

Global Rotation Strategy

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1 Introduction

The following report summarizes the results of an analysis of a Financial Trading System. It backtests the Global Rotation Strategy (GRS) with 5 ETFs over a period from 2003 until 2018. First, the GRS is implemented and trades are performed based on the rules defined by the strategy which was published on the website SeekingAlpha. Additionally, the strategy is benchmarked against a buy and hold strategy. As the GRS uses ETFs which represent the entire world market, the MSCI World Index is used as a benchmark. After the benchmark a possible improvement of the strategy is presented and implemented. Moreover, another improvement step is proposed which includes short selling. All the results of the strategies are presented and measured against each other. Furthermore, a risk analysis is performed based on the CAPM and 3-factor model to evaluate whether the strategies generate excess returns compared to the market.

2 Trading Idea

2.1 Global Rotation Strategy

The GRS is based on a ranking approach. The used ETFs are ranked based on momentum which is measured by the Rate of Change (ROC) indicator. The lookback period is variable and can be tested for different values. The same is true for the invested period. For this report the lookback period will be tested for different values between one month and 12 months. The best result will be presented in the report. The time period for being invested is one month. The strategy suggests to buy the best ranked ETF. Many variations and extensions of the strategy exist which will be used and presented throughout the report.

2.2 Choice of ETFs

In order to achieve substantial returns it is beneficial for a ranking strategy that the selected ETFs are not too volatile and have long-term visible trends. It can be assumed that the best results can be achieved if the used ETFs have a comparable volatility. A large market volume makes sure that the ETFs cannot be easily manipulated. This is the case for all proposed ETFs in the strategy. The 5 chosen ETFs cover the world market. The following ETFs are used:

US Market (MDY- S&P MidCap 400 SPDRs) Europe (IEV- iShares S&P Europe 350 Index Fund) Emerging Markets (EEM- iShares MSCI Emerging Markets) Latin America (ILF- iShares S&P Latin America) Pacific region (EPP - iShares MSCI Pacific ex-Japan)

According to the strategy, the ETFs follow slightly different economic cycles. There are certain periods where one market outperforms another until it becomes overpriced. As a result investors begin to shift there money in other cheaper valued markets. With the GRS strategy, this trends can be followed.

3 Implementation of the trading strategy and Benchmark

3.1 Part A: Initialization

3.1.1 Step 1: General Setup

Pre-Step: Clear the environment.

```
rm(list=ls()) # clear the workspace
```

Define Currency, Instruments, Time zone and other simulation parameters. As well as Currency, Instruments and Time zone, you need to set starting and ending dates for the simulation, names for the portfolio and the account (often both are set to the strategy name), and the amount of starting capital.

```
library(quantstrat)
currency("USD")
Sys.setenv(TZ="UTC")
initdate <- '2003-08-31'
startdate <- '2003-09-02'
enddate <- '2018-12-31'
portfolioname <- "GRS"
accountname <- portfolioname
strategyname <- portfolioname
```

3.1.2 Step 2: Setting the variables

```
#Set values:

startingcapital <- 10000

buypositions <- 1
roc.var <- 3

dir <- "~/Desktop/R/GRS/"
daterange <- '2003::2018'
```

3.1.3 Step 3: Preset for plotting graphs

```
myTheme <- chart_theme()
myTheme$col$dn.col <- 'red'
myTheme$col$up.col <- 'lightblue'
myTheme$col$dn.border <- 'lightgray'
myTheme$col$up.border <- 'lightgray'
```

3.1.4 Step 4: Load and transform data

Loading data into R environment. Transform it to monthly data, use only Close prices and change the columnname to the name of the symbol used.

```
library(INFT361Course)
symbollist <- GetCourseDirList(dir)

# Load data into the environment
LoadCourseDir(dir)

# transform data to monthly data
for (symbol in symbollist)
{
  symname <- symbol
  stock(symbollist,currency="USD")
  # convert data to monthly
  x<-get(symbol)
  x=to.monthly(x,indexAt="startof",drop.time=FALSE, OHLC=TRUE) # needs "endof" and dr
  indexFormat(x) <- '%Y-%m-%d'
  x <- x[, "x.Close"]
  colnames(x)<-gsub("x.", "", colnames(x)) # Change columnnames to Symbol.Open etc.
  colnames(x) <- symbol

  assign(symbol,x)
}
```

3.1.4.1 Merge all symbols together

Merge all symbols together in order to perform the ranking of the ETFs.

```
symbols_close <- do.call(merge,lapply(symbollist,get))
```

3.1.4.2 Calculate ROC

Calculate the ROC for the last n months for the used symbols and store it for ranking in new roc matrix.

```
roc <- ROC(symbols_close, n=roc.var, type="discrete")
roc <- na.omit(roc)
```

3.1.4.3 Rank ETFs

Rank the ETFs based on their rate of change and store the ranks in new ranks matrix.

```
ranks <- as.xts(t(apply(-roc,1,rank)))
```

3.1.4.4 Identify positiv returns

Create new matrix `pos_rets` for the ETFs which assigns a 0 to negative returns and a 1 to positive returns. This is needed to be able to easy access the information about the returns at a specific date.

```
pos_rets <- roc
pos_rets[pos_rets<=0] <- 0
pos_rets[pos_rets>0] <- 1
```

3.1.4.5 Merge all data together

Merge the created matrices together with the original data to have all data of the symbols available together with the created indicators (ranks and `pos_rets`).

```
# Load all original files
LoadCourseDir(dir)

# Convert the symbols to monthly data
for (symbol in symbollist)
{
  symname <- symbol
  stock(symbollist,currency="USD")
  # convert data to monthly
  x<-get(symbol)
  x=to.monthly(x,indexAt="startof",drop.time=FALSE, OHLC=TRUE)
  indexFormat(x) <- '%Y-%m-%d'
  colnames(x)<-gsub("x.", "", colnames(x))

  assign(symbol,x)
}

# lag the ranks by one period as the calculations
# are based on the Close price of the month
# so the rank is the indicator for the next month
# to perform the buy at the opening price

ranks <- lag(ranks,k=1,na.pad=TRUE)
ranks <- na.omit(ranks)

# merge the ranks values to their respective original symbols
for (col in colnames(ranks))
{
  x <- get(col)
  x <- merge(x,ranks[,col])
  colnames(x)[colnames(x) == col] <- "Rank"
  x<-na.omit(x)
  assign(col,x)
}
```

```

# merge the returns indicator values back to their original symbols
for (col in colnames(pos_rets))
{
  x <- get(col)
  x <- merge(x,pos_rets[,col])
  colnames(x)[colnames(x) == col] <- "PosRets"
  x<-na.omit(x)
  assign(col,x)
}

```

3.1.5 Step 5: Order sizing function

The order sizing function is used to ensure that money is equally split between the investment products

```

# order sizing function
osInvestAll <- function (data, timestamp, orderqty,
                        ordertype, orderside, portfolio,
                        symbol, ruletype, ..., orderprice)
{
  datePos <- format(timestamp,"%Y-%m-%d")

  updatePortf(Portfolio=portfolio,Symbol=symbol,Dates=datePos)
  updateAcct(portfolio,Dates=datePos)
  updateEndEq(portfolio,Dates=datePos)

  Posn <- getPosQty(portfolio,Symbol=symbol,Date=datePos)
  equity <- getEndEq(portfolio,datePos) / buypositions

  OpenPrice <- getPrice(get(symbol), prefer="Open")[datePos]

  UnitSize <- as.numeric(trunc(equity/OpenPrice))

  # check whether orderside is long or short and return
  # either positive value for the unit size or a negative value.

  if (Posn == 0) {

    if (orderside == "long"){
      print(orderside)
      osInvestAll <- UnitSize
    } else{
      print(orderside)
      osInvestAll <- -UnitSize
    }
  } else

```



```

    {osInvestAll <- 0
    }
}

```

3.1.6 Step 6: Transaction cost function

In order to include realistic transaction costs, the following transaction costs function is used. Depending on the order volume we have increasing transaction costs. Order volume above 28000

```

# transaction fees function
txnc <- function(TxnQty, TxnPrice, Symbol, ...)
{
  ordervalue = abs(TxnQty) * TxnPrice

  if (ordervalue <= 5000)
    return (-19.95)

  if (ordervalue <= 10000)
    return (-24.95)

  if (ordervalue <= 28000)
    return (-29.95)

  return(-0.11/100 * ordervalue)
}

```

3.2 Part B: Apply Strategy

3.2.1 Step 1: Create Strategy, Portfolio and Account

```

rm.strat(strategyname) # remove if it already exists
initPortf(portfolioname,symbollist,initDate=initdate,currency="USD")
initAcct(accountname,
         portfolios=portfolioname,
         initDate=initdate,
         initEq=startingcapital,
         currency="USD")
initOrders(portfolio=portfolioname,initDate=initdate)
strategy(strategyname,store=TRUE)
strat <- getStrategy(strategyname)

```

3.2.2 Step 2: Define indicators, signals and rules

The original strategy is based on the simple idea that the ETFs are ranked by the ROC (return of the last n months). The best ETF is bought and hold for one month. Therefore two signals and two rules are created:

Signal 1: If the Rank is lower or equal the Buypositions (which is 1 in case we want to buy only one ETF) then the signal is set to TRUE.

Signal 2: If the Rank is above the buyposition variable the signal is set to TRUE.

Rule 1: Long Entry rule which buys the ETF when the longEntry Signal is TRUE. Buy is performed at the Open price and osInvestAll function is used to calculate the ordersize.

Rule 2: Exit rule for the strategy. Based on the longExit signal the rule exits the current position and sells the entire amount in the portfolio.

```
add.signal(strategyname,
            name="sigThreshold",
            arguments=list(column="Rank",
                           threshold = buypositions,
                           relationship="lte"),
            label="longEntry")

add.signal(strategyname,
            name="sigThreshold",
            arguments=list(column="Rank",
                           threshold=buypositions,
                           relationship="gt"),
            label="longExit")

add.rule(strategyname,
          name="ruleSignal",
          arguments=list(sigcol="longEntry",
                         sigval=TRUE,
                         orderqty=100,
                         ordertype="market",
                         orderside="long",
                         replace=FALSE,
                         prefer="Open",
                         osFUN='osInvestAll',
                         TxnFees="txnc",
                         orderset="ocolong"),
          type="enter",
          path.dep=TRUE,
          label="enterLONG")

add.rule(strategyname,
          name="ruleSignal",
          arguments=list(sigcol="longExit",
                         sigval=TRUE,
                         orderqty="all",
                         ordertype="market",
                         orderside="long",
```

```

                                replace=FALSE,
                                prefer="Open",
                                TxnFees="txnc",
                                orderset="ocolong"),
    type="exit",
    path.dep=TRUE,
    label="exitLONG")

```

3.2.3 Step 3: Run the strategy

```

applyStrategy(strategy=strategyname,portfolios=portfolioname)

updatePortf(strategyname)
updateAcct(strategyname)
updateEndEq(strategyname)

```

3.2.4 Step 4: Check orderbook

Check the orderbook to verify that all transactions are made correctly. The orderbook can be found in the appendix.

3.3 Analyze strategy

3.3.1 Step 1: Endequity and Return

Calculate endequity and return of the strategy

```

# end equity
acct <- getAccount(accountname)
equity.v1 <- acct$summary$End.Eq
colnames(equity.v1) <- c("Equity V1")

# returns of the strategy
rets.v1 <- monthlyReturn(equity.v1, type="arithmetic")
colnames(rets.v1) <- c("Returns V1")

```

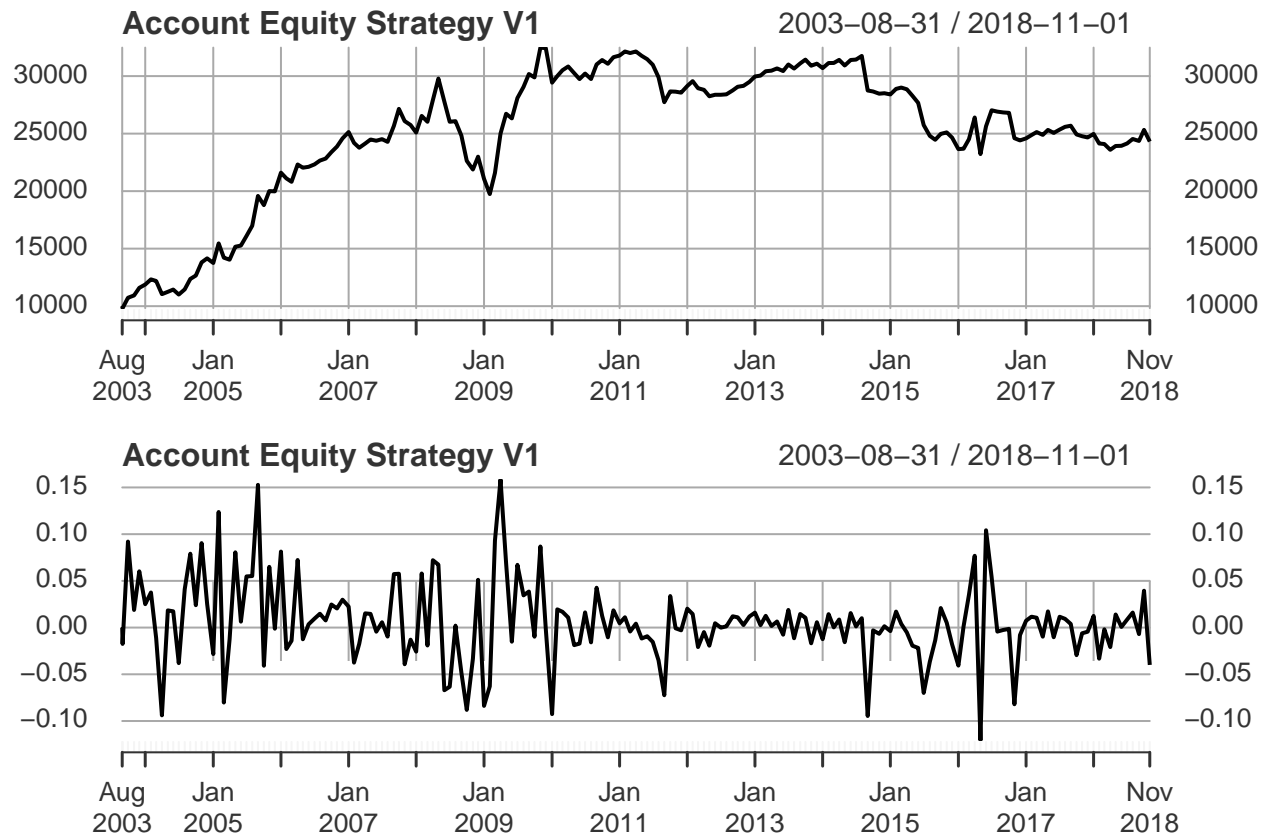
3.3.2 Step 2: Plot Endequity and Return

The Endequity and the return of the strategy are plotted below. We can see that the strategy performs quiet well until the financial crisis 2008. After the crisis the performance is positive as well. However, from 2010 until today the strategy does not generate returns.

```

par(mfrow=c(2,1))
plot(equity.v1, main="Account Equity Strategy V1")
plot(rets.v1, main="Account Equity Strategy V1")

```



```
par(mfrow=c(1,1))
```

3.3.3 Step 3: Visualize the original data

Below are visualizations of the original instruments which are traded. This plots can be used to get a first impression of the long term trend of the instrument and to see which general behaviour of the price movement can be observed.

```
for (symbol in symbollist){
  chart <- get(symbol)
  if (nrow(getTxns(portfolioname,Symbol=symbol)) > 1)
  {
    print(chart_Series(x=chart,name=symbol,
                      theme=myTheme,
                      subset=daterange))
  }
}
```



EPP.csv

2003-09-02 / 2018-11-01



IEV.csv

2003-09-02 / 2018-11-01



ILF.csv

2003-09-02 / 2018-11-01



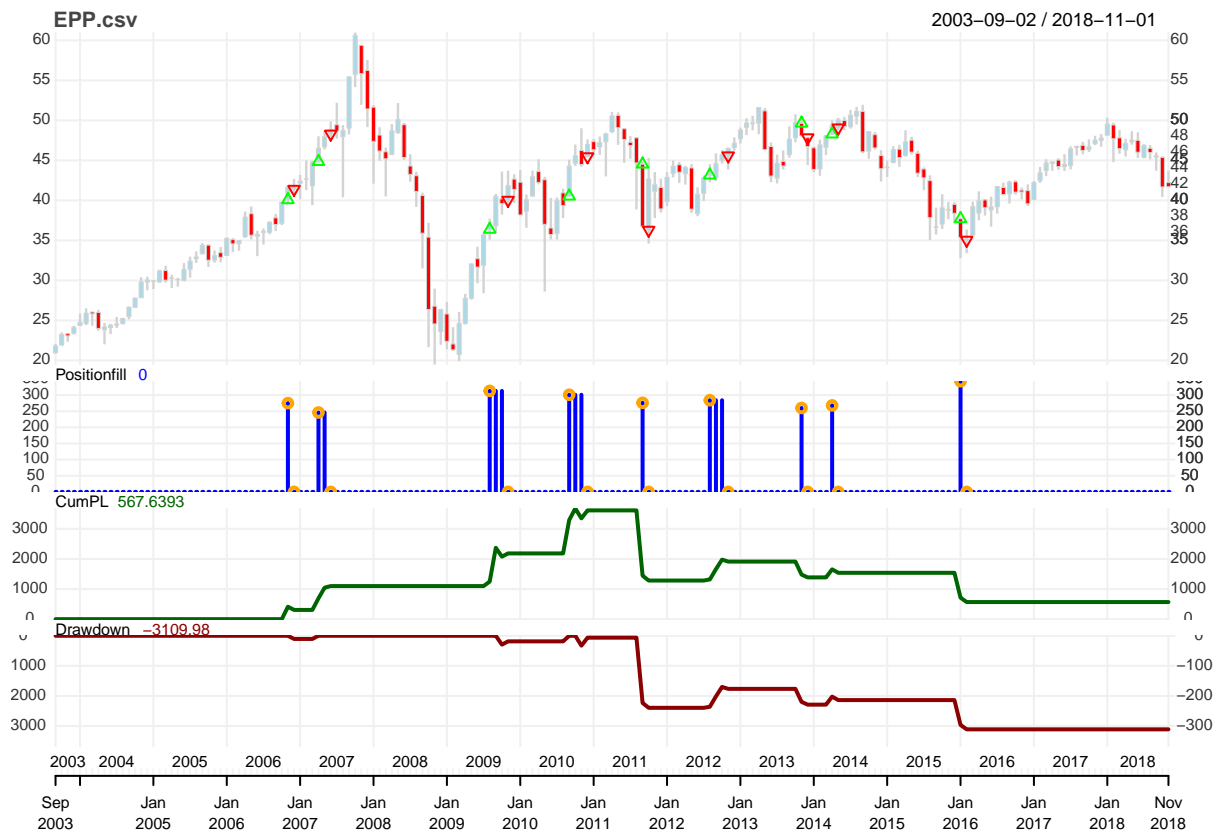


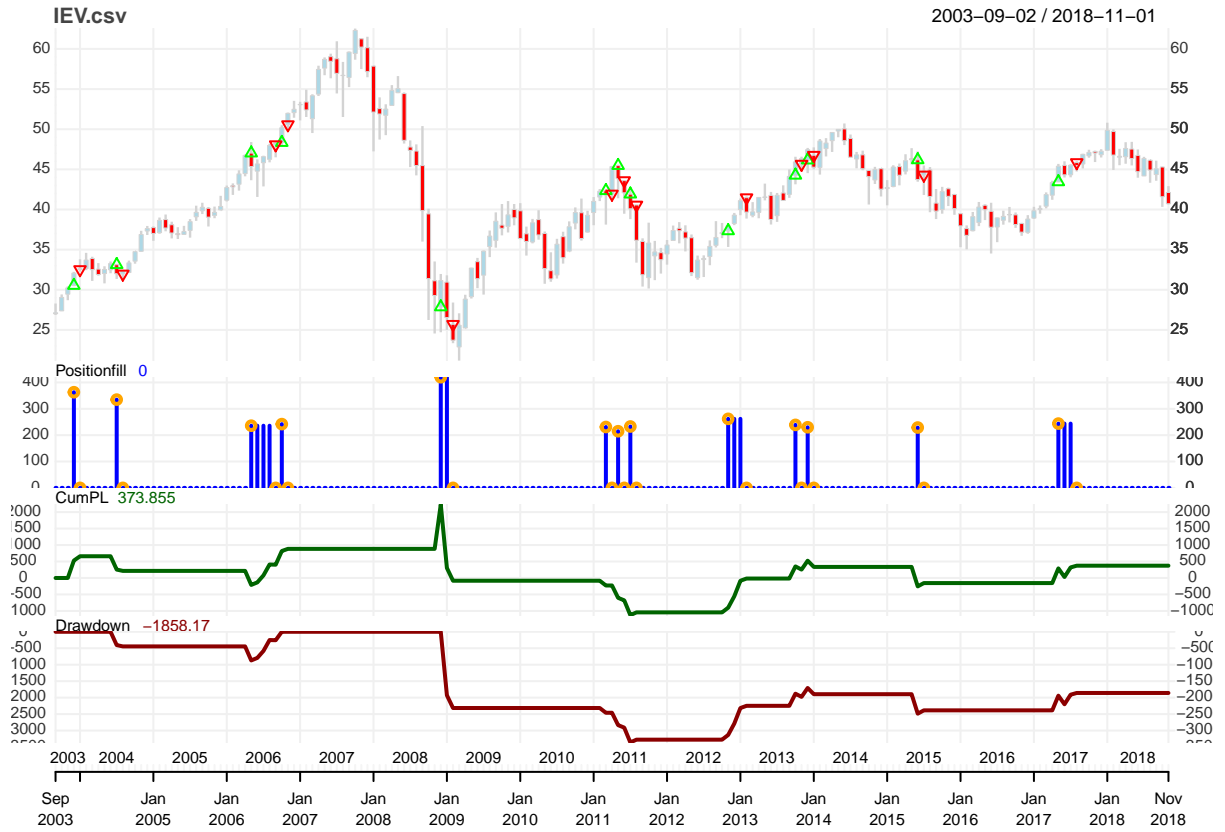
3.3.3.1 Step 4: Visualize all transactions

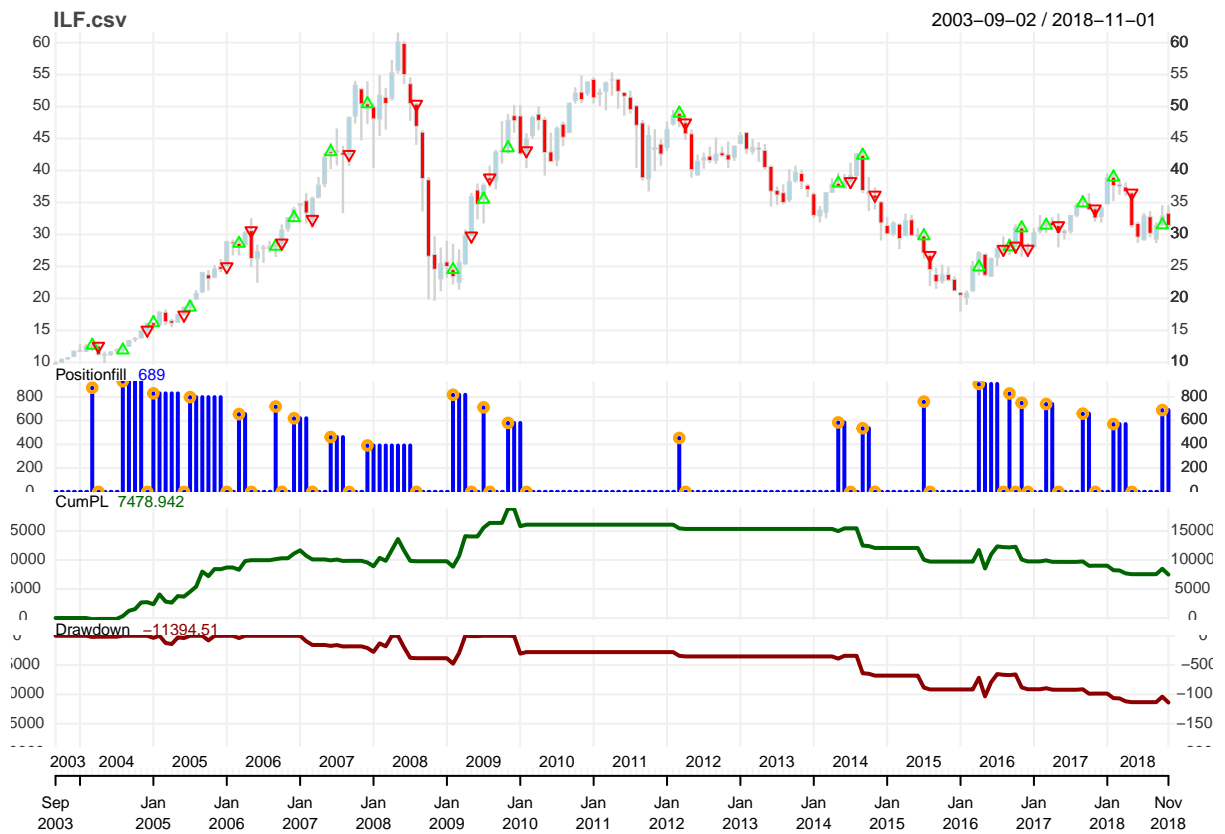
The following graphs show the combined view of the performance of the GRS trading system. It visualizes the trades (buy-transactions are visualized in green and sell-transactions are visualized in red). Moreover, the size of the blue squares indicates the size of the position (height) and the holding duration of the position (width). The green line shows the cumulative net profit curve, while the red line indicates the drawdown on each day compared to the last reached high.

