Robust efficient frontier analysis with a separable uncertainty model

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Working paper, November 2007

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Mean-variance (MV) analysis is often sensitive to model mis-specification or uncertainty, meaning that the MV efficient portfolios constructed with an estimate of the model parameters (i.e., the expected return vector and covariance of asset returns) can give very poor performance for another set of parameters that is similar and statistically hard to distinguish from the one used in the analysis. Robust MV analysis attempts to systematically alleviate the sensitivity problem, by explicitly incorporating an uncertainty model on the parameters in a portfolio selection problem and carrying out the analysis for the worst-case scenario under the model.

This paper concerns robust MV analysis with a separable uncertainty model, in which uncertainty in the mean return vector is independent of that in the covariance matrix, a model which has been widely used in the literature. The main focus is on the (worst-case) robust efficient frontier, ie, the optimal trade-off curve in terms of worst-case MV preference, as the extension of the efficient frontier to the worst-case MV analysis setting. We establish some basic properties of the robust efficient frontier, describe a method for computing it, and give several computationally tractable uncertainty models. We also establish a fundamental relation between the robust efficient frontier and the infimum of all efficient frontiers consistent with the assumptions made on the model parameters. The robust efficient frontier analysis method is illustrated with a numerical example.