Follow-up Workshop on Optimization in Finance

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CIM (International Center for Mathematics)

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Hotel Quinta das Lágrimas, Coimbra, Portugal

October 26-27, 2007

Contents

1 Conference Programme

Friday, October 26

16:30 - 17:30 Registration and Coffee.

17:30 - 18:30 Victor DeMiguel (London Business School), *A Generalized Approach to Portfolio Optimization: Improving Performance By Constraining Portfolio Norms.*

18:30 - 19:30 Jacek Gondzio (University of Edinburgh), *Parallel Solution Techniques in Very Large Scale Financial Planning Problems.*

20:00 Dinner.

Saturday, October 27

10:30 - 11:30 Ralf Werner (Technische Universität München & Hypo Real Estate Holding), *Consistency of Robust Portfolio Estimators.*

11:30 - 12:30 Alexandre d'Aspremont (Princeton University), *Identifying Small Mean Reverting Portfolios.*

12:30 - 15:00 Lunch.

15:00 - 16:00 Peter Laurence (Università di Roma "La Sapienza"), *Hedging Spread Options.*

16:00 - 16:30 Maik Wagner (Friedrich-Schiller University of Jena), *Newsvendor Model and its Application for the Non-Proportional Reinsurance Contract Excess of Loss.*

16:30 - 17:00 Patrícia Xufre (Universidade Nova de Lisboa), *Investment Strategies based on Supervised Learning.*

17:00 - 17:30 Coffee Break.

17:30 - 18:30 Ekkehard Sachs (University of Trier and Virginia Tech), *Optimization Methods in Calibration and Hedging.*

2 Titles and Abstracts — Invited Talks

Identifying Small Mean Reverting Portfolios

Alexandre d'Aspremont
Princeton University

Given asset price time series, we study the problem of forming portfolios with maximum mean reversion while constraining the number of assets in these portfolios. We show that this problem is equivalent to sparse canonical correlation analysis and study various algorithms to solve the corresponding sparse generalized eigenvalue problems. Finally, we test the performance of various convergence trading strategies on these portfolios.

A Generalized Approach to Portfolio Optimization: Improving Performance By Constraining Portfolio Norms

Victor DeMiguel
London Business School

In this paper, we provide a general framework for identifying portfolios that perform well out-of-sample even in the presence of estimation error. This general framework relies on solving the traditional minimum-variance problem (based on the sample covariance matrix) but subject to the additional constraint that the norm of the portfolio-weight vector be smaller than a given threshold. We show that our unifying framework nests as special cases the shrinkage approaches of Jagannathan and Ma (2003), Ledoit and Wolf (2004), and the 1/N portfolio studied in DeMiguel, Garlappi, and Uppal (2007). We also use our general framework to propose several new portfolio strategies. For these new portfolios, we provide a moment-shrinkage interpretation and a Bayesian interpretation where the investor has a prior belief on portfolio weights rather than on moments of asset returns. Finally, we compare empirically (in terms of portfolio variance, Sharpe ratio, and turnover), the out-of-sample performance of the new portfolios we propose to several strategies in the existing literature across five datasets. We find that the norm-constrained portfolios we propose have a lower variance and a higher Sharpe ratio than the portfolio strategies in Jagannathan and Ma (2003), Ledoit and Wolf (2004), the $1/N$ portfolio, and also other strategies in the literature such as factor portfolios and the parametric portfolios in Brandt, SantaClara, and Valkanov (2005).

Parallel Solution Techniques in Very Large Scale Financial Planning Problems

Jacek Gondzio
University of Edinburgh

Financial planning problems by their very nature involve uncertainty and therefore lead to very large-scale optimization problems. Their solution requires carefully designed optimization techniques and the use of high performance computing. These optimization problems display exploitable structure: the blocks corresponding to scenarios are linked through common variables corresponding to earlier stage investment decisions.

Decomposition methods are well-suited to tackle such problems [4, 5]. Moreover, parallel implementations of these techniques enjoy scalability. The main advantage of decomposition methods is that they can split a large problem into pieces hence they can solve larger problems than a direct approach. However, the main disadvantage of decomposition approaches is that they are usually slower than any direct approach (if the latter can handle the large problem).

An alternative to a parallelisation of a decomposition method is to implement a parallel direct solver. We explore such alternative in this talk. We have developed a structure-exploiting parallel interior-point solver for nonlinear programming problems. Its design uses object-oriented programming techniques [1, 6]. The program OOPS (Object-Oriented Parallel Solver: `http://www.maths.ed.ac.uk/~gondzio/parallel/solver.html`) can efficiently handle very large nonlinear problems and achieves scalability on a number of different computing platforms.

We illustrate its performance on a collection of quadratic and nonlinear programming problems with the sizes reaching 350 millions of constraints and 1010 millions of decision variables arising from asset liability management and portfolio optimization [2, 3].

This is a joint work with Andreas Grothey.