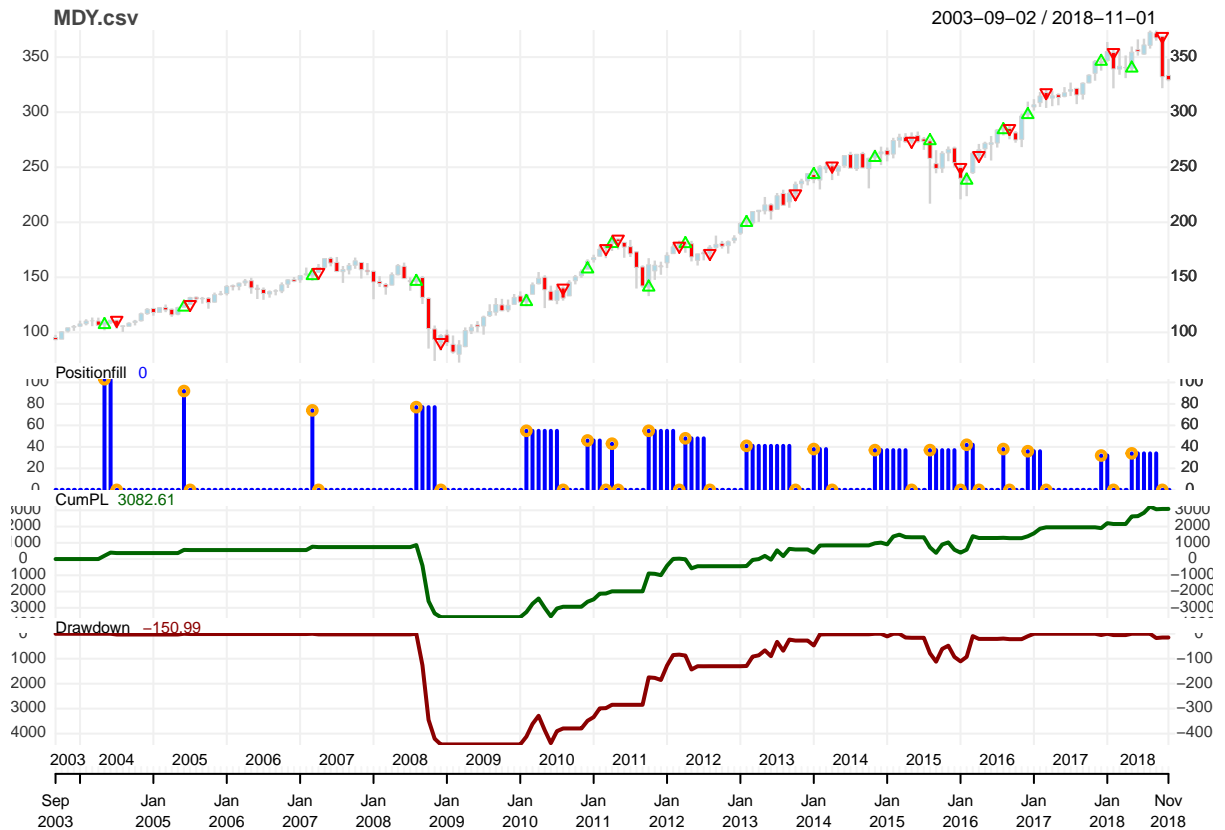
```
par(mfrow=c(1,1))
# plot graph with indicators for transactions
for (symbol in symbollist)
{
  if (nrow(getTxns(portfolioname,Symbol=symbol)) > 1)
  {
    symboldata <- get(symbol)
    chart.Posn(portfolioname,
               Symbol=symbol,
               type='candlesticks',
               theme=myTheme,
               subset=daterange)
  }
}
```











3.3.3.2 Step 5: Performance statistics

To analyze the results of our strategy appropriately we need to create some statistical measures which indicates how well the strategy performs. The following table summarizes some important trading statistics for all instruments. This statistic is just an excerpt of the available statistics which can be calculated and displayed. It is printed here as it can be assumed that they are interesting for investors to rate the trading strategy.

```
library(PerformanceAnalytics)
# Get returns for all instruments in the portfolio
rets.portfolio.v1 <- PortfReturns(Account=accountname)
rownames(rets.portfolio.v1) <- NULL

rets.v1.comb <- cbind(rets.v1, rets.portfolio.v1)

tstats <- tradeStats(Portfolio=portfolioname, Symbols=symbollist)

for (i in 1:nrow(tstats)) {
  trades.tab <- cbind(
    c("Trades", "Win Percent", "Loss Percent", "W/L Ratio"),
    c(tstats[i, "Num.Trades"],
      round(tstats[i, "Percent.Positive"], 2),
      round(tstats[i, "Percent.Negative"], 2),
```

```

    round((tstats[i,"Percent.Positive"]/tstats[i,"Percent.Negative"]),2)))
trades1 <- trades.tab
rownames(trades1) <- c("Trades",
                      "Win Percent",
                      "Loss Percent",
                      "W/L Ratio")

trades1 <- trades1[,2]
print(row.names(tstats[i,]))
print(trades1)
writeLines("")
}

```

```

## [1] "EEM.csv"
##      Trades  Win Percent Loss Percent  W/L Ratio
##      "15"    "53.33"    "46.67"    "1.14"
##
## [1] "EPP.csv"
##      Trades  Win Percent Loss Percent  W/L Ratio
##      "9"     "66.67"    "33.33"    "2"
##
## [1] "IEV.csv"
##      Trades  Win Percent Loss Percent  W/L Ratio
##      "13"    "53.85"    "46.15"    "1.17"
##
## [1] "ILF.csv"
##      Trades  Win Percent Loss Percent  W/L Ratio
##      "22"    "45.45"    "54.55"    "0.83"
##
## [1] "MDY.csv"
##      Trades  Win Percent Loss Percent  W/L Ratio
##      "18"    "83.33"    "16.67"    "5"

```

```

tab.perf <- table.Arbitrary(rets.v1.comb, metrics=c("Return.cumulative",
                                                    "Return.annualized",
                                                    "SharpeRatio.annualized",
                                                    "CalmarRatio"),
                           metricsNames=c("Cumulative Return",
                                           "Annualized Return",
                                           "Annualized Sharp Ratio",
                                           "Calmar Ratio"))
tab.risk <- table.Arbitrary(rets.v1.comb, metrics=c("StdDev.annualized",
                                                    "maxDrawdown",
                                                    "VaR",
                                                    "ES"),
                           metricsNames=c("Annualized StdDev",
                                           "Max Drawdown",
                                           "Value-at-Risk",

```

```

                                "Conditional VaR"),
                                method=c("historical"))
colnames(tab.perf) <- substr(colnames(tab.perf),1,3)
colnames(tab.risk) <- substr(colnames(tab.risk),1,3)

writeLines("Performance Metrics")

```

```
## Performance Metrics
```

```
tab.perf
```

| | Ret | EEM | EPP | IEV | ILF | MDY |
|------------------------|-----------|-----------|-----------|------------|-----------|-----------|
| Cumulative Return | 1.4311626 | 0.2285680 | 0.0067913 | -0.0065177 | 0.1485727 | 0.2594299 |
| Annualized Return | 0.0596484 | 0.0135898 | 0.0004439 | -0.0004287 | 0.0091247 | 0.0152402 |
| Annualized Sharp Ratio | 0.4096519 | 0.1345520 | 0.0056614 | -0.0057701 | 0.0325740 | 0.1552906 |
| Calmar Ratio | 0.1769151 | 0.0601695 | 0.0015183 | -0.0014177 | 0.0119390 | 0.0397280 |

```
writeLines("Risk Metrics")
```

```
## Risk Metrics
```

```
tab.risk
```

| | Ret | EEM | EPP | IEV | ILF | MDY |
|-------------------|------------|------------|------------|------------|------------|------------|
| Annualized StdDev | 0.1456075 | 0.1010005 | 0.0784119 | 0.0742959 | 0.2801212 | 0.0981396 |
| Max Drawdown | 0.3371584 | 0.2258592 | 0.2923854 | 0.3023776 | 0.7642705 | 0.3836126 |
| Value-at-Risk | -0.0695126 | -0.0172231 | -0.0089518 | -0.0140131 | -0.0943069 | -0.0326733 |
| Conditional VaR | -0.0878293 | -0.0602668 | -0.0467302 | -0.0515536 | -0.2036066 | -0.0762445 |

```
# present performance metrics for the entire strategy
```

```

somestats <- data.frame(rownames(tab.perf),
                        tab.perf[,1],
                        rownames(tab.risk),
                        tab.risk[,1])
colnames(somestats) <- c("Performance Metric",
                        "Performance Value",
                        "Risk Metric",
                        "Risk Value")

```

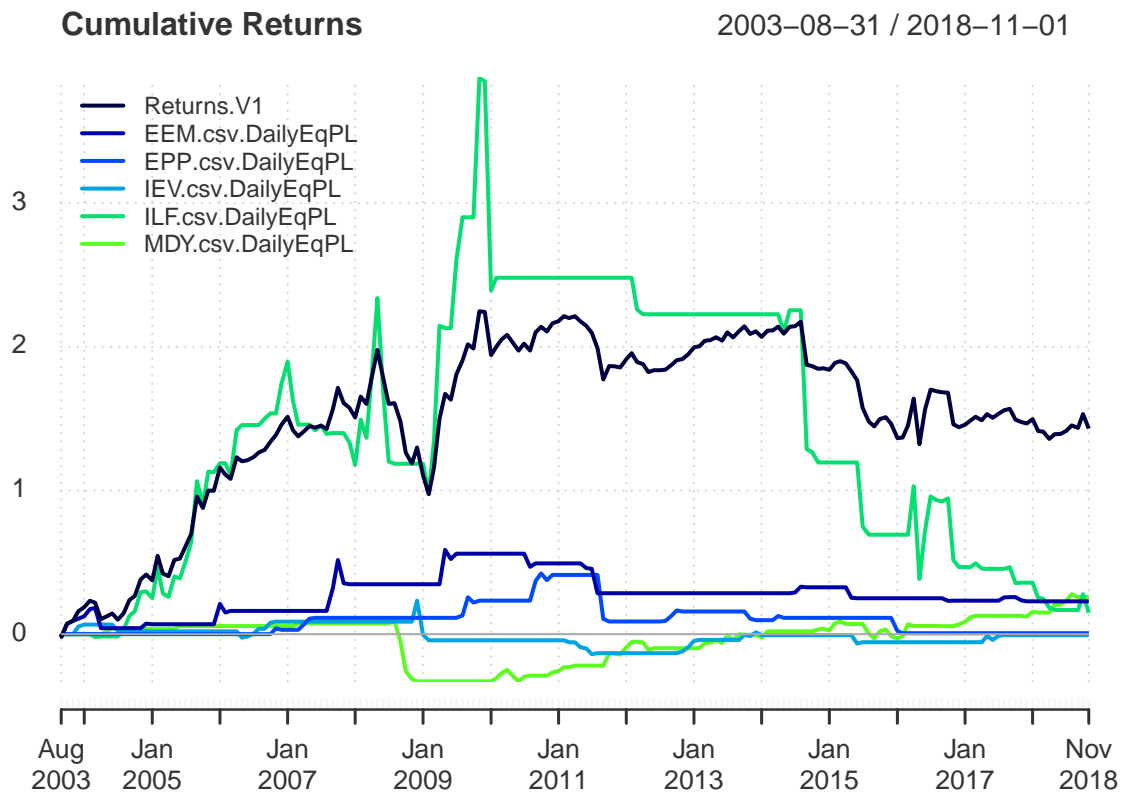
```
somestats
```

| Performance Metric | Performance Value | Risk Metric | Risk Value |
|------------------------|-------------------|-------------------|------------|
| Cumulative Return | 1.4311626 | Annualized StdDev | 0.1456075 |
| Annualized Return | 0.0596484 | Max Drawdown | 0.3371584 |
| Annualized Sharp Ratio | 0.4096519 | Value-at-Risk | -0.0695126 |
| Calmar Ratio | 0.1769151 | Conditional VaR | -0.0878293 |

3.3.3.3 Step 6: Visualize portfolio statistics

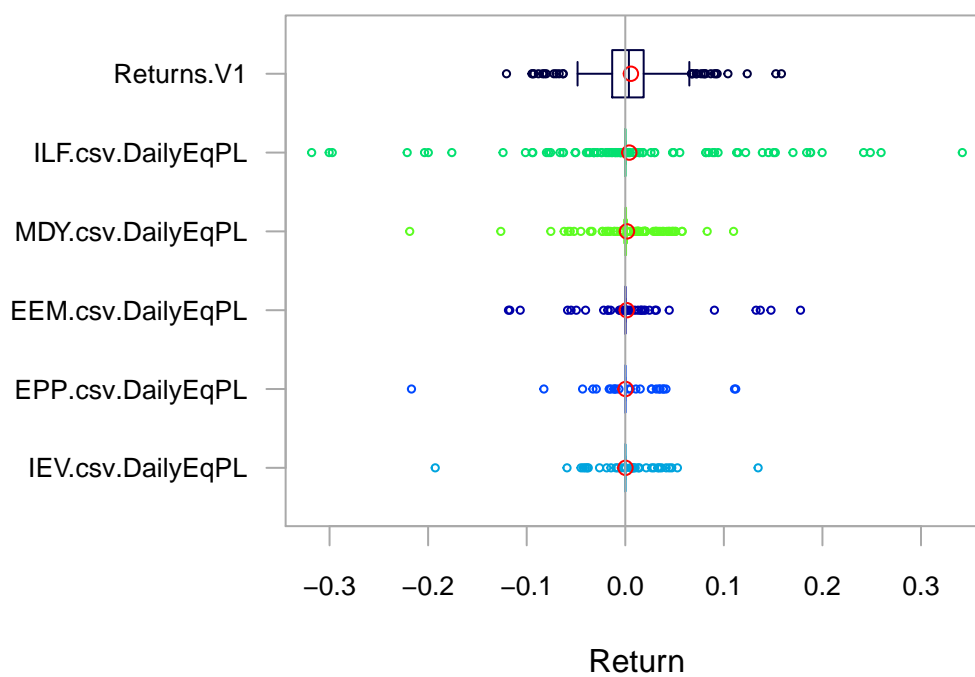
The following plot shows the cumulative returns of the instruments which are used in the strategy in order to see whether the returns of the instruments differentiate significantly from each other.

```
par(mfrow=c(1,1))
chart.CumReturns(rets.v1.comb,
  colorset=rich10equal,
  legend.loc="topleft",
  main="Cumulative Returns")
```

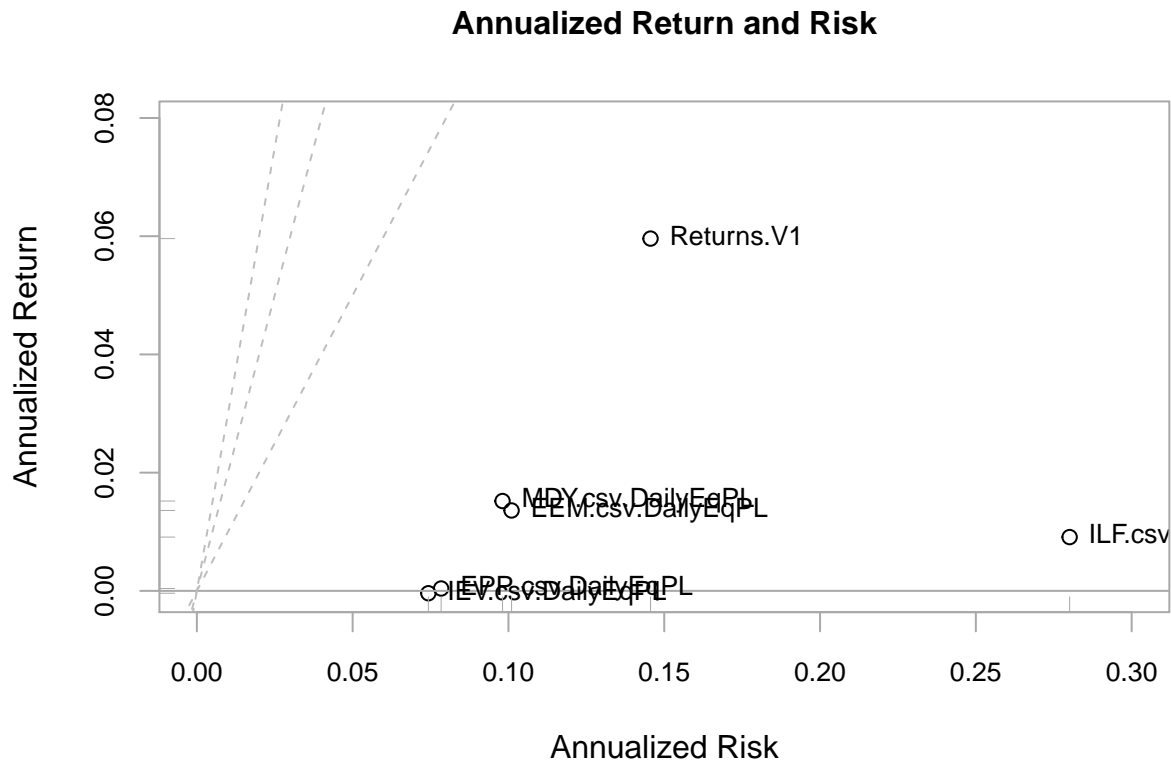


```
chart.Boxplot(rets.v1.comb,colorset=rich10equal)
```

