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Optimal and investable portfolios: An empirical analysis with scenario optimization algorithms under crisis market prospects

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ABSTRACT

This paper develops scenario optimization algorithms for the assessment of investable financial portfolios under crisis market outlooks. To this end, this research study examines from portfolio managers' standpoint the performance of optimum and investable portfolios subject to applying meaningful financial and operational constraints as a result of a financial turmoil. Specifically, the paper tests a number of alternative scenarios considering both long-only and long and short-sales positions subject to minimizing the Liquidity-Adjusted Value-at-Risk (LVaR) and various financial and operational constraints such as target expected return, portfolio trading volume, close-out periods and portfolio weights. Robust optimization algorithms to set coherent asset allocations for investment management industries in emerging markets and particularly in Gulf Cooperation Council (GCC) financial markets are developed. The results show that the obtained investable portfolios lie off the efficient frontier, but that long-only portfolios appear to lie much closer to the frontier than portfolios including both long and short-sales positions. The proposed optimization algorithms can be useful in developing enterprise-wide portfolio management models in light of the aftermaths of the most-recent financial crisis. The developed methodology and risk optimization algorithms can aid in advancing portfolio management practices in emerging markets and predominantly in the wake of the latest credit crunch.

1. Introduction

As a result of the recent financial market shocks, capital-market corporations, institutional investors and portfolio managers are reconsidering specific issues and focusing on: 1) How to not only incorporate risk and reward tradeoffs using modern portfolio theory, but also plan for unexpected market shocks; and 2) the resulting effects of these shocks on the asset management business and its impact on asset allocation and the construction of robust investable portfolios. To this end, prominent financial institutions are linking their downside portfolio risk with the return on capital and integrating market liquidity risk into their assessments in an effort to obtain better understanding of embedded-risk and expected return. As a result, optimization of the capital deployed–rather than just a single view of risk exposures–and its application for optimizing the asset allocation structures of investable market portfolios has become the new role of risk management.[1]

While common risk technique such as Value-at-Risk (VaR) and probability of default are still employed, they fail to anticipate systemic changes in the structure of financial markets. These techniques assume that volatility of the market and correlations among assets change slowly or not at all; they are not designed to handle systemic negative changes caused by jumps in the availability of liquidity or jumps in market values (Scholes and Kimner, 2010). One other critique that can be leveled against the VaR method is that it does not explicitly consider portfolios' asset liquidity risk during the unwinding (close-out) period. In fact, typical VaR models assess the worst change in the mark-to-market portfolio value over a given time horizon but do not account for the actual risk of liquidation. Indeed, neglecting asset liquidity risk can lead to an underestimation of the overall market risk and misapplication of capital cushion for the safety and soundness of financial institutions (Al Janabi, 2011a,b).

In this backdrop and to address the above shortcomings, the goals and challenges in this paper are to develop robust scenario optimization-algorithms for the assessment of investable financial portfolios under crisis market prospects. To this end, this paper examines from portfolio managers' perspective the performance of investable structured portfolios within a Liquidity-Adjusted Value-at-Risk (LVaR) framework, subject to the application of meaningful operational and financial constraints,

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[1] In this paper the concept of investable market portfolios refers to rational portfolios that are contingent on meaningful financial and operational constraints. In this sense, investable market portfolios are not located on the efficient frontiers as defined by Markowitz (1952), and instead have logical and well-structured long/short asset allocation proportions.

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particularly in the wake of the aftermaths of most-recent global financial crisis.[2]

The rationality behind introducing LVaR as an effective portfolio management tool is because it complies with real-life trading situations, where traders can liquidate (or re-balance) small portions of their portfolios on a daily basis according to prevailing market liquidity conditions. To this end, an LVaR approach is introduced to allocate financial assets by minimizing LVaR subject to enforcing meaningful operational and financial constraints that are based on fundamental asset management considerations and practices, such as: a) the target expected return of the investable portfolio; b) total trading volume of the investable portfolio; c) monetary asset allocation of each asset class; d) portfolio managers' choices of pure long positions or a combination of long/short trading positions; and e) the unwinding or close-out liquidity horizons of each asset-class.

In a nutshell, the primary motivation of this research is to set advanced portfolio management optimization techniques (drawn from rational and meaningful financial investment considerations) that can be applied to investable portfolios in emerging markets, such as in the context of the Gulf Cooperation Council (GCC) stock markets. As such, this research study and the obtained empirical results can contribute to the existing body of knowledge and extend current optimization-techniques' literatures related to the assessment of investable financial portfolios. Specifically this paper provides generalized scenario optimization-algorithm foundation that is theoretically appealing while capturing the essential aspects of optimal and investable financial assets and risk-capital allocations under difficult and unfavorable market circumstances. Essentially, the proposed scenario optimization-algorithms can be useful in developing enterprise-wide portfolio management models that financial entities may consider in assessing coherent risk-capital allocations and can offer practical tools to portfolio managers. As such, the portfolio modeling techniques and the achieved empirical results can have many uses and applications for portfolio managers and can have relevant practical implications that will benefit several end-users, such as: institutional investors, portfolio managers, mutual-fund industry and other financial institutions in the GCC region as well as other emerging financial markets.

