CFRM 543 Final Project

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1 Introduction

This project aims to both familiarize one with financial modeling packages in R and to use those tools to develop a portfolio that is appealing to investors. The report is divided into two sections.

In the first section, the goal is to achieve superior gains by modifying two given scripts. The first script works with a global minimum variance portfolio, while the second script uses a maximum quadratic utility portfolio with a risk aversion parameter. We modify the scripts by changing some of the parameters such as the box constraints, lambda value, risk measure (i.e. volatility versus ES). Importantly, in addition to summary plots, the results are reported using a custom performance report that outputs the following:

- Cumulative Return
- Maximum Drawdown
- Annulaized Sharpe Ratio
- Annualized Mean Return
- Annualized Mean Voltility
- Monthly Sharpe Ratio
- Monthly Sortino Ratio
- Monthly Expected Shortfall
- Stable Risk-Adjusted Return Risk Ratio (STARR)

In the second portion of this report, we look at 145 stocks and try to find the best portfolio. This is done as in the first section, and both the minimum variance portfolio and the maximum utility portfolio are estimated using the new data.

2 Analysis of Small Cap Weekly Returns

2.1 Global Minimum Variance Portfolio

2.1.1 Given Portfolios

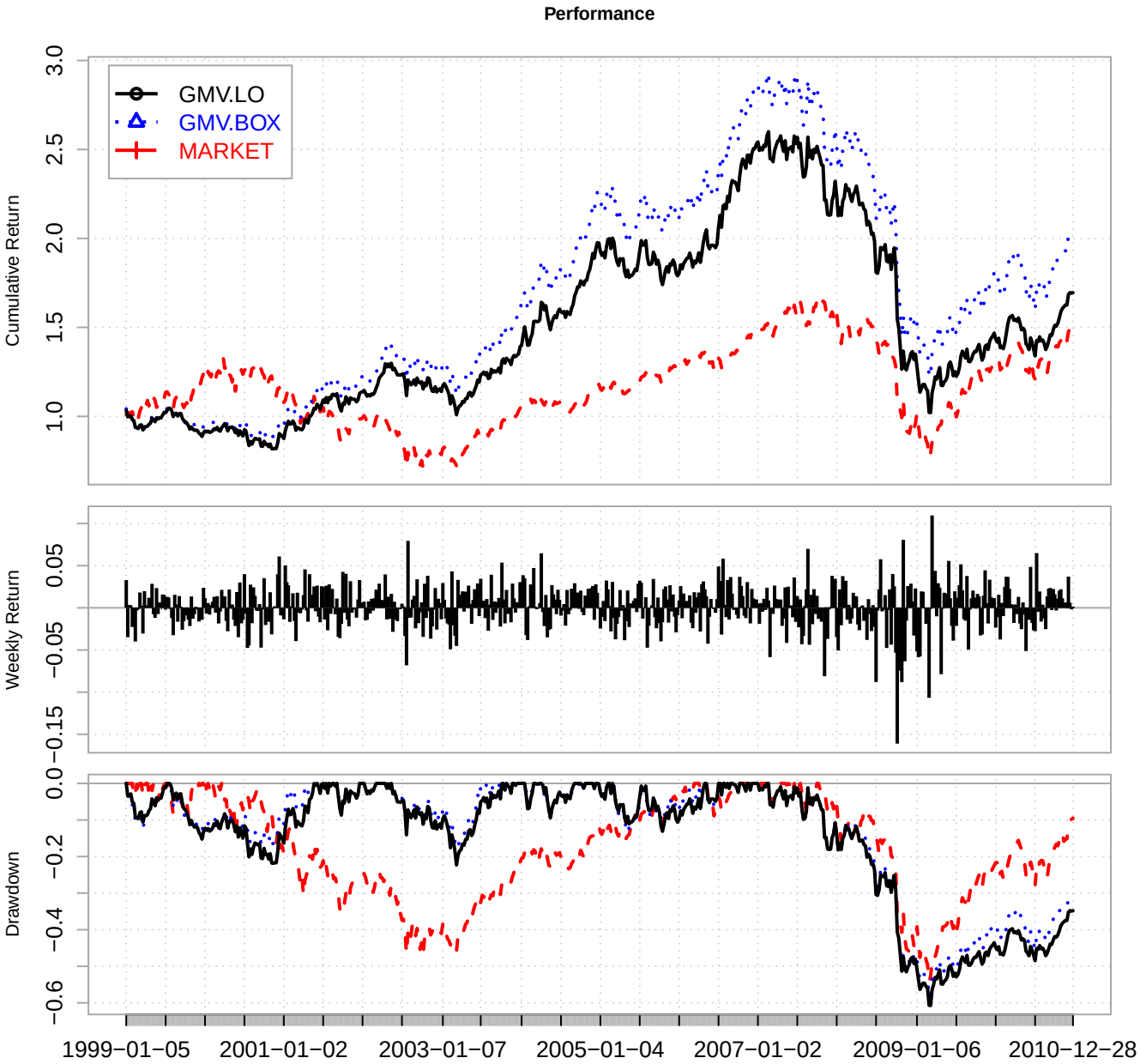
The data for this analysis is provided in the `mpo` package. The initial script is as follows:

```
library(mpo)
library(PortfolioAnalytics)
library(ROI)
library(ROI.plugin.quadprog)
library(ROI.plugin.glpk)
library(lattice)

returns = smallcapW
MARKET = returns[ ,"Weekvwretd"]
returns = smallcapW[ ,1:20]

funds = colnames(returns)
pspec = portfolio.spec(assets=funds)
pspec.fi = add.constraint(pspec, type="full_investment")
pspec.lo = add.constraint(pspec.fi, type="long_only")
pspec.gmvLo = add.objective(pspec.lo, type="risk", name="var")
pspec.box = add.constraint(pspec.fi,type="box",min=0,max=.2)
pspec.gmvBox = add.objective(pspec.box, type="risk", name="var")
```