Return Distribution Comparison



```
chart.RiskReturnScatter(rets.v1.comb)
```

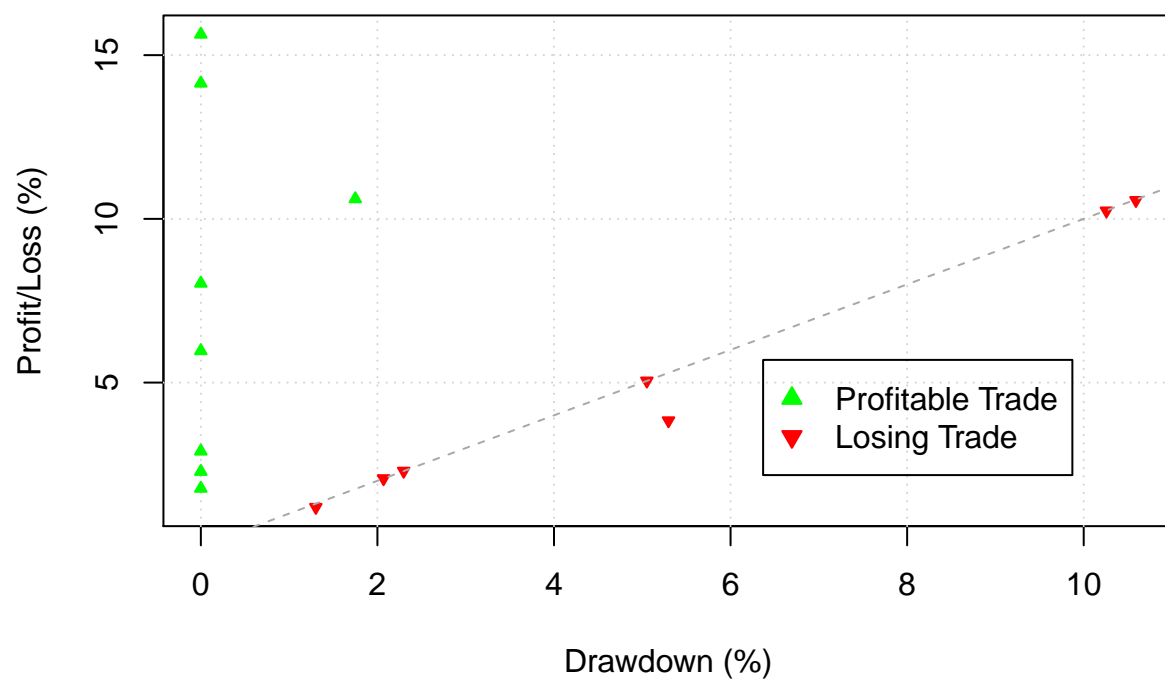


3.3.3.4 Step 7: Could we have performed better or even worse? MAE / MFE

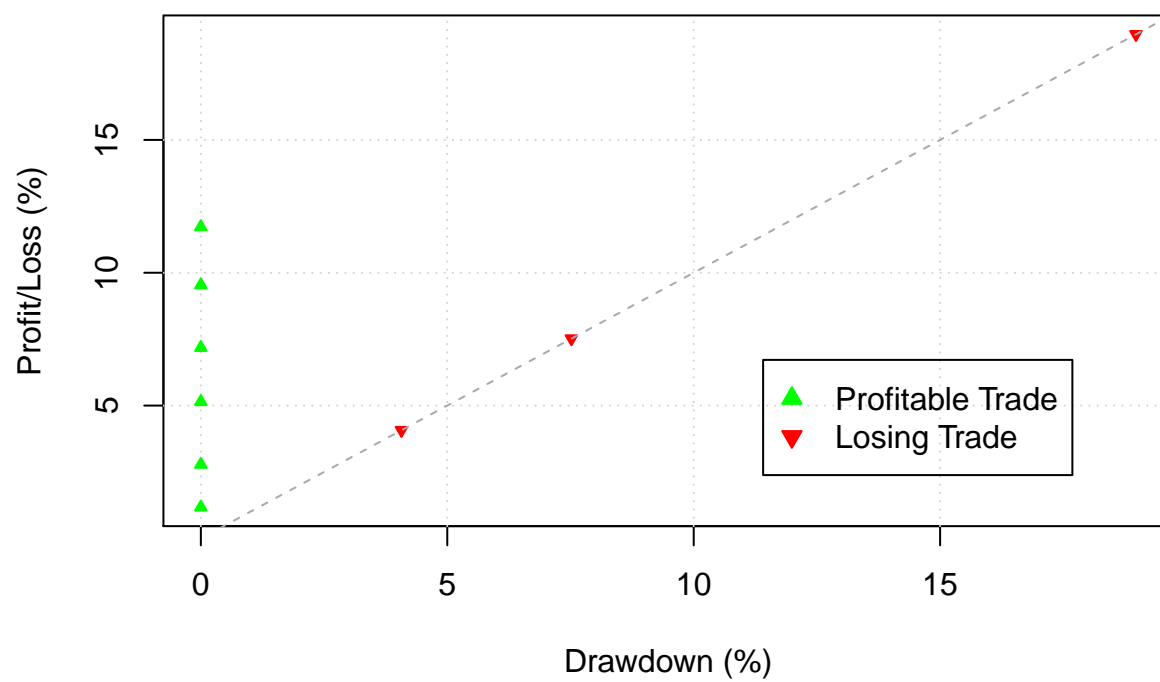
The efficiency of a strategy is also dependent on the question whether we could have performed better or worse. This can be shown with the maximum adverse excursion and the maximum favorable excursion. The Maximum Adverse excursion shows how much we could have lost at most during the trade, while the maximum favorable excursion shows how much we could have earned more than we did. In the MFE case we want all trades to be as close to the diagonal line as possible. Every movement to the bottom right right can be interpreted as a not realized opportunity to earn higher returns.

```
for (instrument in symbollist){
  chart.ME(portfolioname, instrument, type="MAE", scale="percent")
}
```

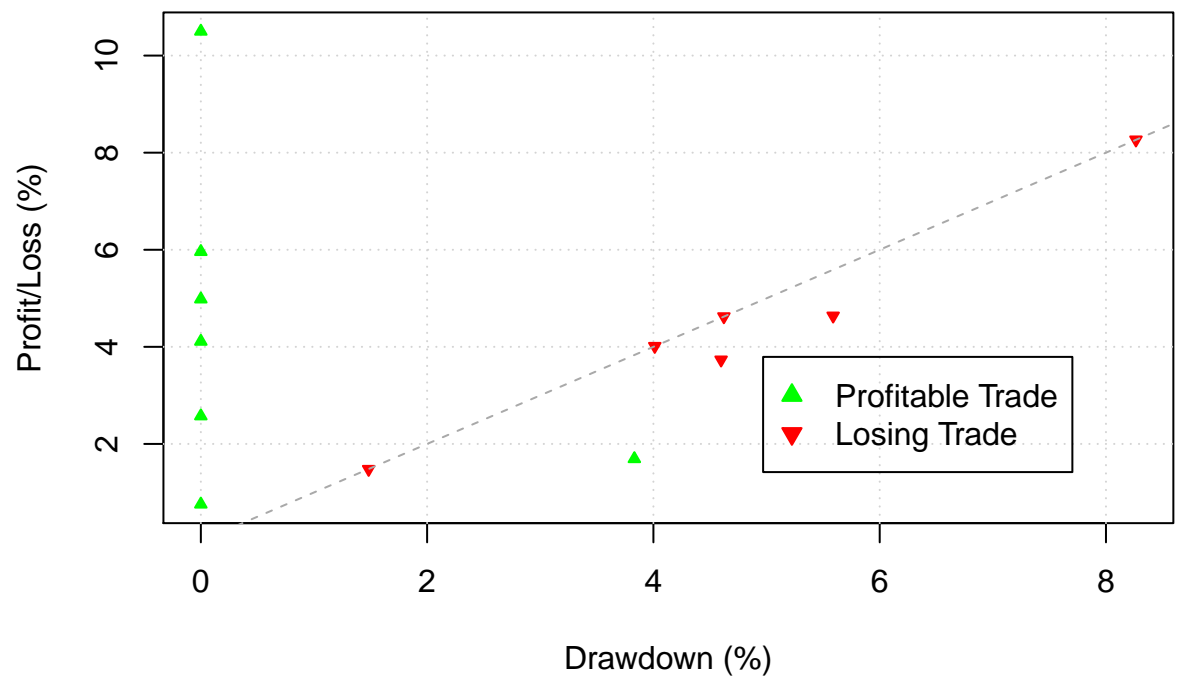
EEM.csv Maximum Adverse Excursion (MAE)



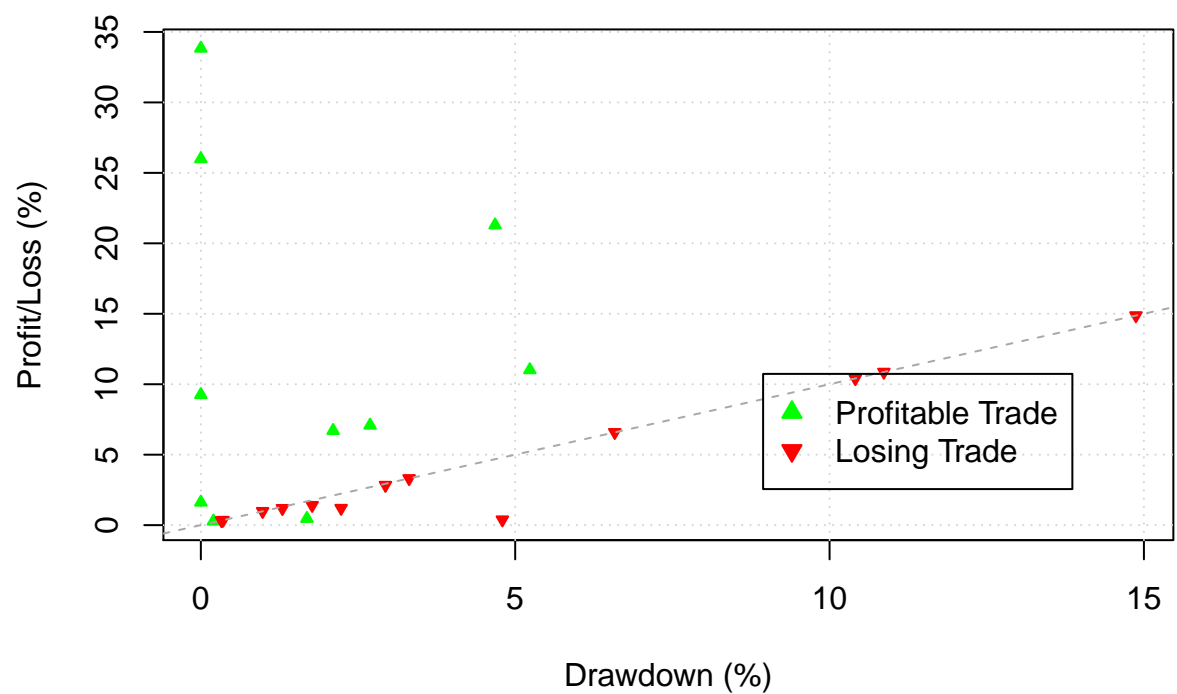
EPP.csv Maximum Adverse Excursion (MAE)



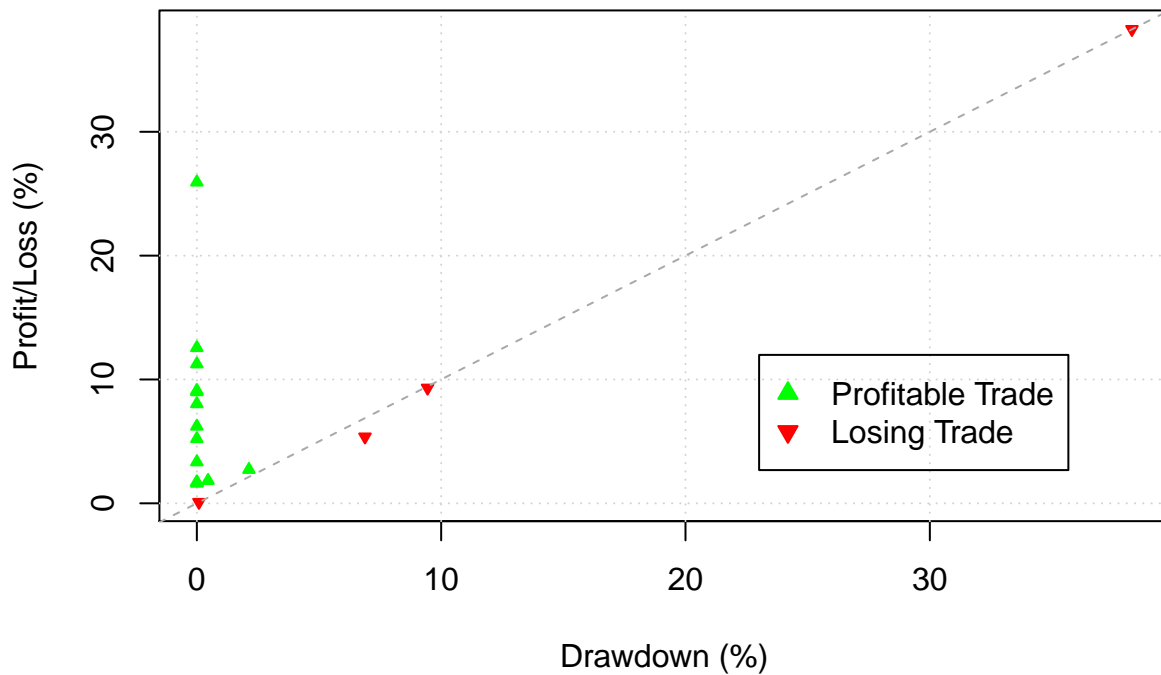
IEV.csv Maximum Adverse Excursion (MAE)



ILF.csv Maximum Adverse Excursion (MAE)



MDY.csv Maximum Adverse Excursion (MAE)



3.3.3.5 Step 8: Strategy Risk

```
logR <- monthlyReturn(equity.v1,type="arithmetic")
index(logR) <- as.yearmon(index(logR))

library(quantmod)

dir <- "~/Desktop/R/GRS/Risk/"
ff <- read.csv(paste0(dir,"FFFactors.csv"))
ffxts <- as.xts(ff[,-1],order.by=as.Date(ff$dates))
index(ffxts) <- as.yearmon(index(ffxts))

funddata <- merge(logR,ffxts)
funddata <- funddata[complete.cases(funddata),]
# Calculate Excess Returns above the risk free rate
funddata$monthly.returns <- funddata$monthly.returns*100
funddata$excessrtn <- funddata$monthly.returns - funddata$rf
```

3.3.3.5.1 Perform a CAPM Regression

```
capm <- lm(excessrtn ~ mkt.rf, data=funddata)
summary(capm)
```



```
##
## Call:
## lm(formula = excessrtn ~ mkt.rf, data = funddata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -13.1819  -1.5270  -0.3787   1.0936  14.6738
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.005985    0.262019   0.023   0.982
## mkt.rf       0.626846    0.065683   9.543 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.442 on 177 degrees of freedom
## Multiple R-squared:  0.3397, Adjusted R-squared:  0.336
## F-statistic: 91.08 on 1 and 177 DF, p-value: < 2.2e-16
```

3.3.3.5.2 Perform a Fama-French 3 factor Regression

```
# Run Fama-French 3 factor Regression
ff3regression <- lm(excessrtn ~ mkt.rf + smb + hml, data=funddata)
summary(ff3regression)
```

```
##
## Call:
## lm(formula = excessrtn ~ mkt.rf + smb + hml, data = funddata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -12.9402  -1.5833  -0.3621   1.1228  14.6474
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.01417    0.26282   0.054   0.957
## mkt.rf       0.59547    0.07241   8.224 4.3e-14 ***
## smb         0.07154    0.12056   0.593   0.554
## hml         0.09746    0.10863   0.897   0.371
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.45 on 175 degrees of freedom
## Multiple R-squared:  0.3443, Adjusted R-squared:  0.333
## F-statistic: 30.63 on 3 and 175 DF, p-value: 5.771e-16
```

The results of the strategy's risk analysis indicate that no excess returns can be generated. The intercept of the regression models (CAPM as well as Fama-French model) is slightly

positive but not significant. This means that risk adjusted and compared to the market we cannot generate an alpha (excess returns). However, the beta-coefficient for the market risk free return is significant and with about 0.6 lower than 1. Thus, the strategy is slightly tilted towards less risky instruments.

3.4 Part C: Compare with Buy and Hold Strategy

After having analyzed the strategy extensively, a comparison to another strategy should be made to evaluate the performance based on a benchmark which could have been an alternative investment. In this case a simple buy and hold strategy is used. At the first date of the trading period we place a buy order and sell our position at the last day of the selected period. In order to do this, we create a new Portfolio and a new Account. As ETFs are used which cover the entire world market, the appropriate Buy and Hold comparison would be an index which covers also the entire world market. Therefore, the MSCI World Index is used as a benchmark.

3.4.1 Step 1: Generate the buy-and-hold portfolio, account, and transactions

```
BuyHoldDirectory = "~/Desktop/R/GRS/BH/"
BuyHoldInstrument = "SPY.csv"

# Any objects, in case there was a buyhold
# portfolio initialized before are removed
suppressWarnings(try(rm(list=c("account.buyhold",
                              "portfolio.buyhold"),
                        pos=.blotter)))

# The Buy and hold instrument is loaded
LoadCourseFile(BuyHoldDirectory,
               BuyHoldInstrument,
               debugme=TRUE,
               dates="2003-08-31::2018")

symname <- BuyHoldInstrument
# The Buy and hold instrument is initialized
stock(BuyHoldInstrument, currency="USD")
# convert data to monthly
x<-get(BuyHoldInstrument)
x=to.monthly(x, indexAt="startof", drop.time=FALSE, OHLC=TRUE)
colnames(x)<-gsub("x.", "", colnames(x))
indexFormat(x) <- '%Y-%m'
assign(BuyHoldInstrument, x)

BuyHoldSymbol<-get(BuyHoldInstrument)
```

```

# The portfolio and account "buyhold" is initialized
initPortf("buyhold",
          BuyHoldInstrument,
          initDate=initdate,
          currency="USD")
initAcct("buyhold",
         portfolios="buyhold",
         initDate=initdate,
         initEq=startingcapital,
         currency="USD")

# The first date of the defined daterange is selected
currentdate <- first(time(BuyHoldSymbol))

# The close price at this date is selected
closeprice <- as.numeric(Cl(BuyHoldSymbol[currentdate,]))

# Calculate the unitsize we can buy with our startingcapital
unitsize <- as.numeric(trunc(startingcapital/closeprice))

# Place the transaction for the instrument at the first date
addTxn("buyhold",
        Symbol=BuyHoldInstrument,
        TxnDate=currentdate,
        TxnPrice=closeprice,
        TxnQty=unitsize,
        TxnFees="txnc")

# Select the last date of the daterange period
lastdate <-last(time(BuyHoldSymbol))

# Select the price at the last date
lastprice <- as.numeric(Cl(BuyHoldSymbol[lastdate,]))

# Sell the position at the last date of the daterange
addTxn("buyhold",
        Symbol=BuyHoldInstrument,
        TxnDate=lastdate,
        TxnPrice=lastprice,
        TxnQty=-unitsize,
        TxnFees="txnc")

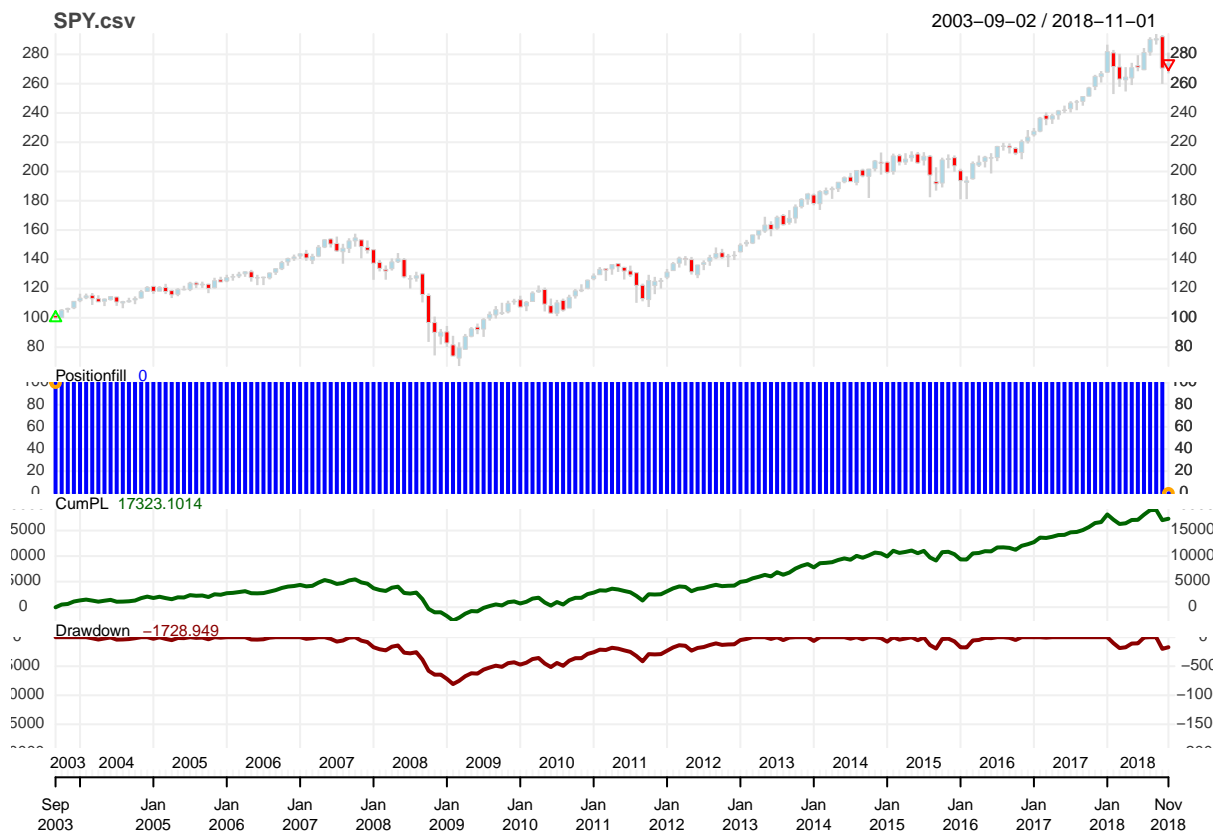
# update portfolio and account
updatePortf(Portfolio="buyhold")

```

```
updateAcct(name="buyhold")
updateEndEq(Account="buyhold")
```

3.4.2 Step 2: Visualize the Buy and Hold strategy

```
chart.Posn("buyhold",
  Symbol=BuyHoldInstrument,
  type='candlesticks',
  theme=myTheme,
  subset=daterange)
```



3.4.3 Step 3: Compare Buy and Hold with GRS

Generate statistics for the buy-and-hold portfolio. Generate returns and metrics of the buy-and-hold portfolio/account and compare statistics for the quantitative/technical portfolio to the buy-and-hold portfolio.

