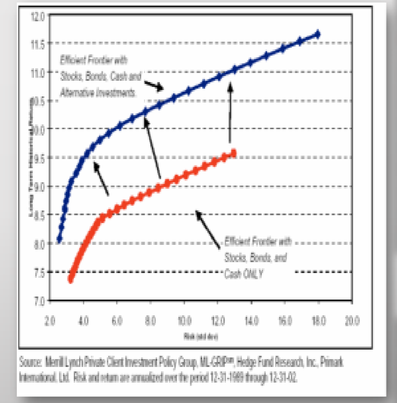
Mean-variance Optimization for Equity Portfolio Selection

Neil Benedict[1], Justin Brewer[1], & Ayham Haddad[1]

➢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



Source: Merrill Lynch Private Client Investment Policy Group, ML-GRIP™, Hedge Fund Research, Inc., Primark International, Ltd. Risk and return are annualized over the period 12-31-1989 through 12-31-02.

http://www.investopedia.com/terms/e/efficientfrontier.asp

The Goal: 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

An investment that is not one of the three traditional asset types (stocks, bonds and cash). Due to their complex nature most alternative investment assets are held by institutional investors or accredited, high-net-worth individuals, limited regulations and relative lack of liquidity. Alternative investments include hedge funds, managed futures, real estate, commodities and derivatives contracts.

➢Variables and Scope

Independent Variables:

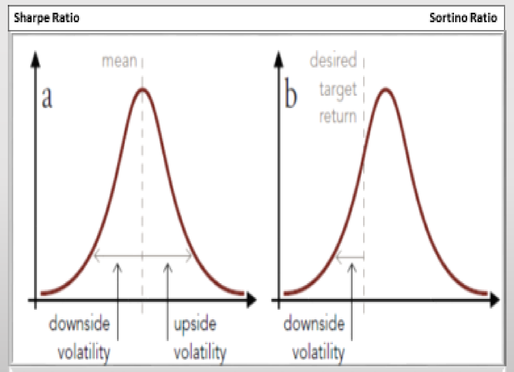
Daily log-returns for 1,275 mid and large cap stocks from the NYSE and the NASDAQ, from 2006-2011 (in-sample) and 2012-2014 (out-of-sample).

Dependent Variables:

Weights for the securities to be held in the investment portfolio.

➢Variables and Scope
Sharpe Ratio VS Sortino Ratio

$$S = \left(\frac{R_p - R_f^T}{\sigma_{p,TDD}}\right)$$



The advantage of the Sortino Ratio is that it only penalizes for downside volatility.

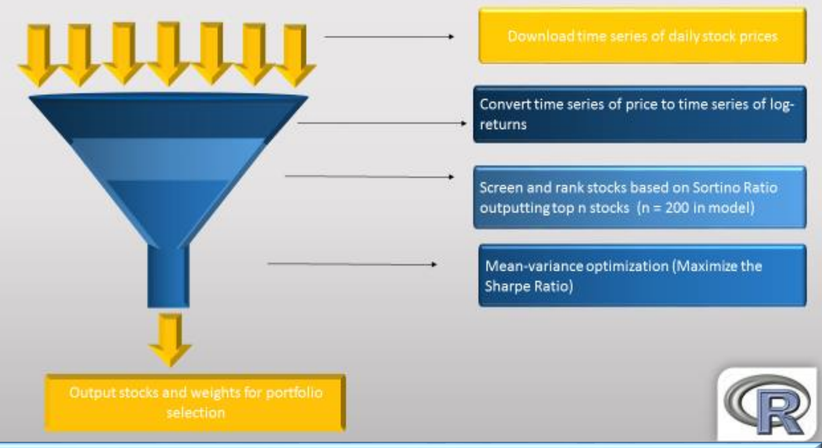
According to Dr. Frank Sortino

- Investors are only interested in risk of returns that fall below a required rate ("Desired Target Return")
- $R_f = T$
  - Target Rate
  - Could be the Risk-Free Rate, but ambiguous
  - 1 year Treasury from Federal Reserve Bank of Saint Louis (FRED Economic Data)
- Risk – TDD, Target Downside Deviation
  - Standard deviation of Returns < T
  - Left Tail

➢Variables and Scope
Sortino Ratio Stock Preference Example

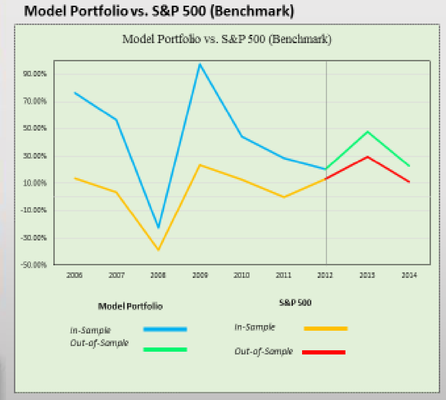
Sortino Ratio only penalizes for downside volatility that's why it will exclude Google Stock (volatile) compared with Priceline .

➢Methodology



➢Findings

Model Portfolio vs. S&P 500 (Benchmark)



	Year	Model Portfolio	S&P 500
In-Sample	2006	76.55%	13.62%
	2007	56.70%	3.53%
	2008	-22.14%	-38.49%
	2009	97.07%	23.45%
	2010	44.22%	12.78%
	2011	28.35%	0.00%
Out-of-Sample	2012	20.58%	13.41%
	2013	47.75%	29.60%
	2014	22.93%	11.39%

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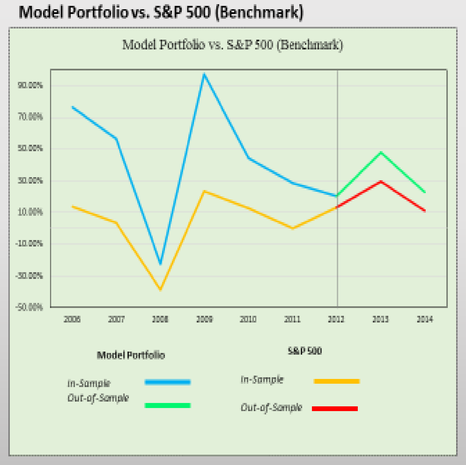

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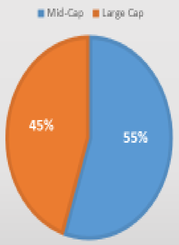
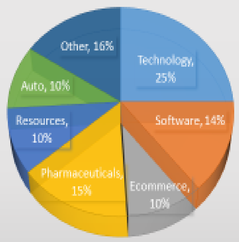
MARKET CAPITALIZATION



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

INDUSTRY CONCENTRATIONS



Almost 49% in Technology industry
15% in Pharmaceuticals

➢Conclusions and Recommendations

- 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 analyses 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 timing model, to determine the optimal portfolio rebalancing time, should be developed for use in conjunction with the portfolio selection model

1. MS in Analytics (MScA) Class of 2015, Graham School of Continuing and Professional Studies, University of Chicago, Chicago, IL