Chapter 8

The Robustness of Portfolio Optimization Models: An Empirical Comparative Analysis

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ABSTRACT

The optimization of investment portfolios is a topic of major importance in financial decision making, and many relevant models can be found in the literature. These models extend the traditional mean-variance framework using a variety of other risk-return measures. Existing comparative studies have adopted a rather restrictive approach, focusing solely on the minimum risk portfolio without considering the whole set of efficient portfolios, which are also relevant for investors. This chapter focuses on the performance of the whole efficient set. To this end, the authors examine the out-of-sample robustness of efficient portfolios derived by popular optimization models, namely the traditional mean-variance model, mean-absolute deviation, conditional value at risk, and a multi-objective model. Tests are conducted using data for S&P 500 stocks over the period 2005-2016. The results are analyzed through novel performance indicators representing the deviations between historical (estimated) efficient frontiers, actual out-of-sample efficient frontiers, and realized out-of-sample portfolio results.

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1. INTRODUCTION

The optimization of investment portfolios seeks to maximize the return of an investment, while reducing risks as much as possible, considering the investor’s risk-return profile. Nowadays portfolio optimization covers a wide range of financial assets, such as stocks, funds, bonds, commodities, currencies, and loans, whereas similar concepts and ideas are also applicable to non-financial portfolios (e.g., project portfolios).

The foundations of portfolio optimization were set by Harry Markowitz in the 1950s, through the introduction of the mean-variance (MV) model. Since then, portfolio optimization has evolved significantly in terms of modeling sophistication. Among others, one can mention the introduction of new risk-return portfolio selection criteria (Szegö, 2002), the addition of realistic features, including transaction costs and cardinality constraints (Angelelli et. al., 2008), new modeling and algorithmic approaches (Fabozzi et. al., 2010; Metaxiotis and Liagkouras, 2012; Mansini et. al., 2014), as well as the consideration of new aspects such as social responsibility and other dimensions in a multi-criteria/objective framework (Ballestero et al., 2012; Xidonas et al., 2012). A recent overview of research developments and trends in portfolio optimization can be found in the work of Kolm, Tutuncu and Fabozzi, (2014).

In the literature, several comparative studies have been presented for different portfolio optimization models. Some examples include the studies of Angelelli et al. (2008), DeMiguel et al. (2009), Gilli and Schumann (2011), as well as Mansini et al. (2003). Despite, however, the rich literature on comparative studies among portfolio optimization models, two main shortcomings can be identified. First, past studies have adopted a rather restrictive point of view focusing solely on the minimum risk portfolio. This approach obviously ignores other relevant efficient portfolios corresponding to different risk-return preferences that an investor may have. Moreover, the comparisons are usually performed on a bi-objective context through a single measure of risk and risk-adjusted financial criteria (e.g., the Sharpe ratio, factor models, etc.). On the other hand, optimization models adopting a multi-objective point of view have not been thoroughly examined on out-of-sample data.

This study aims to fill in these gaps in the literature, focusing on conducting a thorough analysis of the performance of efficient portfolio frontiers generated by popular portfolio optimization models. In the analysis, we consider standard bi-objective models based on different risk measures (variance, mean absolute deviation, conditional value-at-risk) as well as a multi-objective model. The comparison of the obtained frontiers is based on indicators that assess the discrepancies between estimated (historical) frontiers, the actual (future) performance of the portfolios, and a true optimal (ideal) benchmark. Empirical results are presented on a data set consisting of S&P 500 US stocks over the period 2005-2016.
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