The remainder of the paper is organized as follows. The following section discusses relevant literatures reviews and highlights specific objectives of this paper. This is followed by Section 3 in which the quantitative infrastructure of a non-linear dynamic risk-function and robust scenario optimization-algorithms are described. In Section 4 we analyze and interpret empirical results and discuss the simulation results of optimal and investable portfolios. Summary and concluding remarks are drawn in the final section. Full set of empirical testing and simulation results of optimal and investable portfolios are included in Appendix A.

2. Literature review and objectives

Portfolio management has different meanings in different contexts and the measurement of risk/return within a portfolio optimization setting is probably of more importance today than it has ever been during modern financial history. In recent years, the growth of trading activities and frequent occurrences of financial market upheavals has highlighted the necessity for market participants to develop reliable assessment methods and algorithms for portfolio management. Historically, Markowitz's (1952) classical mean–variance analysis was groundbreaking as it provided the framework within which optimal portfolio allocations are still examined today. Probably the most commonly associated measure of risk within this context, and one that has been in operation for the longest time, is the standard deviation. Over time a number of extensions have been suggested. For example, a natural replacement is a GARCH (Bollerslev, 1986; Engle, 1982) time-varying variance measure that allows for volatility clustering which leads to the regularly observed leptokurtic nature of return distributions.

In fact, one of the basic problems of applied finance is the optimal selection of assets, with the aim of maximizing future returns and constraining risk by appropriate measures. Undeniably, the portfolio mean–variance analysis approach, pioneered by Markowitz (1952), is one of the cornerstones of modern portfolio management and has served as the standard procedure for constructing portfolios. Albeit Markowitz's mean–variance portfolio optimization methodology is a landmark in the development of modern investment theory, there are no risk measures universally adopted in financial applications (Al Janabi, 2013). In his classical mean–variance analysis Markowitz (1952) described the theoretical framework for modern portfolio theory and the creation of efficient portfolios under the notion of maximizing expected return subject to some risk constraints. In this framework, risk is defined in terms of the standard deviation of each asset, which implies that the probability of negative returns, as the probability of positive returns, is weighted in the same way by the portfolio manager. As a result, the solution to the Markowitz theoretical models revolves around the portfolio weights, or the percentage of asset allocation that can be invested in each security (Al Janabi, 2013; Markowitz, 1952).

To this end, Markowitz (1952) demonstrated that, for a given levels of risk, one can recognize certain groups of assets that maximize expected return. Accordingly, for asset-allocation purposes, portfolio managers should choose portfolios located along the efficient frontier.[3] As such, Markowitz (1952) considered these optimum portfolios as ‘efficient’ and referred to a continuum of such portfolios in dimensions of expected return and standard deviation as the efficient frontier (Al Janabi, 2013; Markowitz, 1952).

Nonetheless, optimized portfolios do not normally perform as well in practice as one would expect from theory. For example, they are often outperformed by simple allocation strategies such as the equally weighted portfolio (Jobson and Korkie, 1981) or the global minimum variance portfolio (Jorion, 1991). Portfolio weights are often not stable over time but change significantly each time the portfolio is re-optimized, leading to unnecessary turnover and increased transaction costs. Moreover, these portfolios typically present extreme holdings (“*corner solutions*”) in a few securities while other securities have close to zero weight (Al Janabi, 2013; Jobson and Korkie, 1981; Jorion, 1991).

It is well documented (Michaud, 1989) that mean–variance optimizers, if left to their own devices, can sometimes lead to unintuitive portfolios with extreme positions in asset classes. In a portfolio optimization context, assets with large expected returns and low standard

[2] Indeed, there are other relevant studies that have tackled the issues of liquidity and asset pricing but not necessarily within the context of trading portfolios. For the sake of brevity, we provide a succinct narrative of some of the proposed models, detailed as follow: Within the VaR framework, Jarrow and Subramanian (1997) provide a market impact model of liquidity by considering the optimal liquidation of an investment portfolio over a fixed horizon. Bangia et al. (1999) approach the liquidity risk from another angle and provide a model of VaR adjusted for what they call exogenous liquidity—defined as common to all market players and unaffected by the actions of any one participant. It comprises such execution costs as order processing costs and adverse selection costs resulting in a given bid-ask spread faced by investors in the market. In a different vein, Almgren and Chriss (1999) present a concrete framework for deriving the optimal execution strategy using a mean–variance approach, and show a specific calculation method. For other relevant literature on liquidity, asset pricing and portfolio choice and diversification one can refer as well to Takahashi and Alexander (2002); Amihud et al. (2005); Cochrane (2005) and Meucci (2009), among others.

[3] Indeed, institutional investors manage their strategic asset mix over time to achieve favorable returns subject to various uncertainties, financial, operational and regulatory constraints, and other requirements. It has been demonstrated in a number of studies (Blake et al., 1999) that the mix of various classes of assets is a critical factor affecting the performance of institutional investors' diversified funds. While the asset-allocation decision is clearly important for multiple sectors portfolios, the literature is sparse in terms of understanding the process by which active investment managers allocate assets across the spectrum of securities and of analyzing their ability to fine-tune the portfolio's asset-allocation from a fund's strategic benchmark position in an attempt to capture active returns.

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