

R/Finance 2014:Complex Portfolio Optimization with PortfolioAnalytics

Ross Bennett

May 16, 2014

1 Portfolio Optimization

2 PortfolioAnalytics

3 Examples

4 Conclusion

Portfolio Optimization

General

TODO: Add some general comments here about goals and pitfalls of optimization in the context of constructing a portfolio.

Modern Portfolio Theory

“Modern” Portfolio Theory (MPT) was introduced by Harry Markowitz in 1952.

In general, MPT states that an investor’s objective is to maximize portfolio expected return for a given amount of risk.

General Objectives

- Maximize a measure of gain per unit measure of risk
- Minimize a measure of risk
- Maximize a utility function

How do we define risk?

Portfolio Optimization Objectives

- Minimize Risk
 - Volatility
 - Tail Loss (VaR, ES)
 - Other Downside Risk Measure
- Maximize Risk Adjusted Return
 - Sharpe Ratio
 - Modified Sharpe Ratio
 - Several Others
- Risk Budgets
 - Equal Component Contribution to Risk (i.e. Risk Parity)
 - Limits on Component Contribution
- Maximize a Utility Function
 - Quadratic, CRRA, CARA, etc.

PortfolioAnalytics

Overview

PortfolioAnalytics is an R package designed to provide numerical solutions and visualizations for portfolio problems with complex constraints and objectives.

Key Features

- Support for multiple constraint and objective types
- Modular constraints and objectives
- An objective function can be any valid R function
- Custom moments
- Solver agnostic
- Visualizations

Support Multiple Solvers

Linear and Quadratic Programming Solvers

- R Optimization Infrastructure (ROI)
 - GLPK (Rglpk)
 - Symphony (Rsymphony)
 - Quadprog (quadprog)

Global (stochastic or continuous solvers)

- Random Portfolios
- Differential Evolution (DEoptim)
- Particle Swarm Optimization (pso)
- Generalized Simulated Annealing (GenSA)

Workflow

TODO: Add a nice graphic here (Guy might have one)

Specify a Portfolio → Add Constraints → Add Objectives → Run Optimization → Analyze Results

Examples

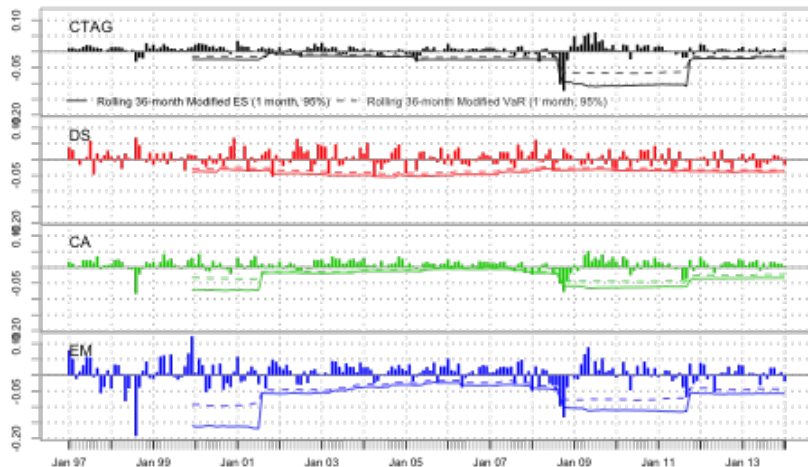
Data

Here we will look at portfolio optimization in the context of portfolio of hedge funds

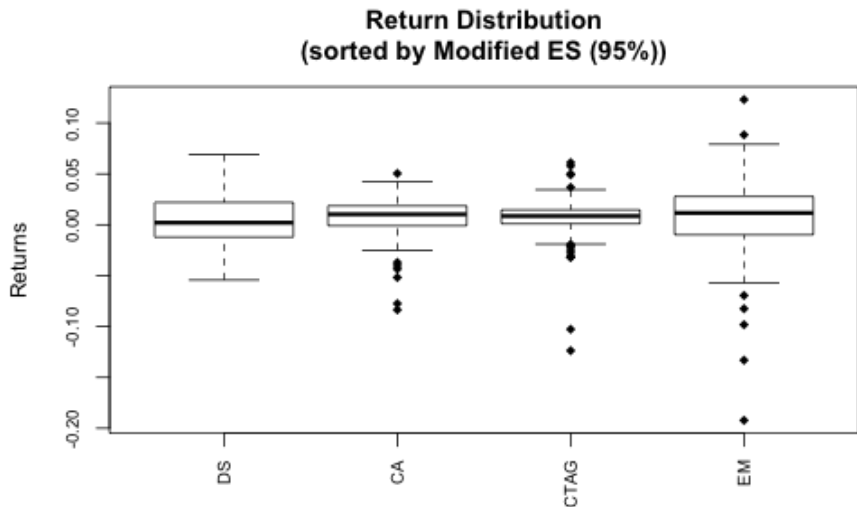
- EDHEC-Risk Alternative Indexes
- Monthly returns from 1/31/1997 to 1/31/2014
 - Convertible Arbitrage (CA)
 - CTA Global (CTAG)
 - Distressed Securities (DS)
 - Emerging Markets (EM)

Monthly Returns

Returns



Distribution of Monthly Returns



Conclusion

Acknowledgements

Many thanks to

- Google: funding for Google Summer of Code (GSoC)
- GSoC Mentors: Brian Peterson, Peter Carl, Doug Martin, and Guy Yollin
- R/Finance Committee