Portfolio Optimisation Project

Dr Ivan Guo

School of Mathematics

In financial mathematics, an investment portfolio refers to a combination of assets, typically stocks, which is assembled for the purpose of generating long term returns. Typically, an investor would like to choose the composition of the portfolio in a way to simultaneously maximise returns and minimise risks. While the return can usually be measured by the increase in value of the portfolio, it is less clear how one should quantify the risk of the portfolio. Some common measures of risks include variance/standard deviation, value-at-risk (VaR) and expected shortfall. Each of these can be measured at different time intervals (daily, weekly, etc.). By carefully selecting the composition of the portfolio, the investor would aim to optimise some objective function which balances the return with the risk, e.g., by maximising the Sharpe ratio.

In this project, we perform an in-sample optimisation of trading portfolios, based on the stocks which have been in the S&P500 in the last 16 years. Several different types of portfolio weights will be considered.

- Static weights (absolute) – where the quantity of each stock is determined at the beginning and fixed throughout the period.
- Static weights (relative) – where the relative proportion of the total wealth invested in each stock is fixed.
- Dynamic weights – where the weights will be some function of the recent stock performances.

There can also be additional constraints on the weights, e.g., forcing them to be non-negative, so only long positions are allowed. We aim to answer questions of the following type:

- Given a fixed time period, a selection of stocks, a weight convention and an objective function, what is the optimal portfolio weights.
- Given a number k, what is the best combination of k stocks to invest in and what are the best weights?
- What do the efficient frontiers look like?

Several different optimisation approach will be studied.

- Randomly generate a large set of possible weights and look for the best ones.
- Use a standard optimisation routine to find the best weights.
- In the case of dynamic weights, use machine learning algorithms to find the best weights.

If time permits, there are also opportunities to explore various extensions of the project including out-of-sample tests and incorporating other factors beyond stock returns.