References

[1] J. Gondzio and A. Grothey, *Reoptimization with the primal-dual interior point method*, SIAM Journal on Optimization 13 (2003) No 3, pp 842–864.

[2] J. Gondzio and A. Grothey, *Parallel IPM solver for structured QPs: application to financial planning problems*, Annals of Operations Research 152 (2007) No 1, pp 319–339.

[3] J. Gondzio and A. Grothey, *Solving Nonlinear Portfolio Optimization Problems with the Primal-Dual Interior Point Method*, European Journal of Operational Research 181 (2007) No 3, pp 1019–1029.

[4] J. Gondzio and R. Kouwenberg, *High performance computing for asset liability management*, Operations Research 49 (2001) No 6, pp 879–891.

[5] J. Gondzio, R. Kouwenberg and T. Vorst, *Hedging Options under Transaction Costs and Stochastic Volatility*, Journal of Economic Dynamics and Control 27 (2003) No 6, pp 1045–1068.

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Hedging Spread Options

Peter Laurence
Università di Roma "La Sapienza"

We introduce the market implied co and antimonotonicity gaps and show how they can be used for investment in index options and spread options. The gaps are calculated by solving optimization problems for multivariate measures subject to moment constraints.

Optimization Methods in Calibration and Hedging

Ekkehard Sachs
University of Trier and Virginia Tech

Efficient optimization algorithms are becoming increasingly important in financial applications. We consider in this talk the pricing of derivatives and show how optimization can be used in different frameworks.

The model calibration is the most prominent area where optimization methods are needed. The problems range from small scale optimization problems to large scale including those with partial differential equations. For each of these there is a range of optimization methods available. We review some of these methods and highlight the important features of certain algorithms.

Another interesting application of optimization can be found in the design of hedging portfolios for exotic options using plain vanilla options. We concentrate on the hedge of barrier options which leads to semi-infinite programming problems.

The talk concludes with numerical examples and an outlook to future directions.

This is joint work with Jan Maruhn, University of Trier and HypoVereinsbank AG.

Consistency of Robust Portfolio Estimates

Ralf Werner
Technische Universität München & Hypo Real Estate Holding

It is a matter of common knowledge that traditional Markowitz optimization based on sample means and covariances performs poorly in practice. For this reason, diverse attempts were made to improve the performance of this portfolio optimization model. In this talk we investigate three popular portfolio selection models built upon classical mean-variance theory. The first model is an extension of the traditional mean-variance optimization by introducing robust estimators. Second, the recently being en vogue robust counterpart approach is considered. The list of models is concluded by an extended version of Michaud's resampling approach. We show that for a very broad class of portfolio constraints these models can be seen as a generalization of the classical mean-variance setting: The optimal portfolios converge to the true optimal Markowitz portfolio if only the sample size is large enough.

3 Titles and Abstracts — Contributed Talks

Newsvendor Model and its Application for the Non-Proportional Reinsurance Contract Excess of Loss

Maik Wagner
Friedrich-Schiller University of Jena

The classical newsvendor problem describes the optimal order quantity for a retailer sourcing a short life cycle product. The newsvendor problem can be modelled using a nonlinear cost function while also taking risk preferences into account. I discuss the application of this model to a special decision problem regarding non-proportional reinsurance covers. In particular, I relate the characteristics of the newsvendor model to those of a non-proportional reinsurance treaty, calculating optimal cover limits and deductibles for risk-averse insurers.

Investment Strategies based on Supervised Learning

Patrícia Xufre and António J. L. Rodrigues
Universidade Nova de Lisboa

The most common neurocomputational approaches to support trading decisions are based on price returns through supervised neural networks. The correponding two-step procedure, including separate forecasting and trading modules, may lead to significantly suboptimal investment strategies. On the other hand, some alternative neurocomputational approaches, including reinforcement learning and neurodynamic programming, have been proposed in the literature, in which the two modules are incorporated into a single system directly optimised with respect to some trading performance measure. However, in these approaches the learning process can be very difficult to accomplish successfully and efficiently. In this paper, we seek to demonstrate that, while preserving computational efficiency, it is possible to improve the financial performance of the forecast-based approach through not only a better optimization of the trading module, but also by considering more appropriate neural forecasting models. In particular, we propose more appropriate ways of designing the training patterns from nonstationary price data, and discuss new trading rules based on different forecast horizons, the optimal combination of several trading strategies, and the use of adaptation rules able to account for any transaction costs. These new proposalls are then tested and compared to previous ones, under different criteria, for several price time series, as well as with artificial data generated according to different stochastic models.

4 Organizers

- A. M. Monteiro, Faculty of Economics, University of Coimbra, Portugal.
- R. H. Tütüncü, Goldman Sachs Asset Management Quantitative Equity New York, USA.
- L. N. Vicente, Department of Mathematics, University of Coimbra, Portugal.

5 Support

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