3.4.3.1 Generate equity and return

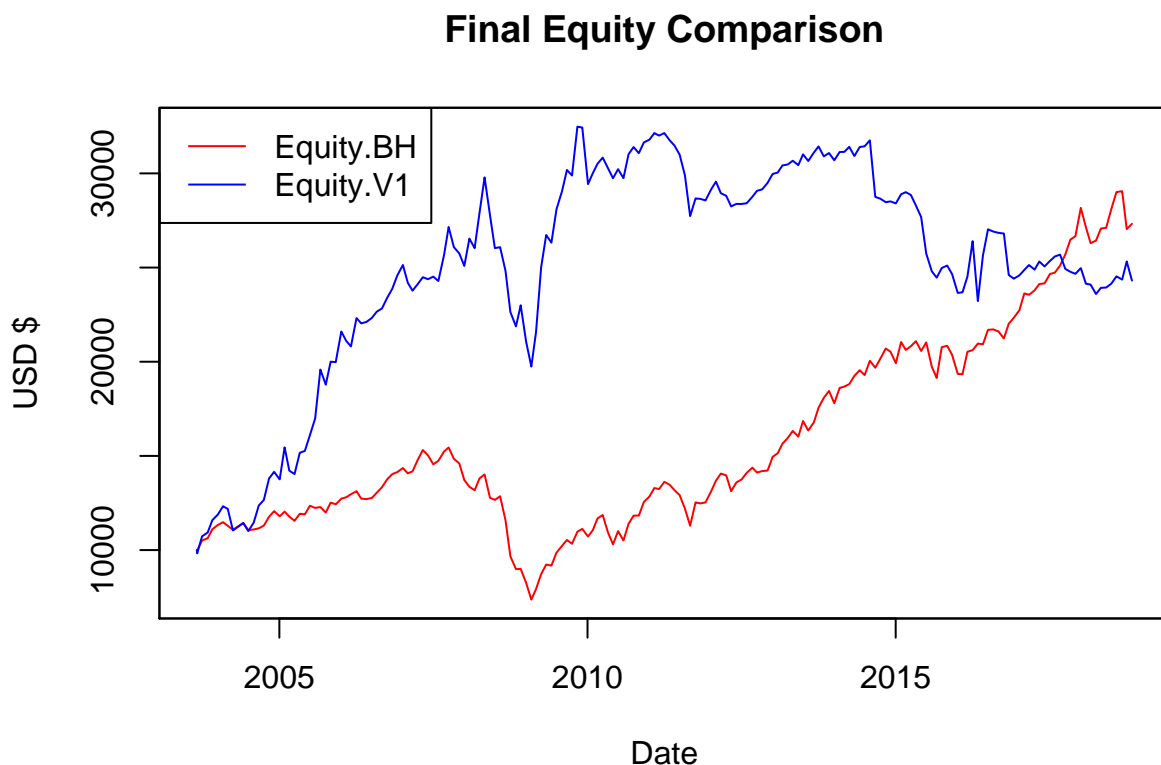
```
equity.bh <- getAccount("buyhold")$summary$End.Eq
colnames(equity.bh) <- c("Equity BH")
equity.bh.v1 <- cbind(equity.bh, equity.v1)
```

```
rets.bh <- monthlyReturn(equity.bh, type="arithmetic")
colnames(rets.bh) <- c("Returns BH")

rets.bh.v1 <- cbind(rets.bh, rets.v1)
```

3.4.3.2 Visually compare Equity curves

```
plot.zoo(equity.bh.v1,
  plot.type="single",
  col=c('red','blue'),
  main="Final Equity Comparison",
  xlab="Date",
  ylab="USD $")
legend(x="topleft",
  legend=colnames(equity.bh.v1),
  col=c("red","blue"),
  lty=1)
```

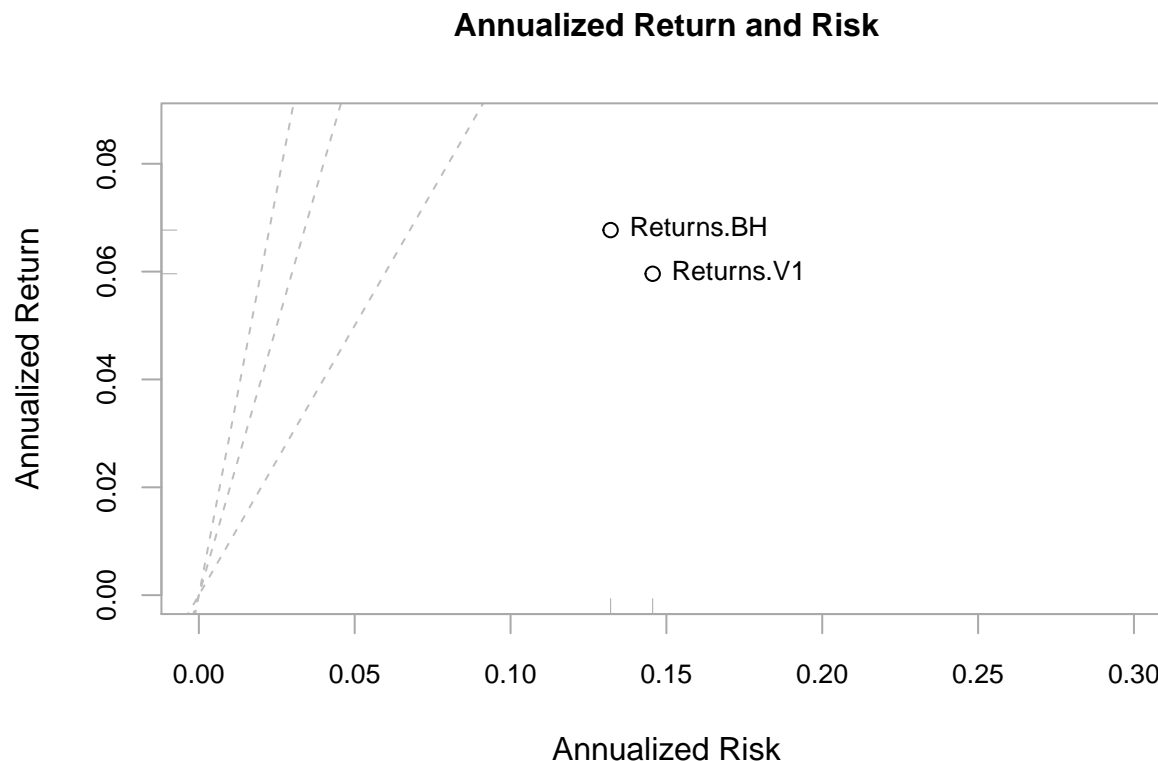


3.4.3.3 Visualization of risk and return

We can see that the Buy and Hold strategy generates higher returns while having a smaller

annualized risk. The sharpe ratio is higher and therefore we cannot outperform the buy and hold strategy.

```
chart.RiskReturnScatter(rets.bh.v1, xlim = c(0,0.3))
```



```
table.AnnualizedReturns(rets.bh.v1)
```

| | Returns.BH | Returns.V1 |
|---------------------------|------------|------------|
| Annualized Return | 0.0677 | 0.0596 |
| Annualized Std Dev | 0.1321 | 0.1456 |
| Annualized Sharpe (Rf=0%) | 0.5128 | 0.4097 |

```
table.AnnualizedReturns(rets.v1)
```

| | Returns V1 |
|---------------------------|------------|
| Annualized Return | 0.0596 |
| Annualized Std Dev | 0.1456 |
| Annualized Sharpe (Rf=0%) | 0.4097 |

```
table.Stats(rets.bh.v1)
```

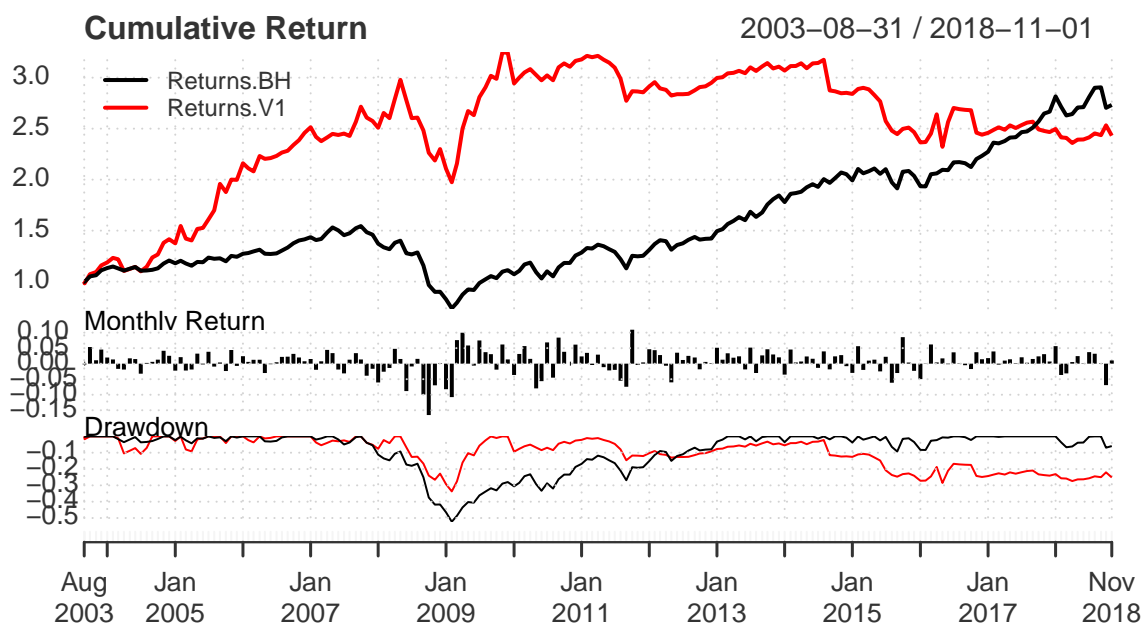
| | Returns.BH | Returns.V1 |
|-----------------|------------|------------|
| Observations | 184.0000 | 184.0000 |
| NAs | 0.0000 | 0.0000 |
| Minimum | -0.1655 | -0.1205 |
| Quartile 1 | -0.0166 | -0.0131 |
| Median | 0.0106 | 0.0037 |
| Arithmetic Mean | 0.0062 | 0.0057 |
| Geometric Mean | 0.0055 | 0.0048 |
| Quartile 3 | 0.0292 | 0.0186 |
| Maximum | 0.1093 | 0.1584 |
| SE Mean | 0.0028 | 0.0031 |
| LCL Mean (0.95) | 0.0007 | -0.0004 |
| UCL Mean (0.95) | 0.0118 | 0.0118 |
| Variance | 0.0015 | 0.0018 |
| Stdev | 0.0381 | 0.0420 |
| Skewness | -0.7724 | 0.3769 |
| Kurtosis | 2.2969 | 1.9048 |

3.4.3.4 Visualization of cumulative Returns

The following plot visualizes the cumulative returns of both strategies. Also here we can see that the GRS outperformed the buy and hold strategy before ca. 2016. However, the returns could not be sustained, thus, the GRS performed over the long run not as good as a simple buy and hold strategy.

```
charts.PerformanceSummary(rets.bh.v1, geometric=T, wealth.index=TRUE)
```

Returns.BH Performance



3.5 Conclusion

The Global Rotation Strategy in its plain generates 5.96% annualized return while the compared buy and hold strategy generates 6.7% annualized return. The Sharp Ratio for the strategy is 0.40 compared to 0.51 for the buy and hold strategy. As we saw, the risk analysis has shown that we cannot generate excess returns with this strategy compared to the market. Especially after 2009 the strategy does not generate enough returns to outperform the buy and hold strategy. In fact, after 2009 the returns of the strategy are not significantly positive while the buy and hold strategy generates positive returns from 2009 until the end of the observation period. The following chapters describe improvement options for the strategy, in order to increase the returns and the performance, especially for the time horizon after the GFC. Note: Without transaction costs, the strategy in its plain form, outperforms the market in regards to annualized returns. This leads to the assumption that the holding period of the ETFs is too short in order to generate enough returns to compensate for the transaction costs.

4 Strategy Improvement

As we saw in the analysis above, the GRS strategy in its plain form cannot outperform a buy and hold strategy of the MSCI World index. A first approach to improve the GRS is only to perform Long trades, when the ROC (the momentum) was positive. For this, we can use the already calculated data from `pos_rets`. This data indicates for every month whether the

ROC was positive in the past period or not. The signals of the standard GRS strategy can be still used with a slight adjustment to the entryLong signal, which is only triggered when both, the rank meets the requirements and the returns were positive.

4.1 Step 1: Initialize account, strategy and portfolio

```
strategyname.alt <- paste(strategyname,".", "v2", sep = "")
portfolioname.alt <- paste(portfolioname,".", "v2", sep = "")
accountname.alt <- paste(accountname,".", "v2", sep = "")
rm.strat(strategyname.alt)
initPortf(portfolioname.alt,symbollist,initDate=initdate,currency="USD")
initAcct(accountname.alt,
          portfolios=portfolioname.alt,
          initDate=initdate,
          initEq=startingcapital,
          currency="USD")
initOrders(portfolio=portfolioname.alt,initDate=initdate)
strategy(strategyname.alt,store=TRUE)
strat <- getStrategy(strategyname.alt)
```

4.2 Step 2: New Strategy Rules

As described above, these are the new rules which includes that the signal longEntry is only set to TRUE, when the Rank requirement is fulfilled and the returns were positive.

```
# Indicator
add.indicator(strategyname.alt,
              name = "sigThreshold",
              arguments=list(column="Rank",
                             threshold=buypositions,
                             relationship="lte"),
              label = "bpos")

# Signal
add.signal(strategyname.alt,
           name="sigFormula",
           arguments=list(columns=c("Rank.bpos", "PosRets"),
                          formula="(Rank.bpos == 1) & (PosRets==1)",
                          label="longEntry")

add.signal(strategyname.alt,
           name="sigThreshold",
           arguments=list(column="Rank",
                          threshold=buypositions,
                          relationship="gt"),
           label="longExit")
```

```

# Rules
add.rule(strategyname.alt,
         name="ruleSignal",
         arguments=list(sigcol="longEntry",
                        sigval=TRUE,
                        orderqty=100,
                        ordertype="market",
                        orderside="long",
                        replace=FALSE,
                        prefer="Open",
                        osFUN='osInvestAll',
                        orderset="ocolong",
                        TxnFees="txnc"),

         type="enter",
         label="LE",
         path.dep=TRUE)

add.rule(strategyname.alt,
         name="ruleSignal",
         arguments=list(sigcol="longExit",
                        sigval=TRUE,
                        orderqty="all",
                        ordertype="market",
                        orderside="long",
                        replace=FALSE,
                        prefer="Open",
                        orderset="ocolong",
                        TxnFees="txnc"),

         type="exit",
         label = "LX",
         path.dep=TRUE)

```

4.3 Step 3: Apply the strategy

```

applyStrategy(strategy=strategyname.alt,portfolios=portfolioname.alt)

updatePortf(strategyname.alt)
updateAcct(strategyname.alt)
updateEndEq(strategyname.alt)

```

4.4 Analysis of improved strategy GRS.V2

4.4.1 Step 1: Calculate equity and return of the improved strategy

```
acct.alt <- getAccount(accountname.alt)

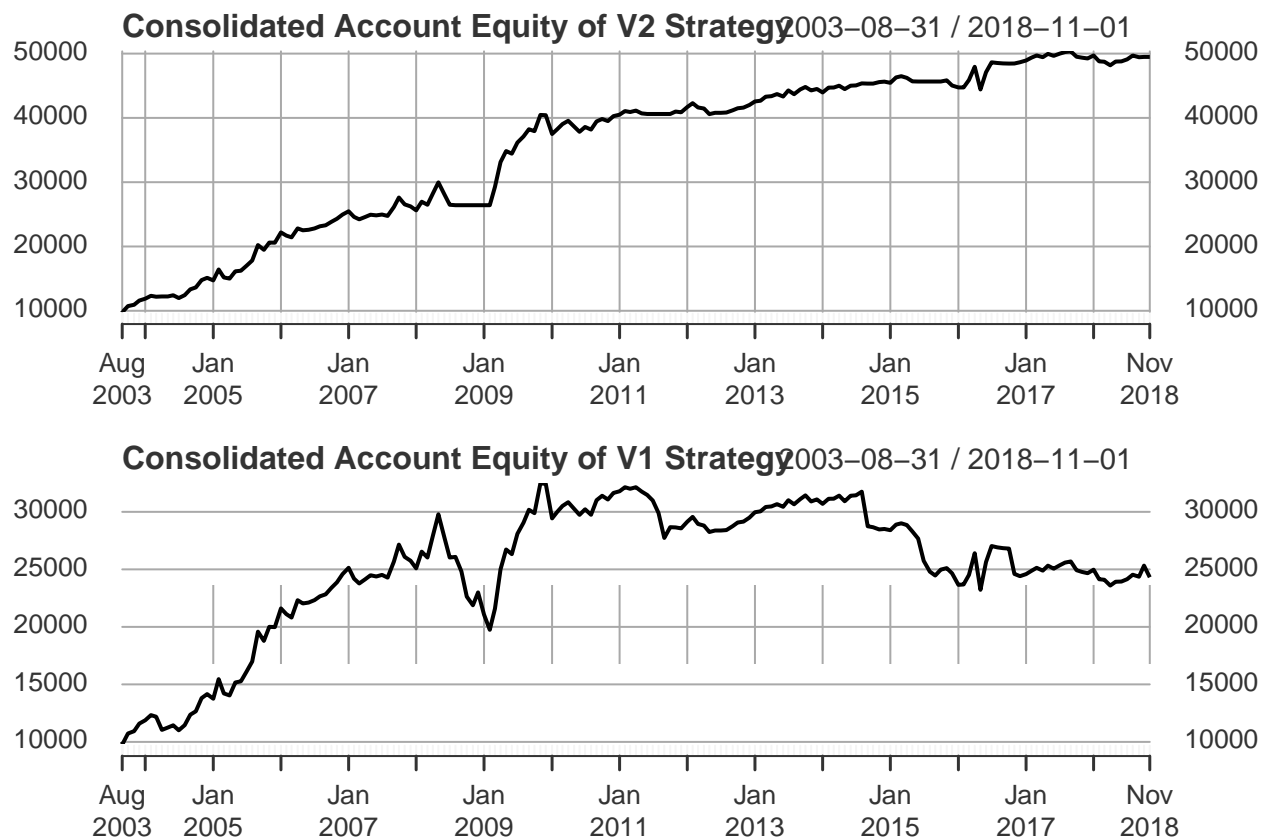
equity.v2 <- acct.alt$summary$End.Eq
colnames(equity.v2) <- c("Equity.V2")

rets.v2 <- monthlyReturn(equity.v2, type = "arithmetic")
colnames(rets.v2) <- c("Return V2")
```

4.4.2 Step 2: Visualize Equity of GRS.V2

We can clearly see that the improved strategy generates more return. Phases where the original strategy generates negative returns, e.g., 2008 - 2009 are improved in the V2 strategy by simply not being invested in the market. This makes sense, as we only enter a trade, when the past 3 months generated positive returns, we avoid phases in which the entire world market (2008-2009) is in a negative trend. As a result, we can see that we are not invested during this time at all.

```
par(mfrow=c(2,1))
plot(equity.v2, main="Consolidated Account Equity of V2 Strategy")
plot(equity.v1, main="Consolidated Account Equity of V1 Strategy")
```

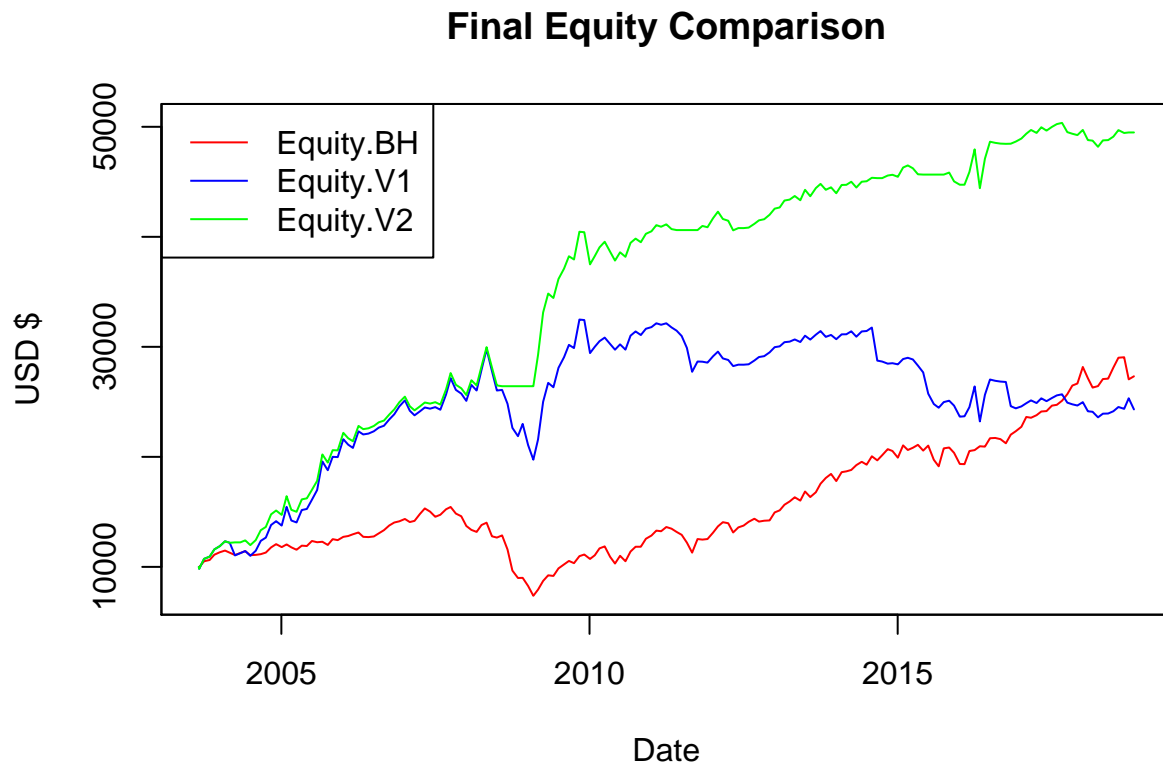


```
par(mfrow=c(1,1))
```

4.4.3 Step 3: Visualize Equity comparison

```
equity.bh.v1.v2 <- cbind(equity.bh, equity.v1, equity.v2)

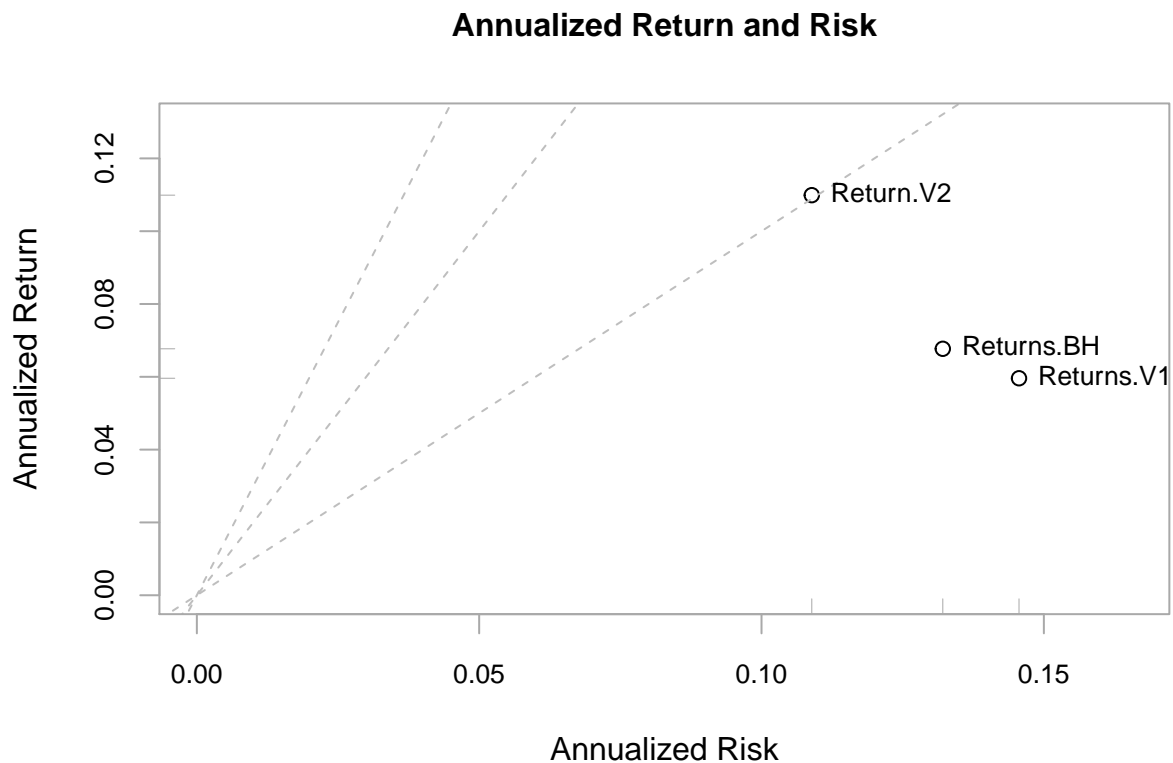
plot.zoo(equity.bh.v1.v2, plot.type="single", col=c('red', 'blue', 'green'), main="Final Equity Comparison",
legend(x="topleft", legend=colnames(equity.bh.v1.v2), col=c("red", "blue", "green"), lty=1))
```



