二· 項目簡介

（項目所屬科學技術領域、主要技術內容、授權專利情況、技術經濟指標及應用推廣情況）

Portfolio optimization and index tracking have been the two key topics in long term research in both academia and business. They are cutting edge research in Quantitative Finance and have become active fields in Data Science. Portfolio optimization techniques have been widely developed to provide the financial companies and institutions with the investment strategy in reality. Index funds have low fees because they are passively managed. Market innovation has significantly broadened the number of index funds available in the market.

The classical techniques for portfolio optimization and index tracking mainly focus on the case with a small number of assets. However, in modern finance, financial investors routinely work with a large number of assets. The large dimension of assets brings two great challenges. First, the high dimensionality significantly increases the computational load, making the computation time as an important concern in practice. Second, data of high dimensions are rarely clean but noisy, which usually leads to large estimation errors. To deal with these challenges, this project develops some novel methods based on regularization techniques for portfolio optimization and index tracking in high dimensions. The regularization techniques, originating from high dimensional statistics, can help reduce estimation errors of parameters in high dimensions and thus are expected to improve the out-of-sample performance.

In particular, this project develops a framework based on the regularization of sample eigenvalues to estimate the inverse covariance matrix of asset returns in high dimensional portfolio selection. The proposed framework enables us to derive a closed form solution to the optimal shrinkage density of the sample eigenvalues, which greatly reduces the computation time. Also, it alleviates overdispersion of sample eigenvalues.

In financial index tracking, one needs to select the subset of assets and to allocate the capital among the selected assets. It is natural to impose the cardinality constraint for sparse index tracking by directly limiting the maximum number of assets held in the tracking portfolio. However, the resulting problem is shown to be NP hard. This project proposes the approach based on the adaptive elastic net (Aenet) as another feasible way for sparse index tracking in high dimensions, owing to its variable selection property. The coordinate descent algorithm is developed to speed up the solution procedure.

The empirical comparisons based on some real data sets demonstrate the superior performance of the new method for portfolio optimization. For example, under the 200S data set with 200 assets, compared to the simple equal weighting (EW) strategy, the proposed method can reduce the portfolio risk by 57% and improve the economic gain by 44.17%. Compared to the up to date approach, Glasso proposed by Goto and Xu (2015), the new method can further reduce the portfolio risk by 4.25% and improve the economic gain by 10.1%.

In sparse index tracking, the proposed Aenet approach has advantages to be computationally efficient and low turnover, compared to the cardinality constraint approach. Under the S&P100 data set, the turnover of Aenet relative to the cardinality constraint approach can be decreased by 59.6%. It takes less than 1 second for Aenet to determine the optimal solution, while the cardinality approach usually requires more than 1200 seconds.

In addition to some source codes, this project has produced some high quality research papers, including 1 on Journal of Financial and Quantitative Analysis (JFQA) (Q1, IF: 3.745), 1 on Quantitative Finance (Q2, IF:

2.222), and 1 on Journal of Quality Technology (Q2, IF: 3.946). Especially, JFQA is one of the top four finance journals. This is the first paper published by University of Macau (UM) on JFQA, which is also the first paper published by UM on the top four finance journals.

（字數不超過 1200 字）