Real estate in an asset allocation: an optimized portfolio through resampling

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Executive Summary

Introduction

Real estate in a multi-asset allocation requires special attention. As real estate assets generally have a low turnover and their market values might not be observable, it is challenging to estimate their risk and return characteristics. However, reliable performance data on an asset class is necessary to compare it to other asset classes and eventually to include it efficiently in a multi-asset portfolio. Meanwhile, the standard optimization method for efficient portfolios, Markowitz modern portfolio theory (classical mean-variance optimization), is challenging on its own. The model is highly sensitive to input data and often suggests extreme asset weightings for a portfolio to be efficient. In order to tackle these shortcomings, Michaud & Michaud have developed a procedure called Resampled Efficient Frontier (resampling). This method is a Markowitz based combination of bootstrapping and Monte Carlo simulation.

Objective

The objective of this thesis is to find out whether resampling is a reasonable approach to optimize portfolios that include real estate assets. An empirical study will help to indicate the optimal allocation towards real estate in a multi-asset portfolio. Furthermore, this thesis finds out how the real estate allocation changes if resampling or classical mean-variance optimization combined with shrinkage of the covariance matrix. Out-of-sample back tests will show which optimization method leads to the best performance in terms of risk and return.

Procedure

The optimal asset allocation is determined via the following optimization methods: classical mean-variance, resampling, shrinkage-mean-variance and shrinkage-resampling. There are six different shrinkage targets that were included for the optimization. The reference investor wants to invest in European real estate, stocks and fixed income instruments (bonds and money market) with a long-term investment horizon. Real estate is represented by the GPR 250 Europe, which is a transaction-based real estate index consisting of the 54 largest listed European real estate

companies. The other asset classes are represented by the DAX, FTSE 100 Index, German GBI 3-5Y, German GBI 7-10Y, UK GBI 3-5Y, UK GBI 7-10Y and the LIBOR 3M. The optimization uses a 20-year time series of monthly total returns from each of the chosen asset. Starting in July 1991 and ending in June 2011. The optimizations are implemented in the statistical software R. First, the efficient portfolios are calculated, its risk and return characteristics as well as the asset weightings are saved. Next, the frontiers with the efficient portfolios and the asset weightings are graphically illustrated. Last, an out-of-sample back test is performed for each of the optimization methods. The back test focuses on three investment strategies: conservative, medium and growth. The optimal asset weightings are calculated based on the return series from July 1991 to June 2006. The resulted weightings are then applied to the return series from July 2006 to June 2011 to calculate the out-of-sample returns of each investment strategy for each optimization method. Finally, these returns are annualized and the volatilities are calculated in order to compare the optimization methods.

Theoretical foundations

The resampling method applied in this thesis is a combination of the classical mean-variance optimization and Monte Carlo resampling/bootstrapping methods. The classical mean-variance optimization was developed by Markowitz and tells an investor how to allocate his portfolio in order to get the maximum return for a target risk level or how to get a target return with taking the minimum required level of risk. The main principle of this theory is diversification. If two or more assets are not correlated, the risk of a portfolio can be reduced to a minimum by optimally combining these assets. The optimal portfolios for several risk levels form the efficient frontier. Monte Carlo resampling/bootstrapping methods refer to a statistical procedure where random samples are repeatedly drawn out of an original population. In this thesis, the original population consists of the historical returns of the input assets. From these returns, the expected returns and (co)variance matrix are calculated. It is assumed that these returns follow a multivariate normal distribution. Totally, 400 samples are drawn. From each of these samples, a new efficient frontier is calculated. As all the 400 efficient frontiers are equally likely, the resampled efficient frontier is the average of all these new frontiers. The resampled efficient frontier plots below the classical mean-variance frontier. The rationale behind this is that resampling takes the estimation error of the input data into account and therefore reflects less risky and less extreme investments.

The shrinkage of the covariance matrix method, which is also applied in this thesis, is based on Bayesian statistics. The idea behind this approach is to optimally weight the sample covariance matrix and a shrinkage target with a shrinkage constant to form the shrinkage estimator (shrunk covariance matrix). The shrinkage target is an in advance defined covariance matrix such as the identity matrix or a constant correlation model. The resampling-shrinkage efficient frontier is then calculated by replacing the sample covariance matrix with the shrinkage estimator.

Results

The results of the thesis show that it is reasonable to use a resampling approach to optimize portfolios that include real estate. First, investors that include real estate in their portfolios are looking for diversification. Resampling promotes diversification. Second, real estate performance data can suffer from considerable estimation errors. Resampling takes this uncertainty into account. Third, real estate investments, such as real properties, are often capital-intensive and therefore not able to fit in an optimized portfolio if the efficient allocation is too small. Resampling leads to substantial allocation towards real estate even in medium-risk portfolios.

Classical mean-variance optimization leads to no allocation towards real estate for medium-risk portfolios and 12% allocation in real estate for high-risk portfolios. Resampling has increased the allocation towards real estate. In resampling, medium-risk portfolios have an allocation of 5% towards real estate. Portfolios on a higher risk level even have an allocation ranging from 20% to 22%. Shrinkage has slightly increased the real estate allocation in both resampling and classical mean-variance optimization. Following a medium or growth investment strategy, resampling resulted in better returns and lower volatility than classical mean-variance optimization in out-of-sample back tests. The results have also shown that the performance of resampling or classical mean-variance optimization can be improved by combining the methods with shrinkage.