

Portfolio Analysis and Optimization with R/Rmetrics

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Keywords: finance, econometrics, portfolio optimization

Modern portfolio theory describes how rational investors will use diversification of investments to optimize their portfolios, and how risky assets should be priced. Financial asset returns are modeled by random variables, and a portfolio is composed as a weighted combination of these assets. A well-accepted mathematical description of portfolio theory was introduced by Markowitz in 1952 as a formal risk/return framework to support investment decision-making. However, there are important limitations to his original formulation, which form the starting point of our investigations.

The underlying assumption of modern portfolio theory states that the measure of investment risk is described by the sample variance of asset returns and that all securities can be adequately represented by a multivariate elliptically contoured distribution. These facts do not always represent the realities of the investment markets, where we are confronted with non-stationary behavior and unusual market behavior, due to structural breaks, bubbles, and even market crashes. Risk is becoming more and more related to bad outcomes and losses, which are considered to weigh more heavily than gains. This view has been put forward by researchers in finance, economics and psychology, which has in turn lead to the introduction of more sophisticated risk measures, such as value-at-risk or shortfall risk. Recent advances in portfolio and financial theory, coupled with today's increased computing power, have overcome some of these limitations. In this talk, we present the implementation of algorithms to support decision-making in portfolio risk analysis and optimization in the framework of the R/Rmetrics software environment. We present the software and selected examples for portfolio design beyond the approach of Markowitz. This includes exploratory data analysis of financial assets, risk measures, robust covariance estimates for portfolios, shortfall risk portfolios, performance analysis and rolling benchmark tests, and we also address the question of how portfolios can be made stress-resistant against unexpected market behavior.