

Meta-heuristics for Portfolio Optimization

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Astract

The methods used for analyzing and optimizing portfolios in the mean-variance framework do not carry over easily to other risk concepts like shortfall probability, expected shortfall etc. Furthermore constraints on the holding size of assets, trading volume, number of assets in a portfolio etc. result in further complications for standard optimization tools.

Given the growing need for methods able to solve these complex optimization tasks and the failure of standard approaches to do so we propose the use of an optimization heuristic called *threshold accepting*.

Heuristic optimization methods have proved useful in applications from different fields like engineering, physics, biomedical sciences etc. They provide approximate solutions to global optimization problems.

In one set of applications we consider problems where the investor maximizes the expected return on the portfolio under constraints on downside risk, measured by shortfall probability, expected shortfall etc. Solutions are constrained by a number of equalities and inequalities. The decision variables, i.e. the number of each asset held in the portfolio, are restricted to be integers. Different criteria for the objective function are experimented. The resulting optimization problem is complex as it exhibits multiple local extrema and discontinuities. In such situations classical optimization methods fail to work efficiently and heuristic optimization techniques can be the only way out.

The second set of applications considers index tracking problems where the performance of the portfolio is measured against a given benchmark. The optimization problem consists in minimizing the tracking error between a portfolio and the benchmark. The objective is to replicate the performance of a given index upon the condition that the number of stocks allowed in the portfolio is smaller than the number of stocks in the benchmark index. Transaction costs are incurred each time that the portfolio is rebalanced.

We find the composition of a portfolio that tracks the performance of the benchmark during a given period in the past and compare it with the performance

of the portfolio in a subsequent period. We report computational results in the cases where the benchmarks are market indices tracked by a small number of assets. We find that the threshold accepting heuristic is an efficient optimization technique for this problem.

Keywords: Threshold Accepting, Heuristic Optimization, Index Tracking, Downside Risk

References

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