Combining equilibrium, resampling, and analyst’s views in portfolio optimization

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Article info

Article history:
Received 5 January 2011
Accepted 30 November 2011
Available online 8 December 2011

JEL classification:
C13
G11
G15
G17

Keywords:
Portfolio optimization
Estimation risk
Equilibrium

1. Introduction

Portfolio optimization methodologies play a central role in strategic asset allocation (SAA) where it is desirable to have portfolios that are efficient, diversified, and stable. Since the development of the traditional mean–variance approach of Markowitz (1952), many improvements have been made to overcome problems, such as lack of diversification and strong sensitivity of optimal portfolio weights to expected returns.

The Black and Litterman (1992) model (hereafter BL) is among the most used approaches. The main idea of this model is that expected returns are the result of two important sources of information: market information in the form of equilibrium returns (implicit returns that clear out the outstanding market allocation), and analysts’ views which tilt the market portfolio to another diversified portfolio compatible with investor beliefs. In this fashion, portfolio managers get an intuitive but formal model to generate optimal allocation.

However, while the BL model offers a very useful and intuitive approach to deal with asset allocation, the inputs considered for the calculation of equilibrium returns are subject to estimation error. Michaud (1998) proposed the use of resampling to deal with estimation error, which is an important source of lack of diversification in mean–variance portfolio. This technique considers that data come from a stochastic process instead of being a deterministic input as in Markowitz (1952).

This paper proposes the use of a portfolio optimization methodology which combines features of both BL and resampling methodologies. This methodology allows a novel combination of equilibrium and investor’s views as in BL, and at same time, deals with estimation risk as in Michaud (1998). Thus, it generates robust and diversified optimal allocations which are desirable properties for long-term investors such as Central Banks and Sovereign Wealth Funds.

The remainder of this paper is as follows. Next section offers a brief literature review over asset allocation methodologies. The third section describes the Black-Litterman-Resampling combined methodology. The fourth section describes the empirical study, and the conclusion section summarizes the results.
including data, implementation and initial results. Section 6 presents the robustness checks and Section 7 concludes the paper.

2. Literature review

The seminal work of Markowitz (1952) provided the first model for asset allocation, arguing that once expected returns and their joint variance were defined, a set of efficient portfolios could be generated and investors would choose the allocation according to their needs. Basically the approach can be summarized as follows:

\[
\text{Min}(1/2)a'\Sigma a \quad (1)
\]

subject to

\[
E[R_a] = a'X ,
\]

where \( X \) is the vector of expected excess asset returns, \( a \) is the vector of allocations, and \( \Sigma \) is the variance–covariance matrix of asset returns. Despite its mathematical simplicity, this model typically generates concentrated allocations which heavily depend on expected returns estimation. Resampling techniques (Michaud, 1998) were developed as a way to deal with estimation error. Markowitz recognized that resampling methods could be used to obtain better estimates for the inputs of the mean–variance optimization (Markowitz and Usmen, 2003).

Jorion (1991) used the Bayesian approach to overcome the weakness of expected returns estimated solely by sample information. He proposed an estimator obtained by “shrinking” the mean values toward a common value, chosen to be the expected return for the minimum variance portfolio. Kempf et al. (2002) applied Bayesian methods and considered estimation risk as a second source of risk, determined by the heterogeneity of the market, which is represented by the standard deviation of the expected returns across risky assets. Both methods proved to generate better out-of-sample estimates for expected returns (as opposed to in-sample estimates), and also produced more diversified portfolios.

Black and Litterman (1992) built a bridge between statistical methods and expert judgment by recognizing that capital asset pricing model (CAPM) offers an appropriate starting point for expected excess returns. Thus, combining CAPM with investors’ views would produce intuitive and diversified allocations. For that, BL as-
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