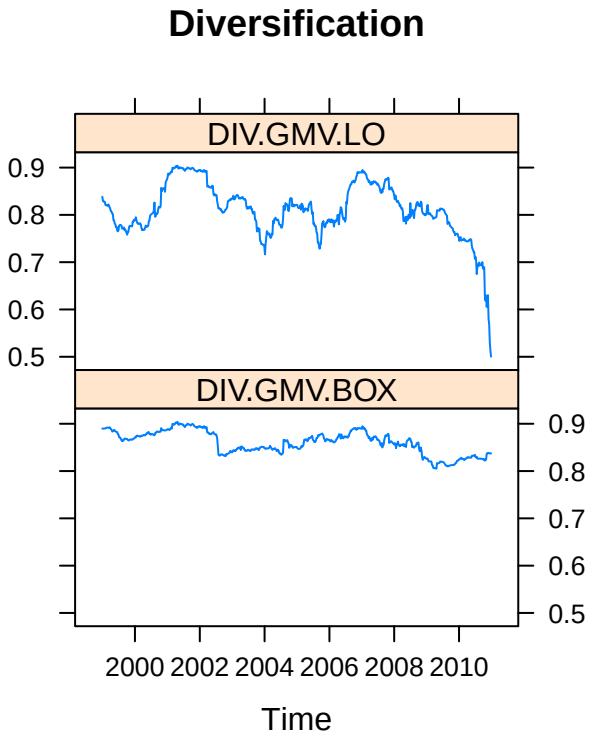
Notice that several different portfolios are produced. We will first compare the performance of the two GMV portfolios here with that of the market, then see if the constraints can be changed to improve performance.

