Portfolio Optimization for Extreme Risk: A Pareto-Dirichlet Approach

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Abstract

This paper extends the traditional mean variance optimization to higher order moments, considering the investor's aversion to extreme risk. We use kurtosis as extreme risk indicator, and construct a mean variance kurtosis efficient portfolio optimization by use of the combination of Pareto improvement method and Dirichlet simulations. Previous high order optimization methods can mis-classify inefficient portfolios as efficient, and the Pareto improvement method is free from such an error. The Dirichlet simulations help to approximate the feasible portfolio set to implement the Pareto improvement method. We propose an empirical study of the ten S&P 500 sectors, and the mean variance kurtosis efficient frontier behaves like linear segment at the two ends and a band spread in the middle. The Sharpe ratio is generalized by synthesizing variance and kurtosis into a single risk indicator, and the optimal portfolios maximizing Sharpe ratio are often mean variance inefficient especially when kurtosis is more weighted in the risk synthesis. This paper shows a feasible implementation of the mean variance kurtosis optimization, which is more comprehensive than the mean variance optimization.

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