4.4.4 Step 4: Compare risk and return

We can clearly see here that with the improved strategy we were not only able to increase the return drastically by eliminating all long transactions during phases when the market was not generating any returns, but we also reduced the risk of the strategy. The sharpe ratio of the improved strategy is 0.85. The Annualized Return Risk scatter plot shows the impact of the simple improvement of the strategy. The annualized return of the GRS.V2 is about 10 %.

```
rets.bh.v1.v2 <- cbind(rets.v2, rets.v1, rets.bh)
chart.RiskReturnScatter(rets.bh.v1.v2)
```



4.4.4.1 General Strategy Statistics

```

tab.perf <- table.Arbitrary(rets.bh.v1.v2, metrics=c("Return.cumulative",
                                                    "Return.annualized",
                                                    "SharpeRatio.annualized",
                                                    "CalmarRatio"),
                           metricsNames=c("Cumulative Return",
                                           "Annualized Return",
                                           "Annualized Sharp Ratio",
                                           "Calmar Ratio"))

tab.risk <- table.Arbitrary(rets.bh.v1.v2, metrics=c("StdDev.annualized",
                                                    "maxDrawdown",
                                                    "VaR",
                                                    "ES"),
                           metricsNames=c("Annualized StdDev",
                                           "Max Drawdown",
                                           "Value-at-Risk",
                                           "Conditional VaR"),
                           method=c("historical"))

```

```

sometstats <- data.frame(rownames(tab.perf), tab.perf[,1], rownames(tab.risk), tab.risk[,1],
                          colnames(sometstats) <- c("Performance Metric", "Performance Value", "Risk Metric", "Risk Value"))

```

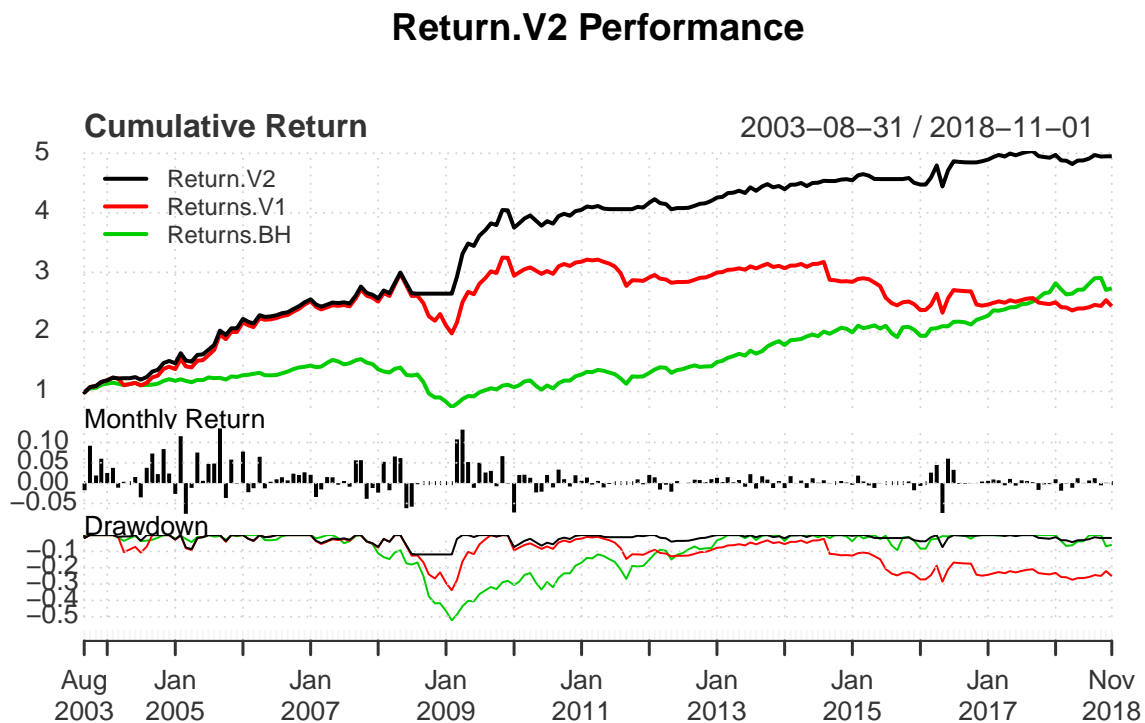
somestats

| Performance Metric | Performance Value | Risk Metric | Risk Value |
|------------------------|-------------------|-------------------|------------|
| Cumulative Return | 3.9484875 | Annualized StdDev | 0.1088522 |
| Annualized Return | 0.1099200 | Max Drawdown | 0.1184020 |
| Annualized Sharp Ratio | 1.0098101 | Value-at-Risk | -0.0260376 |
| Calmar Ratio | 0.9283629 | Conditional VaR | -0.0511959 |

4.4.5 Step 5: Compare returns

When we compare the returns of the Buy and hold strategy, the original strategy and the improved GRS.V2 strategy, we can see that the GRS strategies performed equally well until the financial crisis. While the standard strategy was not able to prevent drawdowns, the improved strategy is robust against such situations as investments are only made when the momentum (measured by ROC) is positive. Therefore, during the financial crisis no investments were done. After that the performance is also comparable. From 2011 the GRS.V2 outperforms the standard strategy strongly. Moreover, we can see that the drawdown decreases drastically as we do not trade during the GFC.

```
tab.perf
tab.risk
charts.PerformanceSummary(rets.bh.v1.v2,geometric=T,wealth.index=TRUE)
```



4.4.6 Step 6: Impact of improvement

The impact of improvement can be seen in the following Relative Performance plot which visualizes the relative performance of the GRS.V2 to the standard strategy. We see that there are phases of comparable performance and phases of clear outperformance. The outperformance happens during phases where the market is in a negative trend.

```
chart.RelativePerformance(rets.v2, rets.v1, main="Comparison of strategies",
  colorset = c("blue", "red"),
  legend.loc = "topleft")
```



4.4.7 Step 7: Strategy Risk

```
rets.v2.tmp <- rets.v2
index(rets.v2.tmp) <- as.yearmon(index(rets.v2.tmp))

dir <- "~/Desktop/R/GRS/Risk/"
ff <- read.csv(paste0(dir, "FFFactors.csv"))
ffxts <- as.xts(ff[, -1], order.by = as.Date(ff$dates))
index(ffxts) <- as.yearmon(index(ffxts))

funddata.alt <- merge(rets.v2.tmp, ffxts)
funddata.alt <- funddata.alt[complete.cases(funddata.alt),]
```

```
# Calculate Excess Returns above the risk free rate
funddata.alt$return.V2 <- funddata.alt$return.V2*100
funddata.alt$excessrtn <- funddata.alt$return.V2 - funddata.alt$rf
```

4.4.7.1 Perform a CAPM Regression

```
capm <- lm(excessrtn ~ mkt.rf, data=funddata.alt)
summary(capm)
```

```
##
## Call:
## lm(formula = excessrtn ~ mkt.rf, data = funddata.alt)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -8.5976 -1.2719 -0.6116  0.5687 12.4385
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.5540     0.2138   2.591  0.0104 *
## mkt.rf        0.3797     0.0536   7.085 3.18e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.809 on 177 degrees of freedom
## Multiple R-squared:  0.2209, Adjusted R-squared:  0.2165
## F-statistic: 50.19 on 1 and 177 DF, p-value: 3.178e-11
```

4.4.7.2 Perform a Fama-French 3 factor Regression

```
# Run Fama-French 3 factor Regression
ff3regression <- lm(excessrtn ~ mkt.rf + smb + hml, data=funddata.alt)
summary(ff3regression)
```

```
##
## Call:
## lm(formula = excessrtn ~ mkt.rf + smb + hml, data = funddata.alt)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -8.5206 -1.2827 -0.5874  0.5535 12.4240
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.55689     0.21510   2.589  0.0104 *
## mkt.rf        0.37068     0.05926   6.255 2.96e-09 ***
## smb          0.01640     0.09867   0.166  0.8682
```



```
## hml          0.03310    0.08890    0.372    0.7101
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.823 on 175 degrees of freedom
## Multiple R-squared:  0.2217, Adjusted R-squared:  0.2083
## F-statistic: 16.62 on 3 and 175 DF,  p-value: 1.523e-09
```

The improved strategy's risk analysis shows that we can generate excess returns after adjusting for risk. The intercept of the regression is in both tested models (CAPM and Fama-French Model) significant and positive with about 0.55 % which leads to an excess return of 6.6 % per year. Moreover, the beta is also significant with about 0.37 which means that our strategy is significantly tilted towards instrument that have lower risk.

4.5 Conclusion

We see that the improved strategy generates an annualized return of 10.9%. The annualized Sharp Ratio is 1. There are two interesting observations which I would like to summarize here. First, by using the rule that we only buy the top ranked ETF if and only if it had positive returns over the observation period, we eliminate the large drawdown during the GFC. The equity curve is just flat at that point which means that we are not invested at all. An improvement to this could be to invest in such market phases into risk free instruments as Bonds. We can minimize the maximum drawdown from 33.7 % in the original strategy to 11 % in the improved version. Second, we observe a much better performance in general after the GFC. The following chapter describes another suggestion how the strategy can be improved even further.

5 Strategy Improvement V3

Now, that we eliminated the negative impact of down-phases in the market, the next improvement is to see whether we can generate profits during these phases by adding short-rules. A short position is opened for the ETF with the worse performance according to the momentum (ROC). Moreover, it is only opened if the return over the momentum period was negativ. The exit of the short position is triggered when ETF is not ranked at the last position anymore OR when the return over the observed period is not negative anymore.

```
strategyname.alt.v3 <- paste(strategyname, ".", "v3", sep = "")
portfolioname.alt.v3 <- paste(portfolioname, ".", "v3", sep = "")
accountname.alt.v3 <- paste(accountname, ".", "v3", sep = "")
rm.strat(strategyname.alt.v3)
initPortf(portfolioname.alt.v3, symbollist, initDate=initdate, currency="USD")
initAcct(accountname.alt.v3, portfolios=portfolioname.alt.v3, initDate=initdate, initEq=sta
initOrders(portfolio=portfolioname.alt.v3, initDate=initdate)
strategy(strategyname.alt.v3, store=TRUE)
strat <- getStrategy(strategyname.alt.v3)
```

5.1 New Strategy Rules

```
# Indicator
add.indicator(strategyname.alt.v3,
              name = "sigThreshold",
              arguments=list(column="Rank",
                             threshold=buypositions, relationship="lte"),
              label = "bpos")

#Signal Long
add.signal(strategyname.alt.v3,
           name="sigFormula",
           arguments=list(columns=c("Rank.bpos", "PosRets"),
                          formula="(Rank.bpos == 1) & (PosRets==1)",
                          label="longEntry")

add.signal(strategyname.alt.v3,
           name="sigThreshold",
           arguments=list(column="Rank",
                          threshold=buypositions,
                          relationship="gt"),
           label="longExit")

# Rules Long
add.rule(strategyname.alt.v3,
         name="ruleSignal",
         arguments=list(sigcol="longEntry",
                        signal=TRUE,
                        orderqty=100,
                        ordertype="market",
                        orderside="long",
                        replace=FALSE,
                        prefer="Open",
                        osFUN='osInvestAll',
                        orderset="ocolong",
                        TxnFees="txnc"),
         type="enter",
         label="LE",
         path.dep=TRUE)

add.rule(strategyname.alt.v3,
         name="ruleSignal",
         arguments=list(sigcol="longExit",
                        signal=TRUE,
                        orderqty="all",
                        ordertype="market",
```

```

        orderside="long",
        replace=FALSE,
        prefer="Open",
        orderset="ocolong",
        TxnFees="txnc"),

    type="exit",
    label = "LX",
    path.dep=TRUE)

# Short indicator
symbolCount <- length(symbollist)
shortThreshold <- symbolCount-buypositions

add.indicator(strategyname.alt.v3,
              name = "sigThreshold",
              arguments=list(column="Rank",
                             threshold=shortThreshold,
                             relationship="gt"),
              label = "ShortBpos")

# Short Signals
add.signal(strategyname.alt.v3,
           name="sigFormula",
           arguments=list(columns=c("Rank.ShortBpos", "PosRets"),
                          formula="(Rank.ShortBpos == 1) & (PosRets==0)"),
           label="shortEntry")

add.signal(strategyname.alt.v3,
           name="sigFormula",
           arguments=list(columns=c("Rank.ShortBpos", "PosRets"),
                          formula="(Rank.ShortBpos == 0) | (PosRets == 1)"),
           label="shortExit")

# Short Rules
add.rule(strategyname.alt.v3,
         name="ruleSignal",
         arguments=list(sigcol="shortEntry",
                        sigval=TRUE,
                        orderqty=100,
                        ordertype="market",
                        orderside="short",
                        replace=FALSE,
                        prefer="Open",
                        osFUN='osInvestAll',
                        TxnFees="txnc"),

         type="enter",

```

```

        path.dep=TRUE,
        label="ShortEntry")

add.rule(strategyname.alt.v3,
        name="ruleSignal",
        arguments=list(sigcol="shortExit",
                        sigval=TRUE,
                        orderqty="all",
                        ordertype="market",
                        orderside="short",
                        replace=FALSE,
                        prefer="Open",
                        TxnFees="txnc"),
        type="exit",
        path.dep=TRUE,
        label="ShortExit")

```

5.2 Apply the strategy

```

applyStrategy(strategy=strategyname.alt.v3,portfolios=portfolioname.alt.v3)

updatePortf(strategyname.alt.v3)
updateAcct(strategyname.alt.v3)
updateEndEq(strategyname.alt.v3)

```

5.3 Analysis of the improved (V3) Strategy

5.3.1 Retrieve Equity of GRS.V3 strategy

```

acct.alt.v3 <- getAccount(accountname.alt.v3)

equity.v3 <- acct.alt.v3$summary$End.Eq
colnames(equity.v3) <- c("Equity.V3")

```

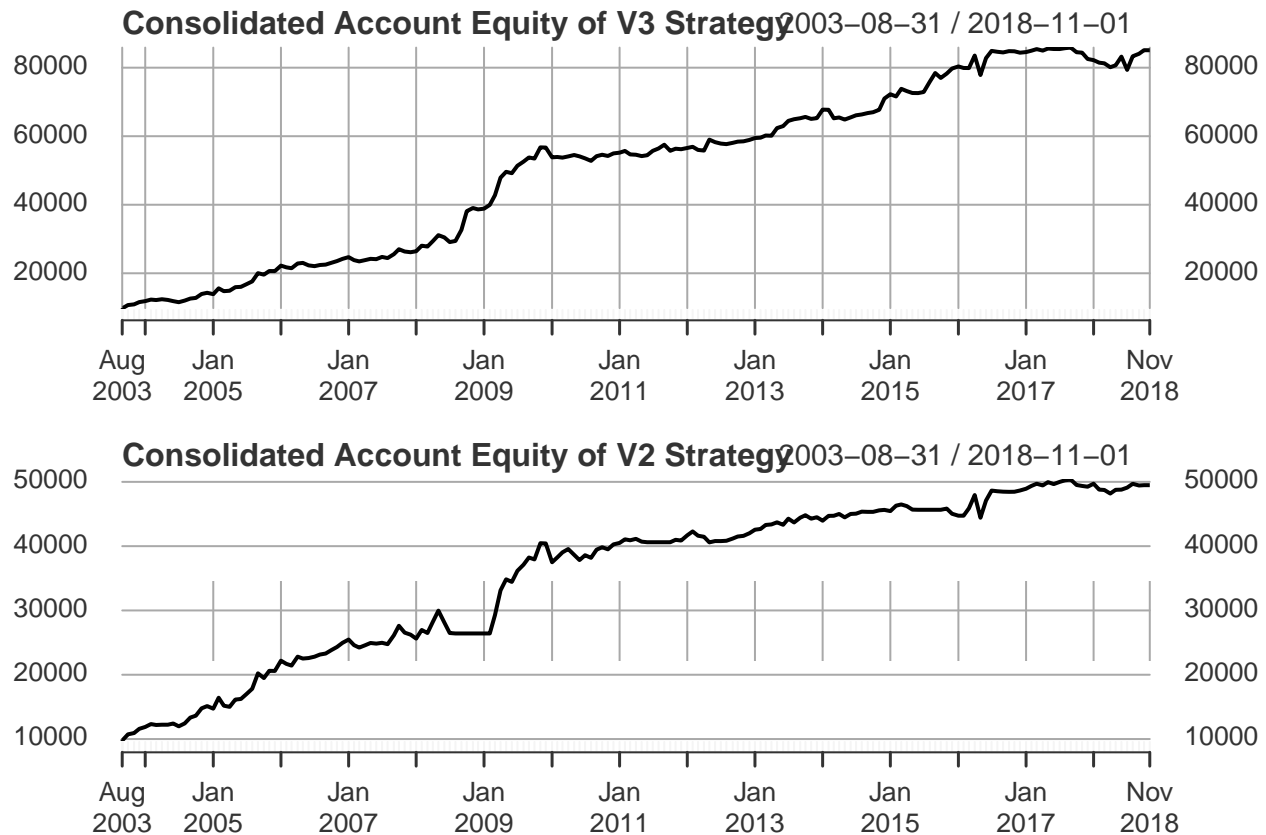
5.3.2 Visualize Equity of GRS.V3

As we can see, the curves look very similar, besides the fact that the scale is different for the GRS.V3 strategy. Through the implementation of short selling rules we are able to increase the returns by a significant amount. Moreover, we are able to generate returns during phases where the V2 strategy simply did not perform any trades. By this we generate returns during strong and weak market phases.

```

par(mfrow=c(2,1))
plot(equity.v3, main="Consolidated Account Equity of V3 Strategy")
plot(equity.v2, main="Consolidated Account Equity of V2 Strategy")

```



```
par(mfrow=c(1,1))
```

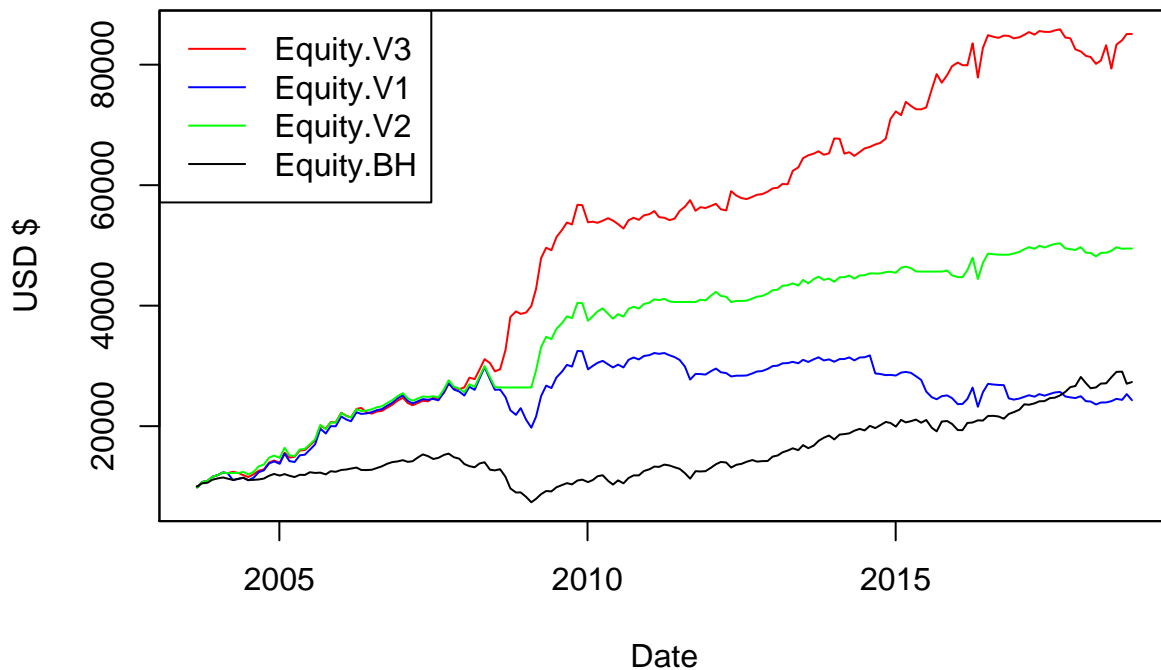
5.3.3 Comparison of all strategies

Especially the comparison of the equity development of all 4 strategies shows the significant difference between the strategies and the impact of the implemented improvements. While the first improvement just eliminated the negative impacts of down-markets, the second improvement used short sells in down-phases in order to generate even more profits.

```
equity.bh.v1.v2.v3 <- cbind(equity.v3, equity.v1, equity.v2, equity.bh)
equity.bh.v1.v2.v3 <- na.omit(equity.bh.v1.v2.v3)

plot.zoo(equity.bh.v1.v2.v3, plot.type="single",
         col=c('red', 'blue', 'green', 'black'),
         main="Final Equity Comparison",
         xlab="Date",
         ylab="USD $")
legend(x="topleft",
       legend=colnames(equity.bh.v1.v2.v3),
       col=c("red", "blue", "green", "black"),
       lty=1)
```