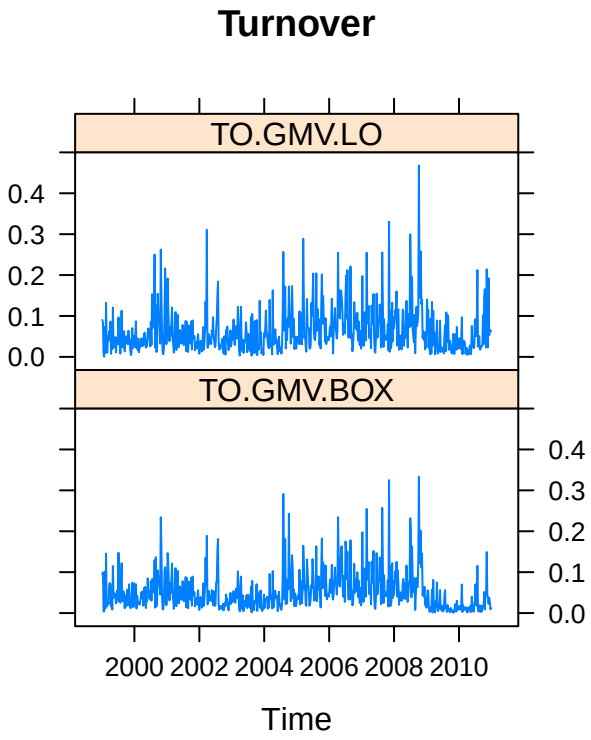


The initial result is that the GMV portfolio with a box constraint produces the greatest result. This can be confirmed with the following table of performance statistics. Note that the cumulative return is much greater for the box return portfolio, as well as the Sharpe Ratio. For both GMV portfolios, the Sharpe Ratio is greater than that of the market.

	GMV.LO	GMV.BOX	MARKET
ES	-0.0595000	-0.0582000	-0.0612000
maxDrawdown	0.6074000	0.5824000	0.5436000
Return.annualized	0.0448000	0.0617000	0.0352000
Return.cumulative	0.6951000	1.0554000	0.5162000
SortinoRatio	0.0637000	0.0819000	0.0532000
StdDev.annualized	0.1842000	0.1833000	0.1946000
SharpeRatio.annualized	0.2432886	0.3364853	0.1807692
SharpeRatio	0.0459141	0.0581146	0.0382322
STARR	0.0153273	0.0202155	0.0137029

Two metrics of interest are diversification and turnover rate. We are interested in diversification because it can provide a sense of how well market risk is "diversified-out", and turnover is important to measure because of transaction costs associated with changing positions. See below plot for a time series of turnover and for diversification:





