Mean-variance Optimization for Equity Portfolio Selection

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Introduction

- Banks, financial institutions, investment funds, and other institutions are tasked with developing and managing a portfolio of investment vehicles to grow the value of the portfolio while managing risk and ideally “beating the market.”
- Selecting investment vehicles to be held in a portfolio of investments is commonly referred to as portfolio management, and the portfolio of investments is typically referred to as the portfolio.
- The focus of this project was on applying mean-variance optimization for building a portfolio of equity securities.
- Due to the increasing availability of large-scale, high-dimensional datasets it is important to be able to leverage tools like R to optimize stock selection.

Problem Statement

The goal is to find the Efficient Frontier

- A set of optimal portfolios that offers the highest expected return for a defined level of risk or the lowest risk for a given level of expected return.
- Alternative investments

Variables and Scope

Sharpe Ratio vs Sortino Ratio

Independent Variables:
- Daily lag returns for 1,776 mid and large cap stocks from the NYSE and the NASDAQ, from 2000-2011 (in-sample) and 2012-2014 (out-of-sample).

Dependent Variables:
- Weights for the securities to be held in the investment portfolio.

Variables and Scope (Stock Preference Example)

Methodology

- Output stocks and weights for portfolio selection.

Findings

- Overall performance of the model portfolio was very strong compared to the benchmark. Mean-variance optimization, used on large time series datasets, can be an effective portfolio selection and research tool.
- The constraints set were conservative in that the model was not allowed to weight any one stock greater than 5% resulting in 23 stocks from a variety of industries, effectively hedging against unique risk. However, a major limitation of mean-variance optimization is the lack of fundamental analysis on the stocks selected for the portfolio.
- The model portfolio is comparable to a long-term growth equity fund. However, without fundamental analysis including balance sheets, P/E ratio, and other metrics there could be stocks selected for companies that do not have true long-term growth potential (aggressive short-term growth stocks).
- The model should be used as a supplementary tool for narrowing down stocks on which to perform fundamental analyses, and a slimming model, to determine the optimal portfolio rebalancing time, should be developed for use in conjunction with the portfolio selection model.

Conclusions and Recommendations

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Findings

Model Portfolios, S&P 500 (Benchmark)

<table>
<thead>
<tr>
<th>Year</th>
<th>Model Portfolio</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>76.55%</td>
<td>13.62%</td>
</tr>
<tr>
<td>2007</td>
<td>56.78%</td>
<td>3.55%</td>
</tr>
<tr>
<td>2008</td>
<td>-22.14%</td>
<td>-31.49%</td>
</tr>
<tr>
<td>2009</td>
<td>97.07%</td>
<td>23.45%</td>
</tr>
<tr>
<td>2010</td>
<td>44.22%</td>
<td>12.70%</td>
</tr>
<tr>
<td>2011</td>
<td>28.39%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

In-Sample

- Out-of-Sample

- Almost 49% in Technology Industry
- 13% in Pharmaceuticals

In-Sample

- MARKET CAPITALIZATION
- INDUSTRY CONCENTRATIONS

- Large Cap: companies with a market capitalization value of more than $20 billion
- Mid Cap: companies with a market capitalization value between $2 and $10 billion

- S = \left( \frac{R_p - R_f}{\sigma_p} \right) (Desired Target Return)

- Risk = TDD, Target Downside Deviation

- Standard deviation of returns + T

- Lower tail

- According to Dr. Frank Sortino

- Investors are only interested in risk of returns that fall below a required rate

- R_p = \text{Target Rate}
- R_f = \text{Risk-free Rate, but analogous}
- 1 Year Treasury from Federal Reserve Bank of New York (prime overdue)
- Risk = TDD, Target Downside Deviation
- Standard deviation of returns + T
- Lower tail