Final Equity Comparison



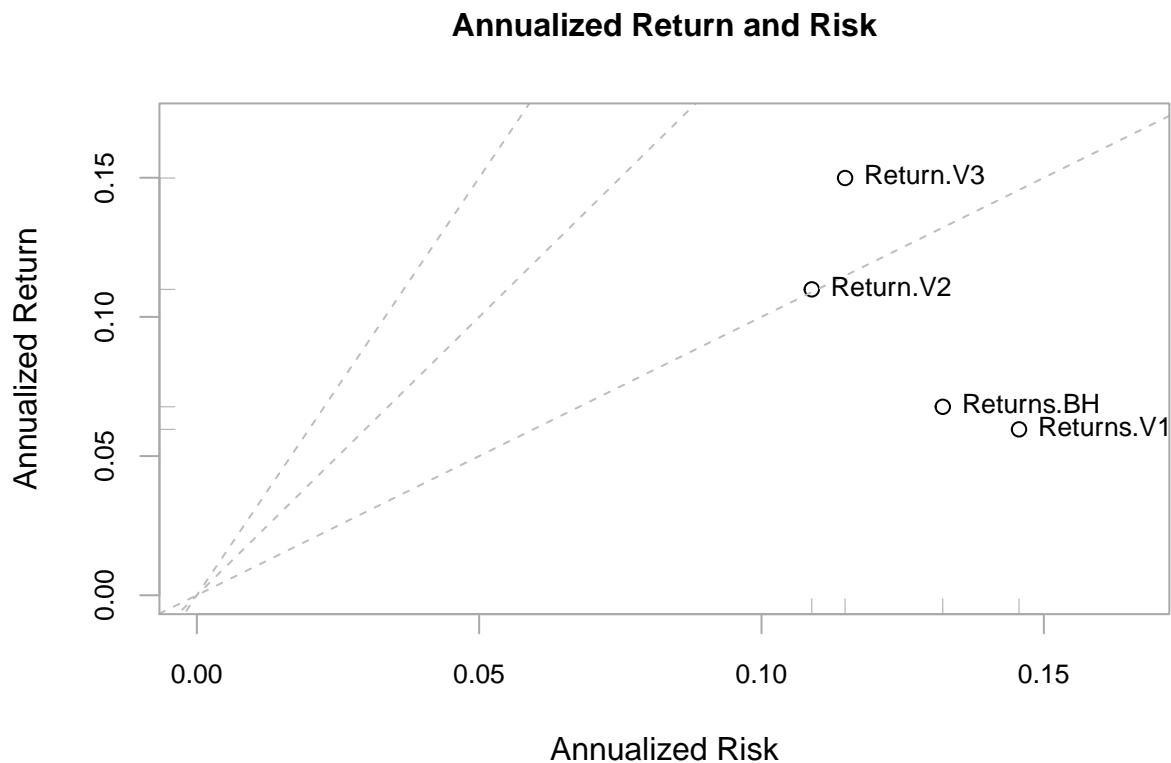
5.3.4 Visualizing Risk and Return

The visualization and comparison of the Risk and Return scatter shows that the risk increased minimally but the return increased significantly, compared to the GRS.V2 strategy. The annualized Sharpe Ratio is now 1.3. The annualized return is 14.9 % with an annualized standard deviation of 11%. Moreover, the maximum drawdown decreased again compared to the previous strategy to only 7.5 %.

```
rets.v3 <- monthlyReturn(equity.v3, type = "arithmetic")
colnames(rets.v3) <- c("Return V3")

rets.bh.v1.v2.v3 <- cbind(rets.v3, rets.v1, rets.v2, rets.bh)
rets.bh.v1.v2.v3 <- na.omit(rets.bh.v1.v2.v3)

chart.RiskReturnScatter(rets.bh.v1.v2.v3)
```



```
table.AnnualizedReturns(rets.bh.v1.v2.v3)
```

5.3.4.1 General Strategy Statistics of the improved V3 strategy

```
tab.perf <- table.Arbitrary(rets.bh.v1.v2.v3, metrics=c("Return.cumulative",
  "Return.annualized",
  "SharpeRatio.annualized",
  "CalmarRatio"),
  metricsNames=c("Cumulative Return",
  "Annualized Return",
  "Annualized Sharp Ratio",
  "Calmar Ratio"))
tab.risk <- table.Arbitrary(rets.bh.v1.v2.v3, metrics=c("StdDev.annualized",
  "maxDrawdown",
  "VaR",
  "ES"),
  metricsNames=c("Annualized StdDev",
  "Max Drawdown",
  "Value-at-Risk",
  "Conditional VaR"),
  method=c("historical"))
```

```
somestats <- data.frame(rownames(tab.perf),tab.perf[,1], rownames(tab.risk),tab.risk[,1],
colnames(somestats) <- c("Performance Metric", "Performance Value", "Risk Metric", "Risk Value")
somestats
```

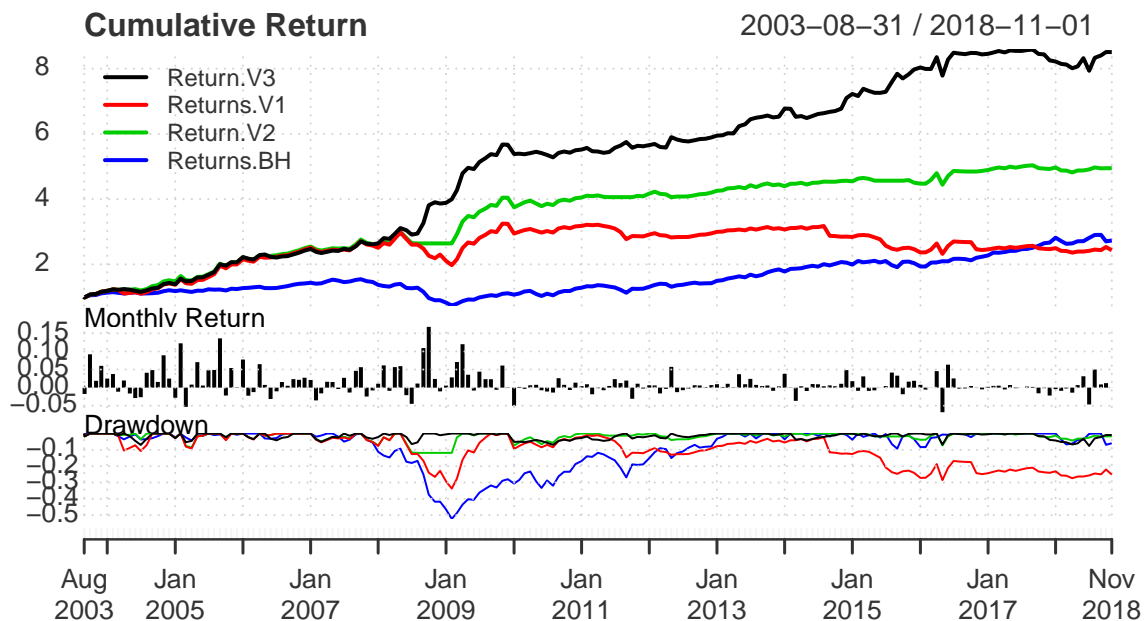
| Performance Metric | Performance Value | Risk Metric | Risk Value |
|------------------------|-------------------|-------------------|------------|
| Cumulative Return | 7.5087708 | Annualized StdDev | 0.1148201 |
| Annualized Return | 0.1498561 | Max Drawdown | 0.0758307 |
| Annualized Sharp Ratio | 1.3051385 | Value-at-Risk | -0.0286469 |
| Calmar Ratio | 1.9761937 | Conditional VaR | -0.0425340 |

5.3.5 Compare returns of all strategies

The comparison of the returns of all strategies shows again what we already saw in the equity comparison plot. In contrast to the V2 strategy, the GRS.V3 performed trades throughout the entire period and generated even in phases of global crisis returns.

```
tab.perf
tab.risk
charts.PerformanceSummary(rets.bh.v1.v2.v3,geometric=T,wealth.index=TRUE)
```

Return.V3 Performance



5.3.6 Direct comparison GRS.V2 and GRS.V3

The relative performance of the V3 strategy compared to the V2 strategy shows that especially during the financial crisis the strategy which included short-selling outperformed the GRS.V2 strategy. We can also see that before the GFC the improved strategy did not lead to the expected increase in returns. The previous strategy (V2) performed slightly better. This is due to the fact that the market was in an up-trend where shortselling was sometimes responsible for a loss in returns. However, the GFC boosted the returns of the improved V3 strategy compared to the previous V2 strategy. The main reason is the implementation of the shortselling rules.

```
chart.RelativePerformance(rets.v3, rets.v2, main="Comparison of strategies", colorset =
```



5.3.7 Could we have performed better

In the following, the MAE and MFE plots for all traded instruments are plotted. We can see, that there is still some room for improvement which could be improved by initiating stop loss or trailing stop orders.

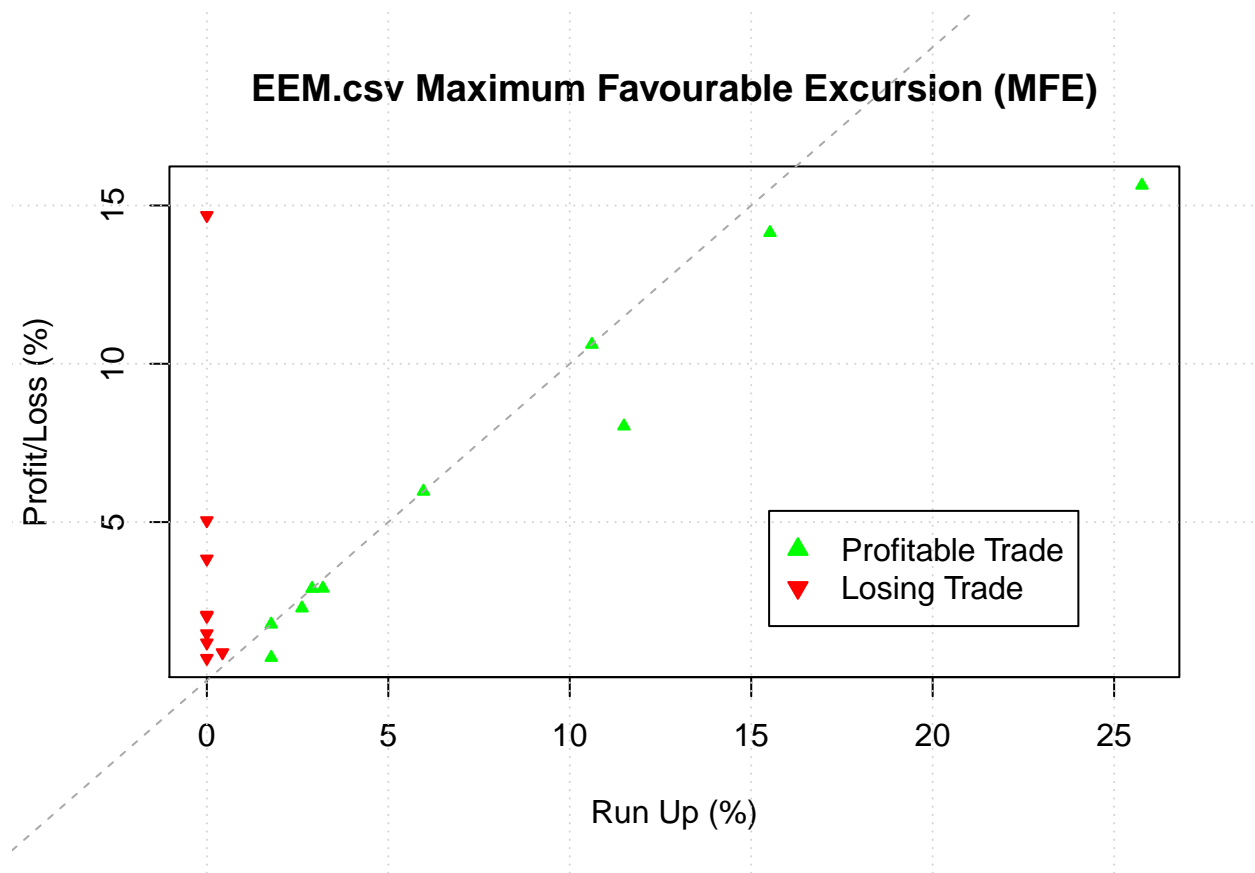
```
for (symbol in symbollist)
{
  if (nrow(getTxns(portfolioname.alt.v3,Symbol=symbol)) > 1)
  {
    symboldata <- get(symbol)
```

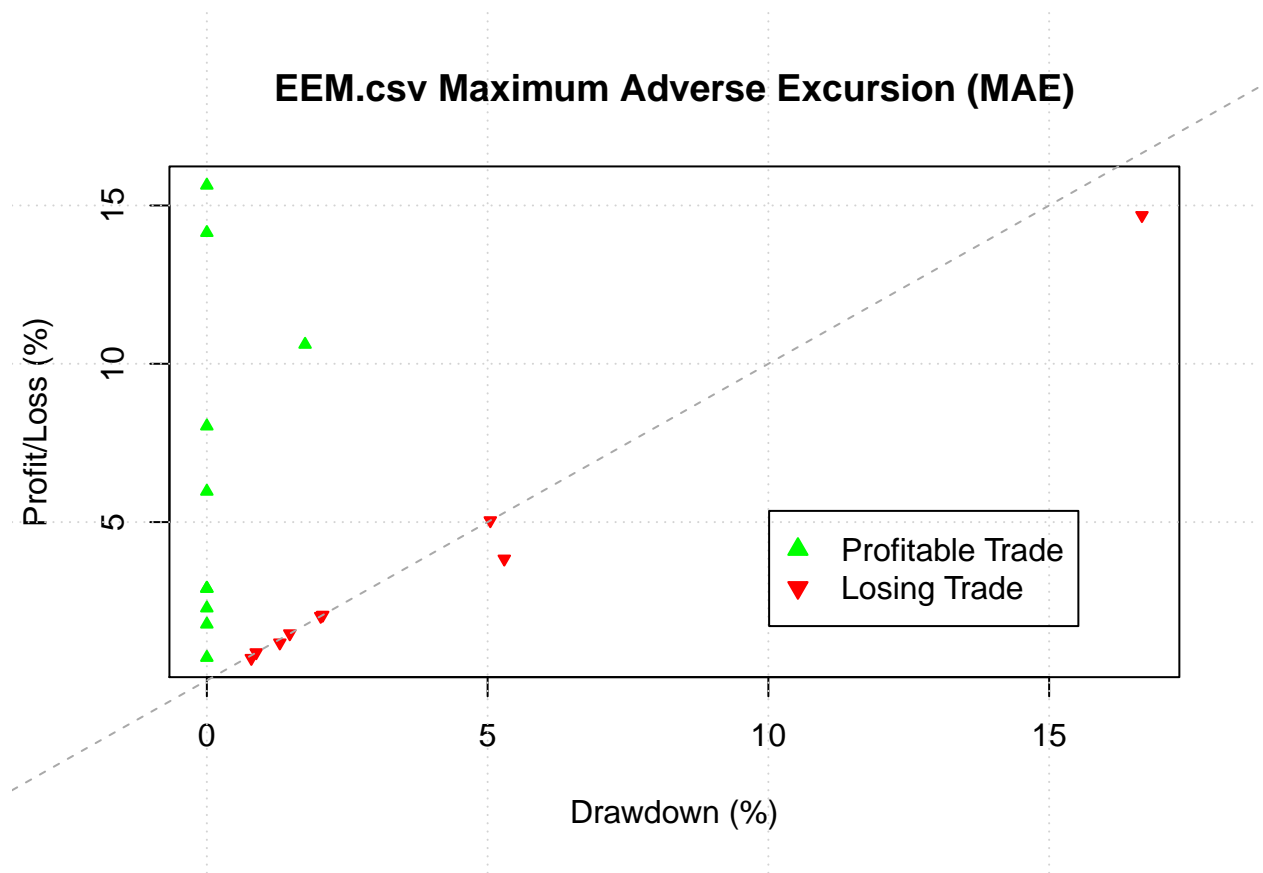
```

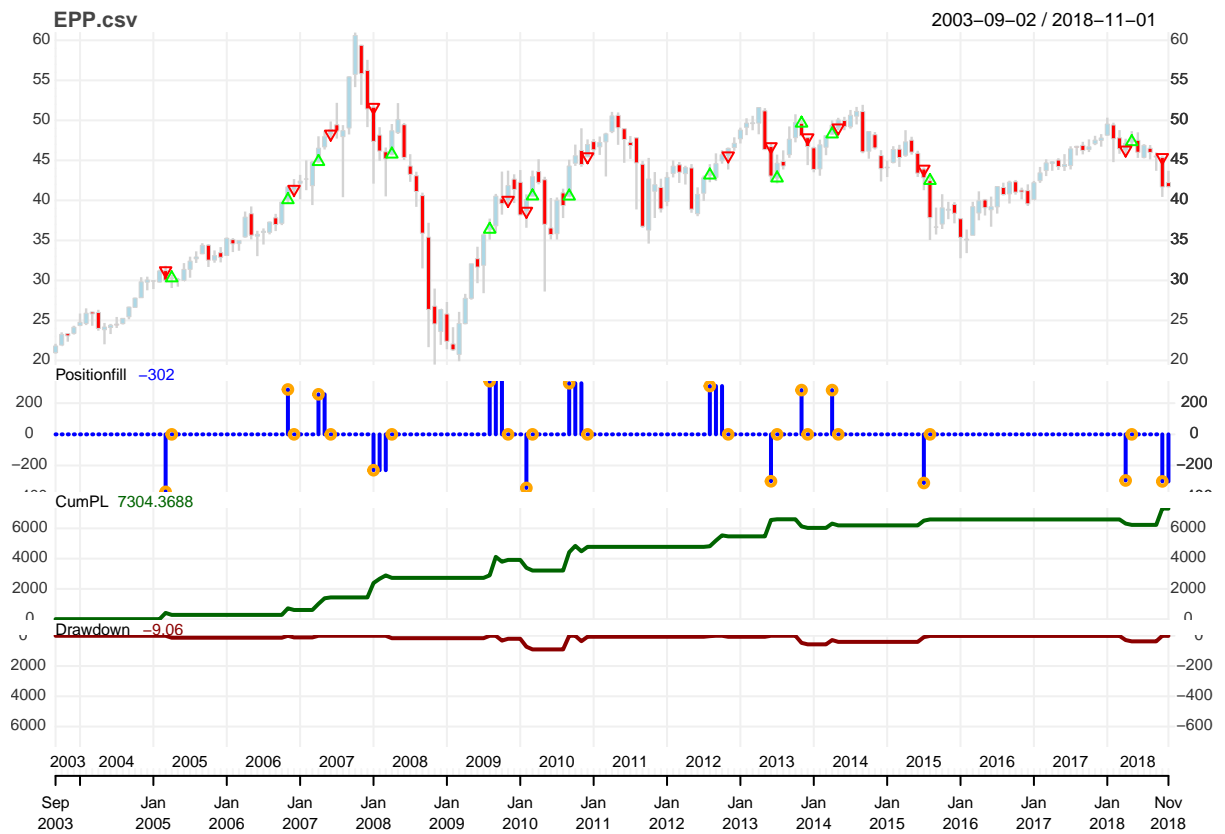
chart.Posn(portfolioname.alt.v3,Symbol=symbol,type='candlesticks', theme=myTheme
chart.ME(portfolioname.alt.v3, Symbol=symbol, type="MFE", scale="percent")
chart.ME(portfolioname.alt.v3, Symbol=symbol, type="MAE", scale="percent")
}
}

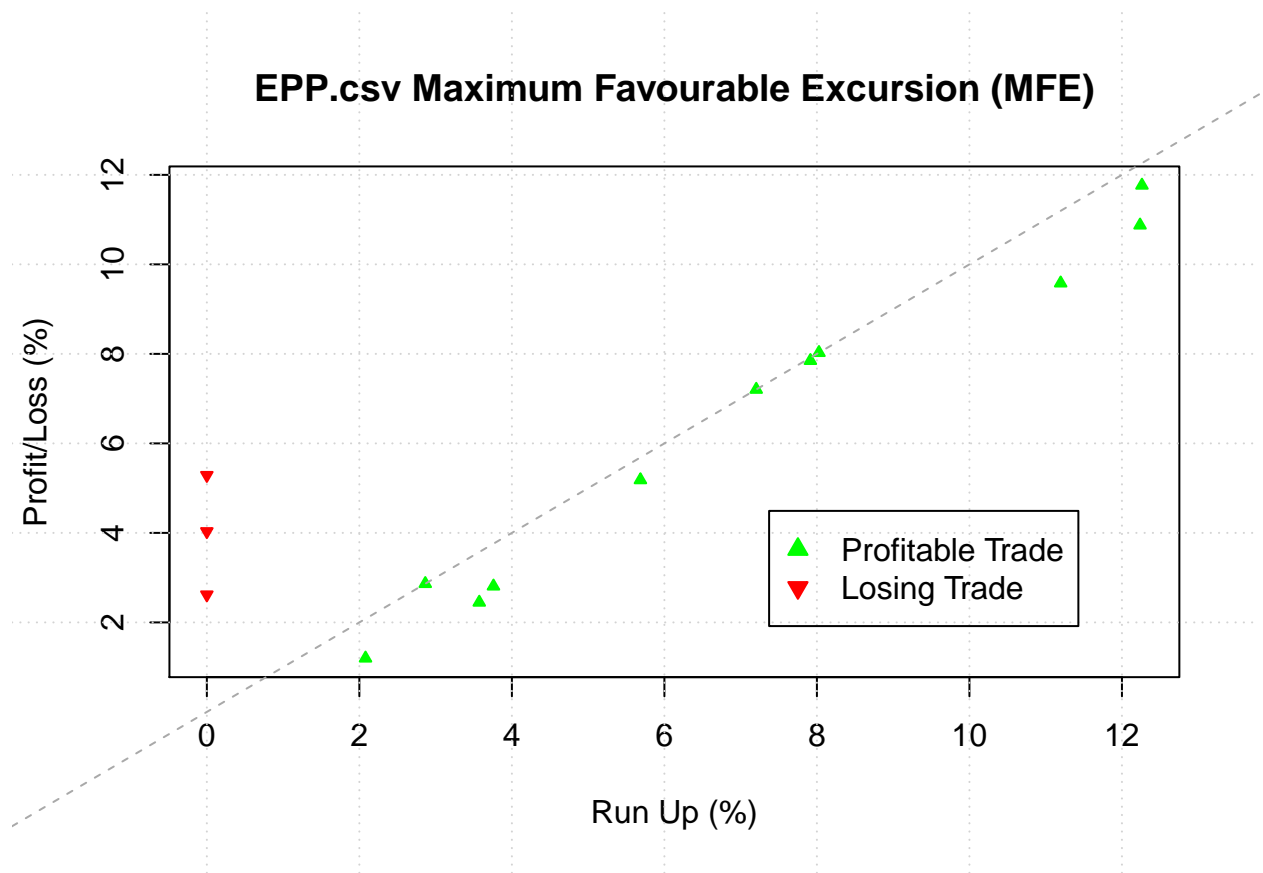
```



