

The Hull, the Feasible Set, and the Risk Surface: A Review of the Portfolio Modeling Infrastructure in R/Rmetrics

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Abstract

In this talk we give an overview of our current research and new tools for portfolio optimization implemented in R and Rmetrics.

We present the portfolio modeling infrastructure implemented in our R packages. We summarize the many different reward-risk models that can be solved by the software, ranging from standard mean-variance portfolio optimization, shortfall risk minimization, scenario optimization, reward/risk ratio maximization, and to general non-linear risk objectives. These can be subject to box, linear, group, quadratic covariance, general non-linear and integer constraints. At the heart of this approach to compute the efficient frontier of a portfolio is the “R Optimization Infrastructure”, which is currently under active development. This includes the ROI package by the Vienna group and the Rmetrics2AMPL library, written by our group at the ETH in Zurich. We discuss the differences and similarities of the two approaches and the advantages of each for use in portfolio design.

The optimized weights of portfolio that lie on the efficient frontier are neither optimally balanced nor diversified. Neither do the risk budgets or the tail dependence structure of the portfolio returns have minimum variance. We will show, from a risk point of view, what advantages an investor can achieve by investing in more risk-diversified portfolios than by investing in traditional efficient portfolios. For this, we present the implementation of new R functions to compute the hull of the feasible set, and to explore portfolios covering the whole feasible set. For each point we then compute performance and risk attributions and discuss their volatility and risk surface on top of the feasible set as a powerful graphical decision tool.

For the dynamical analysis of portfolios we report on an R generator tool for creating Google motion charts. Motion charts are dynamic Flash-based animations that can be used to explore several indicators or components of a complex adaptive system and to obtain further insight on its evolution over time. As an example, we show the temporal development of the efficient frontier of a mean-variance Markowitz portfolio. Besides allowing us to explore risk and reward dynamically, this approach also gives an insight into the co-movement of performance and risk attributions. In addition to the frontier chart, we can use line and bar charts in order to compare and better assess alternative investment decisions.

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