	GMV.LO	GMV.BOX
DIV	0.8099462	0.8600362
TO	0.0641324	0.0531403

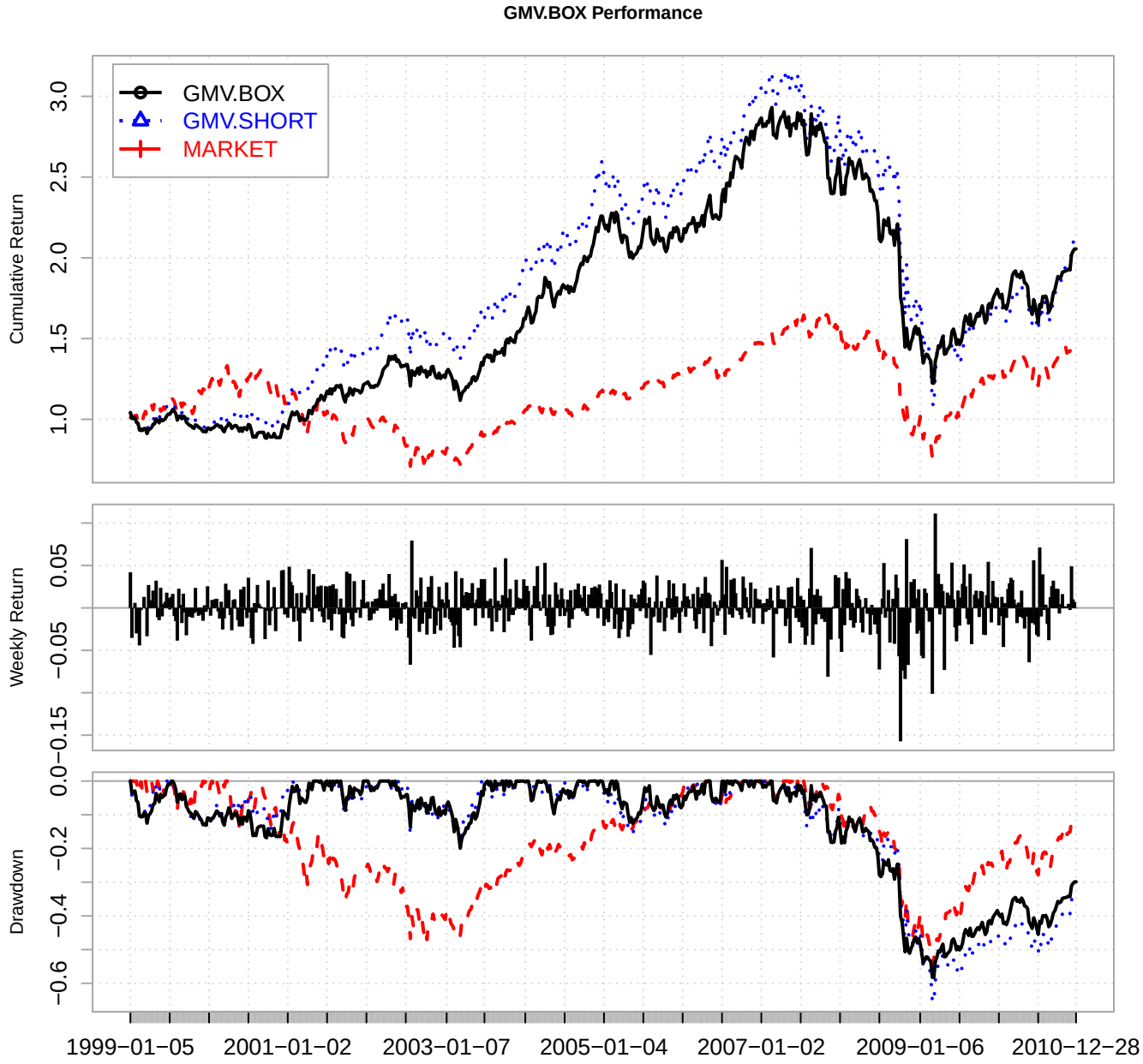
There are a few notable events in each chart. The diversification plot for the long only GMV portfolio has a steep decline toward the end of the time horizon in question. In contrast, the box plot maintains a relatively stable diversification value, around roughly 85% diversified. Similarly, the turnover appears less extreme for the box portfolio compared to the long only portfolio; the long only portfolio at one point turns over more than 40% of its positions, but the box portfolio has a maximum around 30%. So far in the analysis, the box constrained portfolio is most appealing.

2.1.2 Box Portfolio with Shorting

The initial constrained box portfolio is long only. Shorting can improve performance, though the long positions must be restricted further from the 20% in the given specification. Here, the lower bound is effectively infinite with a -100% limit, while the upper bound is a mere 7%. The portfolio metrics are summarized below (comparisons are to box portfolio from section 2.1.1 and market):

	GMV.BOX	GMV.SHORT	MARKET
ES	-0.0582000	-0.0686000	-0.0612000
maxDrawdown	0.5824000	0.6579000	0.5436000
Return.annualized	0.0617000	0.0641000	0.0352000
Return.cumulative	1.0554000	1.1123000	0.5162000
SortinoRatio	0.0819000	0.0796000	0.0532000
StdDev.annualized	0.1833000	0.2178000	0.1946000
SharpeRatio.annualized	0.3364853	0.2942728	0.1807692
SharpeRatio	0.0581146	0.0546681	0.0382322
STARR	0.0202155	0.0293331	0.0137029

Notice that, though the cumulative return is greater than that of the original box constraint portfolio, the Sharpe Ratio is lesser.



2.1.3 GMV with Concentration Risk Aversion Parameter

2.2 Quadratic Utility Portfolio

2.2.1 Given Portfolios

2.2.2 Alternative Lambda Values

3 Analysis of 145 Stocks