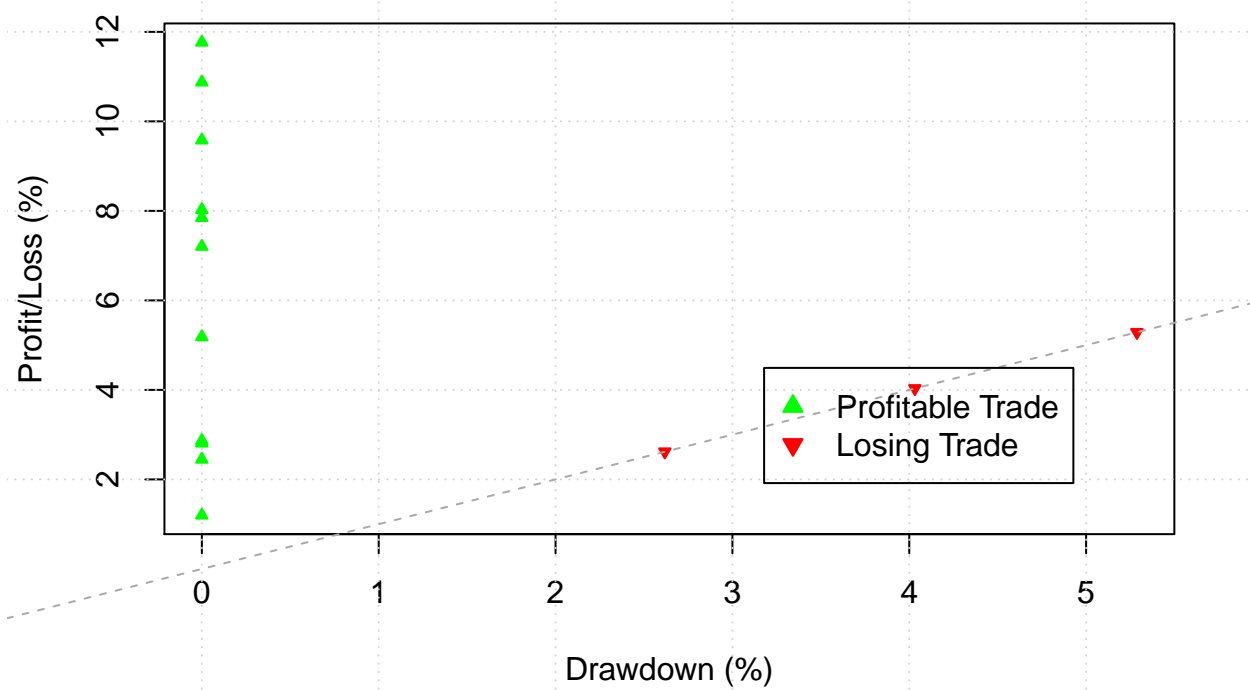


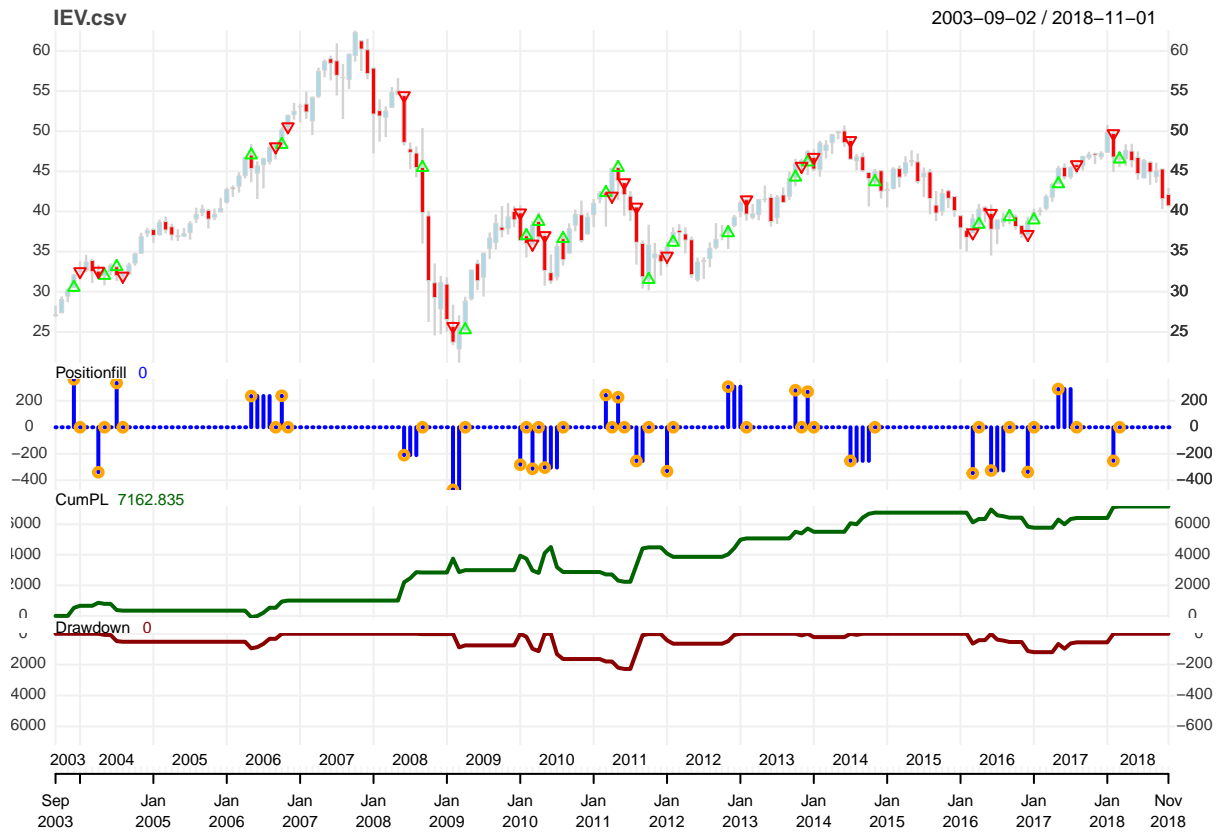




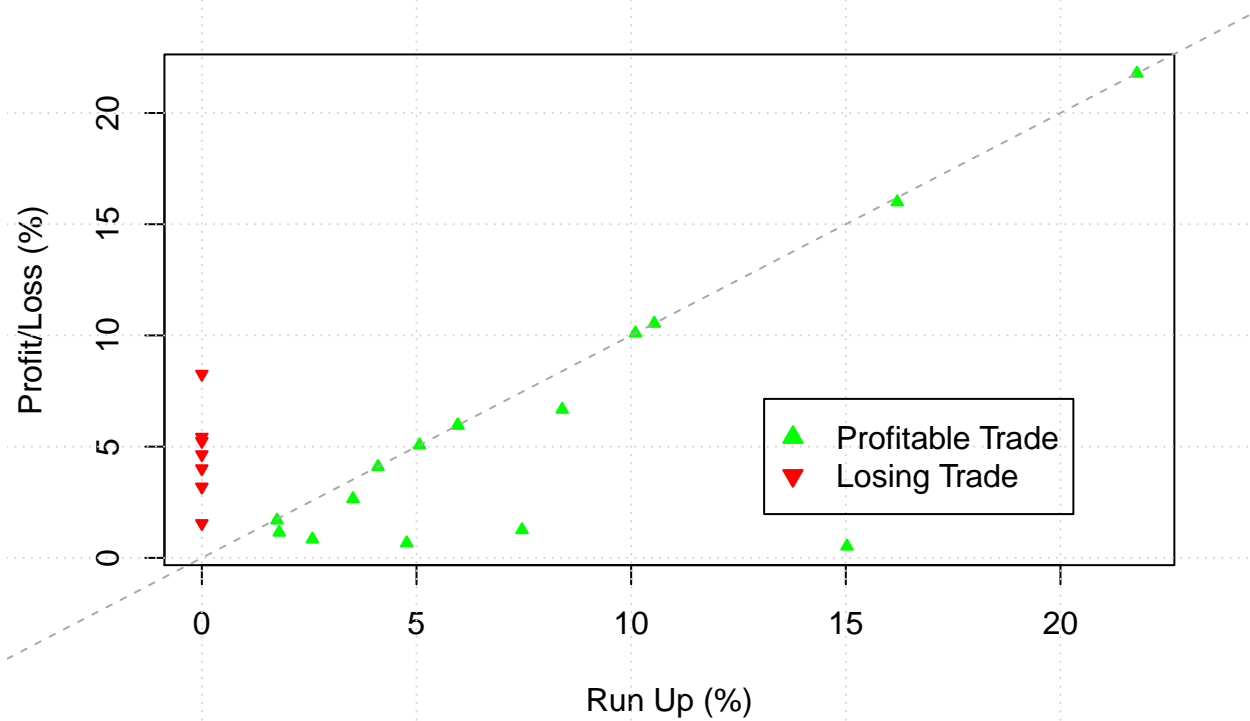


EPP.csv Maximum Adverse Excursion (MAE)

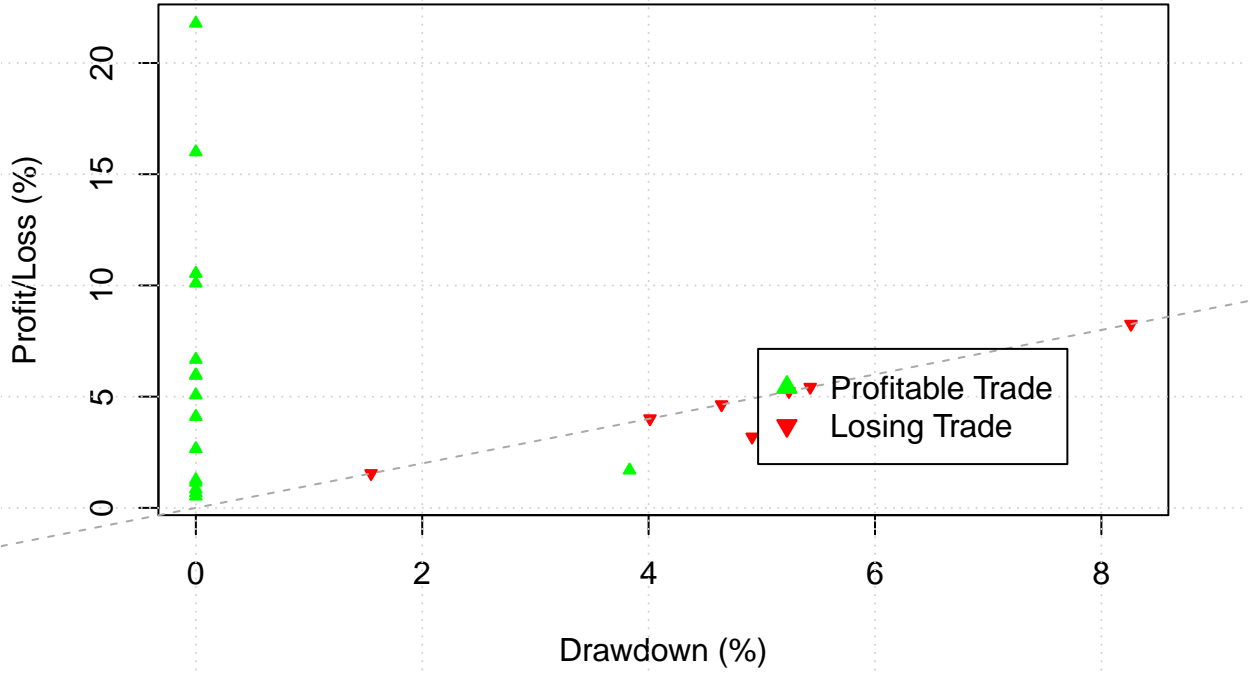




IEV.csv Maximum Favourable Excursion (MFE)

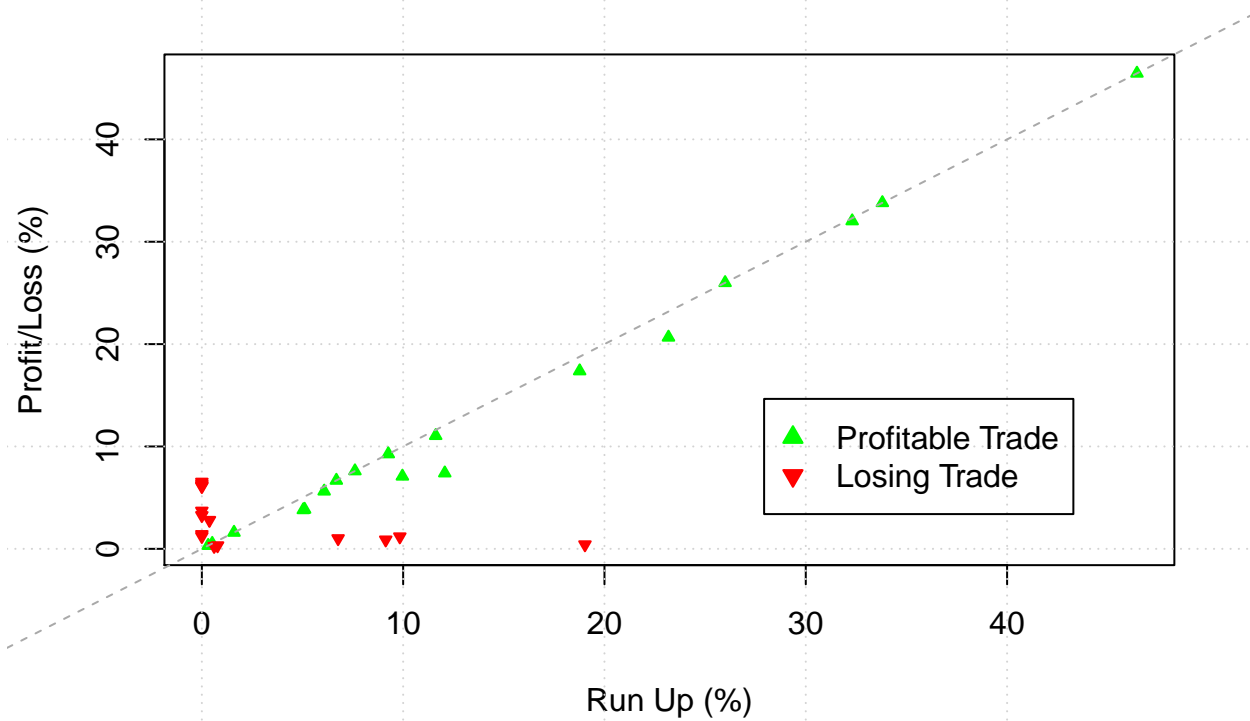


IEV.csv Maximum Adverse Excursion (MAE)

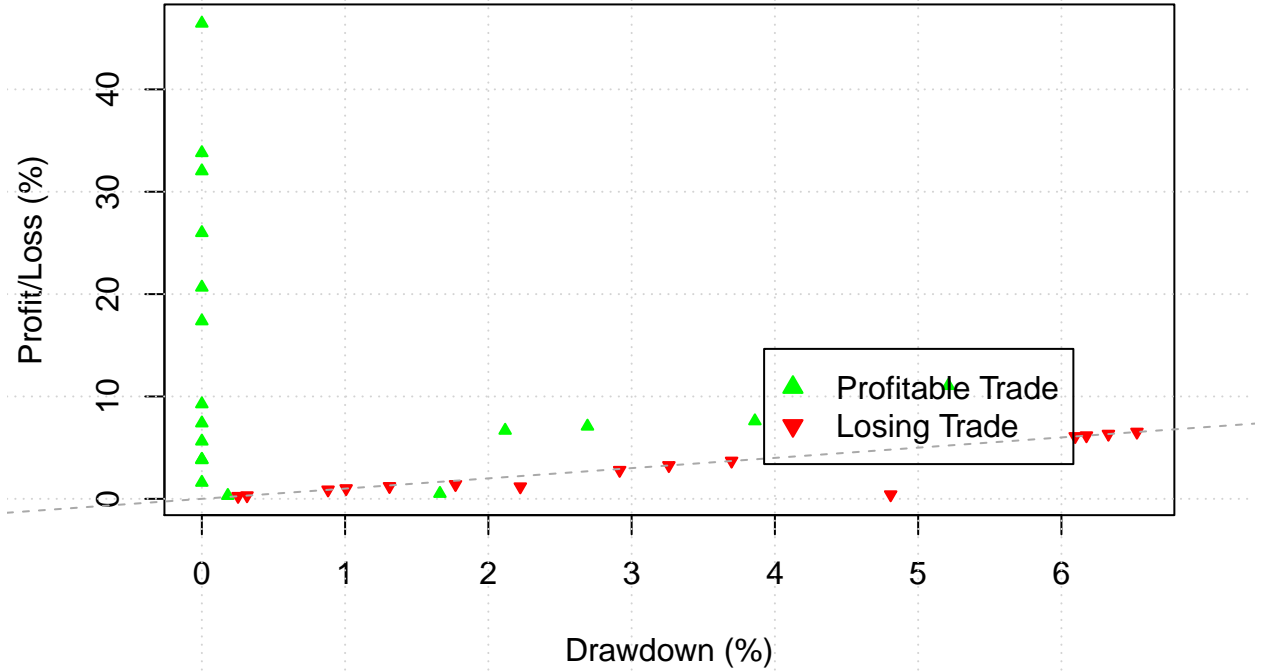


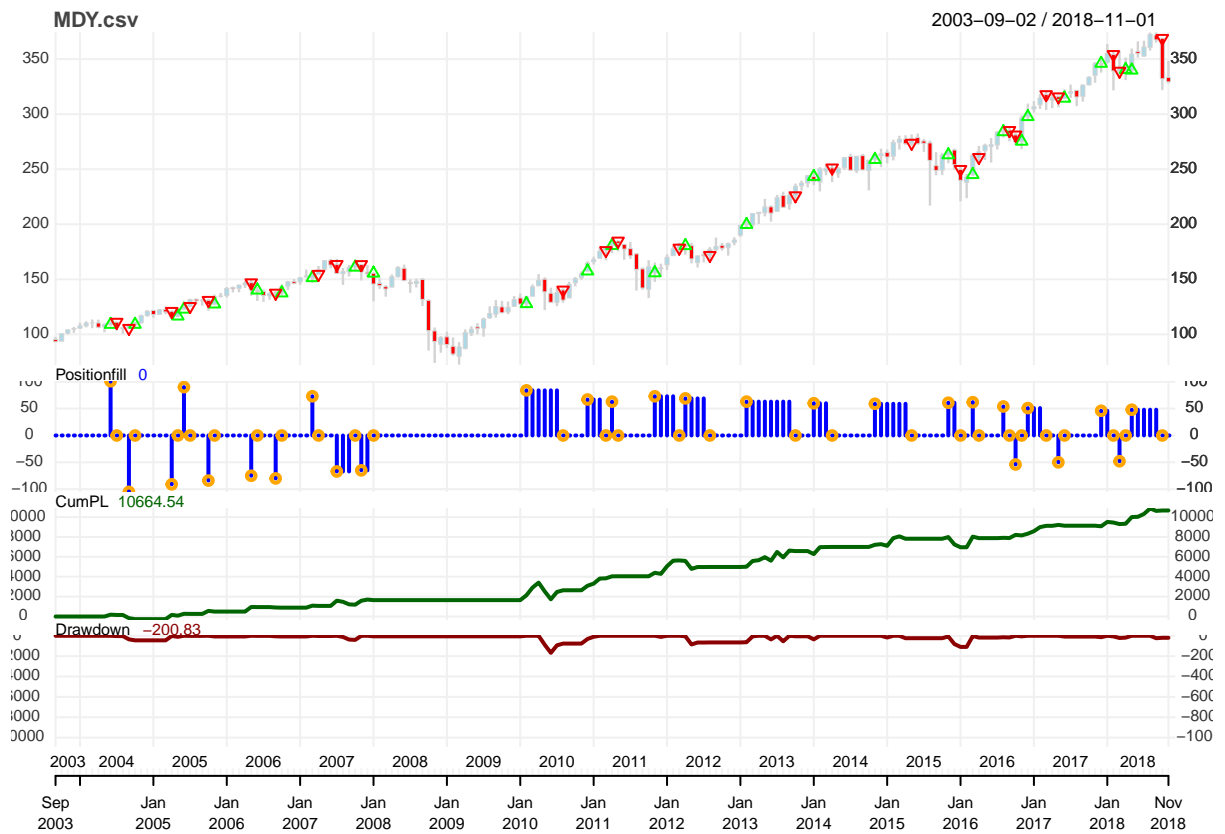


ILF.csv Maximum Favourable Excursion (MFE)

