation problem* in a market subject to a possibly (asymptotically) *infinite number of shocks* arriving at random times and with unknown consequences. Assuming CRRA investors, a concept of robustness is adopted to incorporate crash scenarios in the model, leading to the definition of worst-case crash scenarios. Crashes are not embedded in any probabilistic framework, allowing for model ambiguity and *Knightian uncertainty* within an otherwise canonical optimal allocation problem.
- Kopa and Post (2015): A general test to analyze *the second-order stochastic dominance* (SSD) of an asset portfolio relying on the solution of an LP problem is

presented: SSD efficiency takes the entire portfolio distribution into account rather than a finite set of moments. The key contribution here is related to the *test generality* and its implementation through a *pair of primal and dual LP problems*: the proposed technique turns out to be extremely efficient from a computational viewpoint. An inefficiency degree on feasible portfolios is also evaluated.

- Bruni et al. (2015): The authors tackle a portfolio performance assessment problem in relative terms, where a portfolio manager is assumed to follow a strategy aimed at *overperforming a stochastic market benchmark* and at the same time controlling the downside. As such, the article follows an established portfolio selection criterion, but here the benchmark portfolio is an index and the optimization problem is formulated as a *bi-criteria optimization* problem with *endogenous evaluation of the risk exposure* with a set of linear equations. The concept of *enhanced indexation* is relatively established but the formulation of the portfolio selection problem in the suggested form is innovative.
- Thiele and Cetinkaya (2015): A computationally efficient method is proposed to solve one period portfolio optimization problems with *quantile and inter-quantile constraints* on the terminal portfolio distribution. From a computational standpoint, the recursive approximation of the quantile constraints is tackled through a *sequence of LP problems* based on a progressive refinement of the quantile estimates. The authors present an interesting comparison for *increasing investment universes* of up to 2000 assets of the results generated when the quantiles are associated with a lognormal price distribution leading to an SOCP formulation and different approximation schemes.
- Driouchi et al. (2015): A short but nice piece of work, in which the canonical Black–Scholes–Merton and the Margrabe option pricing formulae are revisited taking into account market sentiment and *ambiguity issues* in the derivation of the pricing kernel. Model uncertainty is captured through a *Choquet–Brownian motion asset valuation* model. In this setting, MMBS prices are subcases. Unlike previous attempts, even if within a relatively simple analytical framework, the authors derive an extended set of *greeks* needed for hedging purposes from an ambiguity-consistent closed-form pricing formula.
- Cerqueti et al. (2015): Last but not least, this article offers a rich set of new mathematical results, that is, Markov chain bootstrapping methods for the case of *multivariate continuous random processes*. From a methodological viewpoint, the problem of partitioning the continuous state space is tackled by the solution of an *optimization problem,* to which contiguity constraints can be added to speed up the problem solution. The article is rather methodological and relevant from a statistical standpoint, but its results are easily applicable to credit risk analysis, regime-switching portfolio optimization models and price dynamics modeling. *Two case studies* to energy price modeling and financial market dynamics are considered to validate the approach.

Overall, we believe as Editors that the included contributions convey a rather remarkable degree of theoretical and scientific innovation with a strong applied philosophy.

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