Dynamic Portfolio Construction and Portfolio Risk Measurement

Murat Mazibas
PhD in Finance
University of Exeter
September 2011

Abstract

The research presented in this thesis addresses different aspects of dynamic portfolio construction and portfolio risk measurement. It brings the research on dynamic portfolio optimization, replicating portfolio construction, dynamic portfolio risk measurement and volatility forecast together. The overall aim of this research is threefold. First, it is aimed to examine the portfolio construction and risk measurement performance of a broad set of volatility forecast and portfolio optimization model. Second, in an effort to improve their forecast accuracy and portfolio construction performance, it is aimed to propose new models or new formulations to the available models. Third, in order to enhance the replication performance of hedge fund returns, it is aimed to introduce a replication approach that has the potential to be used in numerous applications, in investment management.

In order to achieve these aims, Chapter 2 addresses risk measurement in dynamic portfolio construction. In this chapter, further evidence on the use of multivariate conditional volatility models in hedge fund risk measurement and portfolio allocation is provided by using monthly returns of hedge fund strategy indices for the period 1990 to 2009. Building on Giamouridis and Vrontos (2007), a broad set of multivariate GARCH models, as well as, the simpler exponentially weighted moving average (EWMA) estimator of RiskMetrics (1996) are considered. It is found that, while multivariate GARCH models provide some improvements in portfolio performance over static models, they are generally dominated by the EWMA model. In particular, in addition to providing a better risk-adjusted performance, the EWMA model leads to dynamic allocation strategies that have a substantially lower turnover and could therefore be expected to involve lower transaction costs. Moreover, it is shown that these results are robust across the low - volatility and high-volatility sub-periods.

Chapter 3 addresses optimization in dynamic portfolio construction. In this chapter, the

advantages of introducing alternative optimization frameworks over the mean-variance framework in constructing hedge fund portfolios for a fund of funds. Using monthly return data of hedge fund strategy indices for the period 1990 to 2011, the standard mean-variance approach is compared with approaches based on CVaR, CDaR and Omega, for both conservative and aggressive hedge fund investors. In order to estimate portfolio CVaR, CDaR and Omega, a semi-parametric approach is proposed, in which first the marginal density of each hedge fund index is modelled using extreme value theory and the joint density of hedge fund index returns is constructed using a copula-based approach. Then hedge fund returns from this joint density are simulated in order to compute CVaR, CDaR and Omega. The semi-parametric approach is compared with the standard, non-parametric approach, in which the quantiles of the marginal density of portfolio returns are estimated empirically and used to compute CVaR, CDaR and Omega. Two main findings are reported. The first is that CVaR-, CDaR- and Omega-based optimization offers a significant improvement in terms of risk-adjusted portfolio performance over mean-variance optimization. The second is that, for all three risk measures, semi-parametric estimation of the optimal portfolio offers a very significant improvement over non-parametric estimation. The results are robust to as the choice of target return and the estimation period.

Chapter 4 searches for improvements in portfolio risk measurement by addressing volatility forecast. In this chapter, two new univariate Markov regime switching models based on intraday range are introduced. A regime switching conditional volatility model is combined with a robust measure of volatility based on intraday range, in a framework for volatility forecasting. This chapter proposes a one-factor and a two-factor model that combine useful properties of range, regime switching, nonlinear filtration, and GARCH frameworks. Any incremental improvement in the performance of volatility forecasting is searched for by employing regime switching in a conditional volatility setting with enhanced information content on true volatility. Weekly S&P500 index data for 1982-2010 is used. Models are evaluated by using a number of volatility proxies, which approximate true integrated volatility. Forecast performance of the proposed models is compared to renowned return-based and range-based models, namely EWMA of Riskmetrics, hybrid EWMA of Harris and Yilmaz (2009), GARCH of Bollerslev (1988), CARR of Chou (2005), FIGARCH of Baillie *et al*. (1996) and MRSGARCH of Klaassen (2002). It is found that the proposed models produce more accurate out of sample forecasts, contain more information about true volatility and exhibit similar or

better performance when used for value at risk comparison.

Chapter 5 searches for improvements in risk measurement for a better dynamic portfolio construction. This chapter proposes multivariate versions of one and two factor MRSACR models introduced in the fourth chapter. In these models, useful properties of regime switching models, nonlinear filtration and range-based estimator are combined with a multivariate setting, based on static and dynamic correlation estimates. In comparing the out-of-sample forecast performance of these models, eminent return and range-based volatility models are employed as benchmark models. A hedge fund portfolio construction is conducted in order to investigate the out-of-sample portfolio performance of the proposed models. Also, the out-of-sample performance of each model is tested by using a number of statistical tests. In particular, a broad range of statistical tests and loss functions are utilized in evaluating the forecast performance of the variance covariance matrix of each portfolio. It is found that, in terms statistical test results, proposed models offer significant improvements in forecasting true volatility process, and, in terms of risk and return criteria employed, proposed models perform better than benchmark models. Proposed models construct hedge fund portfolios with higher risk-adjusted returns, lower tail risks, offer superior risk-return tradeoffs and better active management ratios. However, in most cases these improvements come at the expense of higher portfolio turnover and rebalancing expenses.

Chapter 6 addresses the dynamic portfolio construction for a better hedge fund return replication and proposes a new approach. In this chapter, a method for hedge fund replication is proposed that uses a factor-based model supplemented with a series of risk and return constraints that implicitly target all the moments of the hedge fund return distribution. The approach is used to replicate the monthly returns of ten broad hedge fund strategy indices, using long-only positions in ten equity, bond, foreign exchange, and commodity indices, all of which can be traded using liquid, investible instruments such as futures, options and exchange traded funds. In out-of-sample tests, proposed approach provides an improvement over the pure factor-based model, offering a closer match to both the return performance and risk characteristics of the hedge fund strategy indices.

Contents