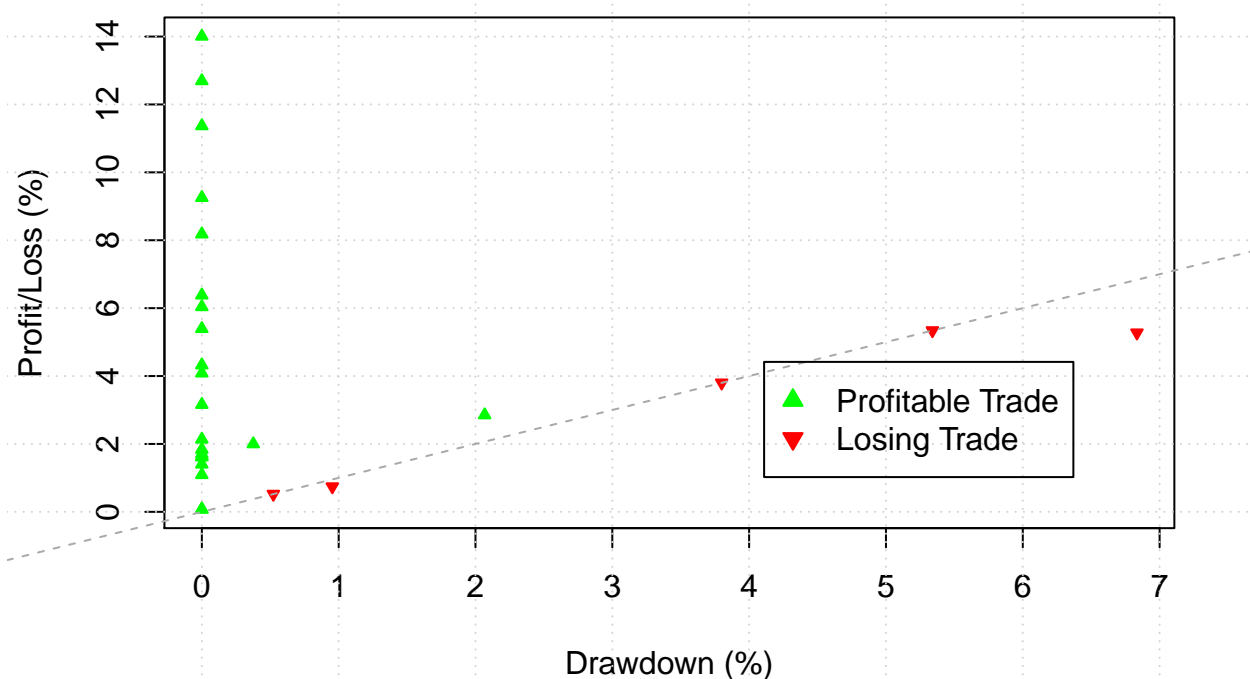


ILF.csv Maximum Adverse Excursion (MAE)





MDY.csv Maximum Adverse Excursion (MAE)



5.3.8 Strategy Risk

```
rets.v3.tmp <- rets.v3
index(rets.v3.tmp) <- as.yearmon(index(rets.v3.tmp))

dir <- "~/Desktop/R/GRS/Risk/"
ff <- read.csv(paste0(dir,"FFFactors.csv"))
ffxts <- as.xts(ff[,-1],order.by=as.Date(ff$dates))
index(ffxts) <- as.yearmon(index(ffxts))

funddata.alt.v3 <- merge(rets.v3.tmp,ffxts)
funddata.alt.v3 <- funddata.alt.v3[complete.cases(funddata.alt.v3),]
# Calculate Excess Returns above the risk free rate
funddata.alt.v3$Return.V3 <- funddata.alt.v3$Return.V3*100
funddata.alt.v3$excessrtn <- funddata.alt.v3$Return.V3 - funddata.alt.v3$rf
```

5.3.8.1 Perform a CAPM Regression

```
capm <- lm(excessrtn ~ mkt.rf, data=funddata.alt.v3)
summary(capm)
```

```
##
```



```
## Call:
## lm(formula = excessrtn ~ mkt.rf, data = funddata.alt.v3)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -7.9434 -1.8359 -0.6576  1.1817 15.4113
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.152140   0.252597   4.561 9.47e-06 ***
## mkt.rf       -0.008093   0.063321  -0.128   0.898
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.318 on 177 degrees of freedom
## Multiple R-squared:  9.229e-05, Adjusted R-squared: -0.005557
## F-statistic: 0.01634 on 1 and 177 DF, p-value: 0.8984
```

5.3.8.2 Perform a Fama-French 3 factor Regression

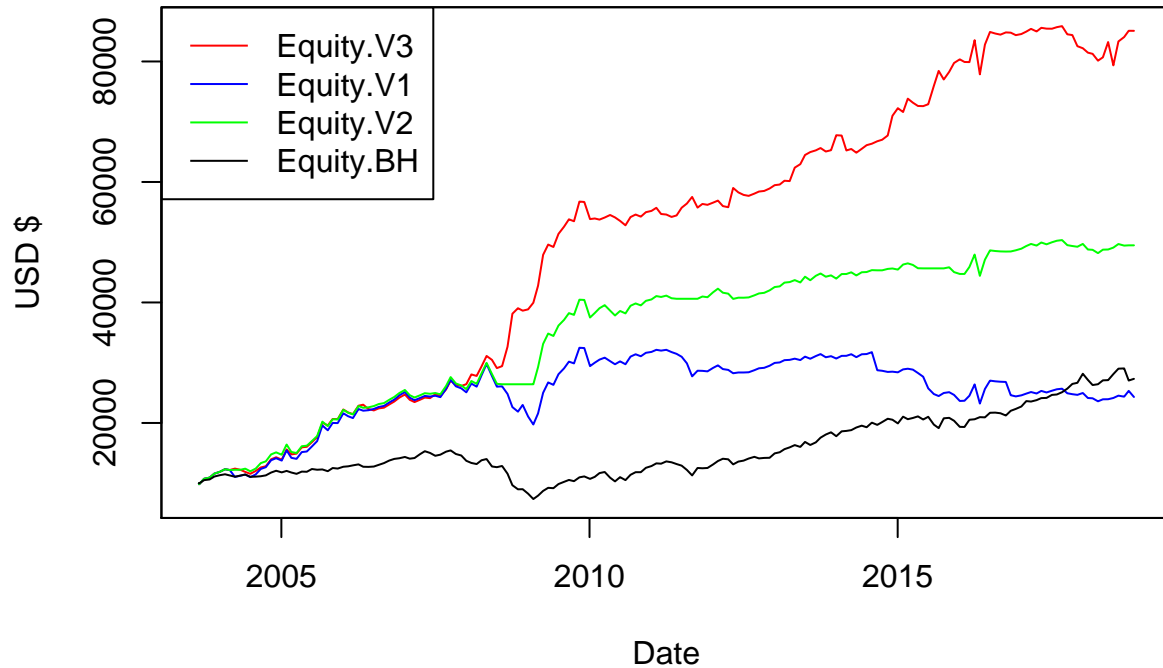
```
# Run Fama-French 3 factor Regression
ff3regression <- lm(excessrtn ~ mkt.rf + smb + hml, data=funddata.alt.v3)
summary(ff3regression)
```

```
##
## Call:
## lm(formula = excessrtn ~ mkt.rf + smb + hml, data = funddata.alt.v3)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -7.6562 -1.8439 -0.5579  1.1875 15.2531
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.16024   0.25267   4.592 8.37e-06 ***
## mkt.rf       -0.05062   0.06961  -0.727   0.468
## smb          0.12023   0.11590   1.037   0.301
## hml          0.10464   0.10443   1.002   0.318
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.317 on 175 degrees of freedom
## Multiple R-squared:  0.01242, Adjusted R-squared: -0.004509
## F-statistic: 0.7337 on 3 and 175 DF, p-value: 0.5332
```

The analysis of the improved V3 strategy's risk shows again what we have seen with the V2 improvement strategy. We can generate a significant alpha of about 13.9 % per year after adjusting for risk. This can be seen as a very strong outperformance of the market.

6 Conclusion

Final Equity Comparison



Performance Metrics

| | Returns.V1 | Returns.BH | Return.V2 | Return.V3 |
|------------------------|------------|------------|-----------|-----------|
| Cumulative Return | 1.4311626 | 1.7323101 | 3.9484875 | 7.5087708 |
| Annualized Return | 0.0596484 | 0.0677494 | 0.1099200 | 0.1498561 |
| Annualized Sharp Ratio | 0.4096519 | 0.5127792 | 1.0098101 | 1.3051385 |
| Calmar Ratio | 0.1769151 | 0.1296325 | 0.9283629 | 1.9761937 |

Risk Metrics

| | Returns.V1 | Returns.BH | Return.V2 | Return.V3 |
|-------------------|------------|------------|------------|------------|
| Annualized StdDev | 0.1456075 | 0.1321220 | 0.1088522 | 0.1148201 |
| Max Drawdown | 0.3371584 | 0.5226270 | 0.1184020 | 0.0758307 |
| Value-at-Risk | -0.0695126 | -0.0612741 | -0.0260376 | -0.0286469 |
| Conditional VaR | -0.0878293 | -0.0897504 | -0.0511959 | -0.0425340 |

The GRS is based on ranking. The 5 ETFs, which represent the world economy (US, EU, Latin America, Emergin Markets, Asia Pacific) are ranked based on momentum, specifically based on the Rate of Change (ROC) indicator. The ROC is calculated based on the monthly returns of the last 3 months. The best ranked ETF is bought and held for 1 month. If an

ETF is ranked the best in two consecutive months it is simply held and not sold. Otherwise it is sold and the ETF which is now ranked best is bought. We clearly see that This strategy outperforms the market before the GFC but has a huge drawdown during the GFC as during this time even the best ranked ETFs generated negative returns. A possible improvement, with the goal to limit the losses, was to only trade, when the ROC was positive. By this, it could be ensured, that there was no investment during the GFC (see green curve above). However, this could also be further improved by investing in risk free instruments during phases when no ETF generates positive returns. The third step was to even further improve the strategy by not only not trading during phases of only negative returns, but also include shortselling. The result is the red equity curve above. It can be clearly shown that through shortselling of the last ranked ETF increased returns can be generated. Not only during the GFC but also during the entire time after the GFC. The comparison of the performance and risk metrics (see table above) shows the values for all strategies. It was used naive moneymanagement. All available equity was used to buy the positions. Moreover, realistic transaction costs were included in the backtesting. In summary, the strategy itself performs quiet well. When adding transaction costs, the plain strategy does not outperform the buy and hold strategy in regards to returns and risk. The proposed improvements led to a significant increase in performance with a annualized return of 14.9%, an annualized Sharp Ratio of 1.3, and a maximum drawdown of 7.5%. The improved strategy performs excellent during different market phases. We see a steep performance during uptrends (After dot-com bubble until the GFC) but also during the GFC through shortselling and during phases where many markets performed sideways without a clear trend. It can be assumed that such a strategy could perform as good as during the tested period in the future. Although an extensive test of the strategy was performed, a formal optimization approach could bring up even more profitable and robust strategies. This could be part of future research regarding the Global Rotation Strategy.

7 Appendix

7.1 Orderbook

```
ob <- getOrderBook(portfolioname)
ob
```

| ## | ## \$GRS | ## \$GRS\$EEM.csv | ## | Order.Qty | Order.Price | Order.Type | Order.Side |
|----|---------------------|-------------------|----------|-----------|-------------|------------|------------|
| ## | 2003-09-02 00:00:00 | "652" | "15.333" | "market" | "long" | | |
| ## | 2003-12-01 00:00:00 | "all" | "17.044" | "market" | "long" | | |
| ## | 2004-01-02 00:00:00 | "605" | "18.344" | "market" | "long" | | |
| ## | 2004-03-01 00:00:00 | "all" | "19.538" | "market" | "long" | | |
| ## | 2004-04-01 00:00:00 | "591" | "19.543" | "market" | "long" | | |
| ## | 2004-05-03 00:00:00 | "all" | "17.642" | "market" | "long" | | |
| ## | 2004-12-01 00:00:00 | "529" | "21.8" | "market" | "long" | | |
| ## | 2005-01-03 00:00:00 | "all" | "22.411" | "market" | "long" | | |
| ## | 2006-01-03 00:00:00 | "384" | "30.06" | "market" | "long" | | |

| | | | | | | |
|----|------------|----------|-----------------|--------------|-----------------------|--------|
| ## | 2006-03-01 | 00:00:00 | "all" | "32.63" | "market" | "long" |
| ## | 2007-09-04 | 00:00:00 | "250" | "44.217" | "market" | "long" |
| ## | 2007-12-03 | 00:00:00 | "all" | "51.37" | "market" | "long" |
| ## | 2009-05-01 | 00:00:00 | "399" | "28.71" | "market" | "long" |
| ## | 2009-07-01 | 00:00:00 | "all" | "32.92" | "market" | "long" |
| ## | 2010-08-02 | 00:00:00 | "262" | "42.18" | "market" | "long" |
| ## | 2010-09-01 | 00:00:00 | "all" | "40.79" | "market" | "long" |
| ## | 2011-06-01 | 00:00:00 | "228" | "48.43" | "market" | "long" |
| ## | 2011-07-01 | 00:00:00 | "all" | "47.58" | "market" | "long" |
| ## | 2011-08-01 | 00:00:00 | "232" | "47.67" | "market" | "long" |
| ## | 2011-09-01 | 00:00:00 | "all" | "42.87" | "market" | "long" |
| ## | 2014-07-01 | 00:00:00 | "254" | "43.55" | "market" | "long" |
| ## | 2014-09-02 | 00:00:00 | "all" | "45.05" | "market" | "long" |
| ## | 2015-05-01 | 00:00:00 | "264" | "43.09" | "market" | "long" |
| ## | 2015-06-01 | 00:00:00 | "all" | "41.14" | "market" | "long" |
| ## | 2016-10-03 | 00:00:00 | "303" | "37.53" | "market" | "long" |
| ## | 2016-11-01 | 00:00:00 | "all" | "37.28" | "market" | "long" |
| ## | 2017-08-01 | 00:00:00 | "258" | "44" | "market" | "long" |
| ## | 2017-09-01 | 00:00:00 | "all" | "45.01" | "market" | "long" |
| ## | 2017-11-01 | 00:00:00 | "243" | "46.7" | "market" | "long" |
| ## | 2017-12-01 | 00:00:00 | "all" | "45.98" | "market" | "long" |
| ## | | | Order.Threshold | Order.Status | Order.StatusTime | |
| ## | 2003-09-02 | 00:00:00 | NA | "closed" | "2003-10-01 00:00:00" | |
| ## | 2003-12-01 | 00:00:00 | NA | "closed" | "2004-01-02 00:00:00" | |
| ## | 2004-01-02 | 00:00:00 | NA | "closed" | "2004-02-02 00:00:00" | |
| ## | 2004-03-01 | 00:00:00 | NA | "closed" | "2004-04-01 00:00:00" | |
| ## | 2004-04-01 | 00:00:00 | NA | "closed" | "2004-05-03 00:00:00" | |
| ## | 2004-05-03 | 00:00:00 | NA | "closed" | "2004-06-01 00:00:00" | |
| ## | 2004-12-01 | 00:00:00 | NA | "closed" | "2005-01-03 00:00:00" | |
| ## | 2005-01-03 | 00:00:00 | NA | "closed" | "2005-02-01 00:00:00" | |
| ## | 2006-01-03 | 00:00:00 | NA | "closed" | "2006-02-01 00:00:00" | |
| ## | 2006-03-01 | 00:00:00 | NA | "closed" | "2006-04-03 00:00:00" | |
| ## | 2007-09-04 | 00:00:00 | NA | "closed" | "2007-10-01 00:00:00" | |
| ## | 2007-12-03 | 00:00:00 | NA | "closed" | "2008-01-02 00:00:00" | |
| ## | 2009-05-01 | 00:00:00 | NA | "closed" | "2009-06-01 00:00:00" | |
| ## | 2009-07-01 | 00:00:00 | NA | "closed" | "2009-08-03 00:00:00" | |
| ## | 2010-08-02 | 00:00:00 | NA | "closed" | "2010-09-01 00:00:00" | |
| ## | 2010-09-01 | 00:00:00 | NA | "closed" | "2010-10-01 00:00:00" | |
| ## | 2011-06-01 | 00:00:00 | NA | "closed" | "2011-07-01 00:00:00" | |
| ## | 2011-07-01 | 00:00:00 | NA | "closed" | "2011-08-01 00:00:00" | |
| ## | 2011-08-01 | 00:00:00 | NA | "closed" | "2011-09-01 00:00:00" | |
| ## | 2011-09-01 | 00:00:00 | NA | "closed" | "2011-10-03 00:00:00" | |
| ## | 2014-07-01 | 00:00:00 | NA | "closed" | "2014-08-01 00:00:00" | |
| ## | 2014-09-02 | 00:00:00 | NA | "closed" | "2014-10-01 00:00:00" | |
| ## | 2015-05-01 | 00:00:00 | NA | "closed" | "2015-06-01 00:00:00" | |
| ## | 2015-06-01 | 00:00:00 | NA | "closed" | "2015-07-01 00:00:00" | |

| | | | | | | |
|----|----------------|----------|-----------|-------------|------------|-----------------------|
| ## | 2016-10-03 | 00:00:00 | NA | | "closed" | "2016-11-01 00:00:00" |
| ## | 2016-11-01 | 00:00:00 | NA | | "closed" | "2016-12-01 00:00:00" |
| ## | 2017-08-01 | 00:00:00 | NA | | "closed" | "2017-09-01 00:00:00" |
| ## | 2017-09-01 | 00:00:00 | NA | | "closed" | "2017-10-02 00:00:00" |
| ## | 2017-11-01 | 00:00:00 | NA | | "closed" | "2017-12-01 00:00:00" |
| ## | 2017-12-01 | 00:00:00 | NA | | "closed" | "2018-01-02 00:00:00" |
| ## | | | Prefer | Order.Set | Txn.Fees | Rule |
| ## | 2003-09-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2003-12-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2004-01-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2004-03-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2004-04-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2004-05-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2004-12-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2005-01-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2006-01-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2006-03-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2007-09-04 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2007-12-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2009-05-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2009-07-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2010-08-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2010-09-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2011-06-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2011-07-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2011-08-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2011-09-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2014-07-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2014-09-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2015-05-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2015-06-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2016-10-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2016-11-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2017-08-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2017-09-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2017-11-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2017-12-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | | | | | | |
| ## | \$GRS\$EPP.csv | | | | | |
| ## | | | Order.Qty | Order.Price | Order.Type | Order.Side |
| ## | 2006-11-01 | 00:00:00 | "275" | "40.0667" | "market" | "long" |
| ## | 2006-12-01 | 00:00:00 | "all" | "41.4" | "market" | "long" |
| ## | 2007-04-02 | 00:00:00 | "246" | "44.8367" | "market" | "long" |
| ## | 2007-06-01 | 00:00:00 | "all" | "48.3" | "market" | "long" |
| ## | 2009-08-03 | 00:00:00 | "313" | "36.37" | "market" | "long" |
| ## | 2009-11-02 | 00:00:00 | "all" | "40.03" | "market" | "long" |

| | | | | | | |
|----|------------|----------|-----------------|--------------|-----------------------|--------------------|
| ## | 2010-09-01 | 00:00:00 | "301" | "40.52" | "market" | "long" |
| ## | 2010-12-01 | 00:00:00 | "all" | "45.47" | "market" | "long" |
| ## | 2011-09-01 | 00:00:00 | "276" | "44.52" | "market" | "long" |
| ## | 2011-10-03 | 00:00:00 | "all" | "36.29" | "market" | "long" |
| ## | 2012-08-01 | 00:00:00 | "284" | "43.15" | "market" | "long" |
| ## | 2012-11-01 | 00:00:00 | "all" | "45.58" | "market" | "long" |
| ## | 2013-11-01 | 00:00:00 | "260" | "49.63" | "market" | "long" |
| ## | 2013-12-02 | 00:00:00 | "all" | "47.84" | "market" | "long" |
| ## | 2014-04-01 | 00:00:00 | "268" | "48.28" | "market" | "long" |
| ## | 2014-05-01 | 00:00:00 | "all" | "49.07" | "market" | "long" |
| ## | 2016-01-04 | 00:00:00 | "343" | "37.7" | "market" | "long" |
| ## | 2016-02-01 | 00:00:00 | "all" | "35.04" | "market" | "long" |
| ## | | | Order.Threshold | Order.Status | Order.StatusTime | |
| ## | 2006-11-01 | 00:00:00 | NA | "closed" | "2006-12-01 00:00:00" | |
| ## | 2006-12-01 | 00:00:00 | NA | "closed" | "2007-01-03 00:00:00" | |
| ## | 2007-04-02 | 00:00:00 | NA | "closed" | "2007-05-01 00:00:00" | |
| ## | 2007-06-01 | 00:00:00 | NA | "closed" | "2007-07-02 00:00:00" | |
| ## | 2009-08-03 | 00:00:00 | NA | "closed" | "2009-09-01 00:00:00" | |
| ## | 2009-11-02 | 00:00:00 | NA | "closed" | "2009-12-01 00:00:00" | |
| ## | 2010-09-01 | 00:00:00 | NA | "closed" | "2010-10-01 00:00:00" | |
| ## | 2010-12-01 | 00:00:00 | NA | "closed" | "2011-01-03 00:00:00" | |
| ## | 2011-09-01 | 00:00:00 | NA | "closed" | "2011-10-03 00:00:00" | |
| ## | 2011-10-03 | 00:00:00 | NA | "closed" | "2011-11-01 00:00:00" | |
| ## | 2012-08-01 | 00:00:00 | NA | "closed" | "2012-09-04 00:00:00" | |
| ## | 2012-11-01 | 00:00:00 | NA | "closed" | "2012-12-03 00:00:00" | |
| ## | 2013-11-01 | 00:00:00 | NA | "closed" | "2013-12-02 00:00:00" | |
| ## | 2013-12-02 | 00:00:00 | NA | "closed" | "2014-01-02 00:00:00" | |
| ## | 2014-04-01 | 00:00:00 | NA | "closed" | "2014-05-01 00:00:00" | |
| ## | 2014-05-01 | 00:00:00 | NA | "closed" | "2014-06-02 00:00:00" | |
| ## | 2016-01-04 | 00:00:00 | NA | "closed" | "2016-02-01 00:00:00" | |
| ## | 2016-02-01 | 00:00:00 | NA | "closed" | "2016-03-01 00:00:00" | |
| ## | | | Prefer | Order.Set | Txn.Fees | Rule Time.In.Force |
| ## | 2006-11-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2006-12-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2007-04-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2007-06-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2009-08-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2009-11-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2010-09-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2010-12-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2011-09-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2011-10-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2012-08-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2012-11-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |
| ## | 2013-11-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" "" |
| ## | 2013-12-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" "" |

```
## 2014-04-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2014-05-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2016-01-04 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2016-02-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
##
```

```
## $GRS$IEV.csv
```

```
## Order.Qty Order.Price Order.Type Order.Side
```

```
## 2003-12-01 00:00:00 "363" "30.535" "market" "long"
## 2004-01-02 00:00:00 "all" "32.52" "market" "long"
## 2004-07-01 00:00:00 "335" "33.12" "market" "long"
## 2004-08-02 00:00:00 "all" "31.97" "market" "long"
## 2006-05-01 00:00:00 "236" "47.025" "market" "long"
## 2006-09-01 00:00:00 "all" "48.075" "market" "long"
## 2006-10-02 00:00:00 "242" "48.335" "market" "long"
## 2006-11-01 00:00:00 "all" "50.57" "market" "long"
## 2008-12-01 00:00:00 "420" "27.86" "market" "long"
## 2009-02-02 00:00:00 "all" "25.7" "market" "long"
## 2011-03-01 00:00:00 "231" "42.34" "market" "long"
## 2011-04-01 00:00:00 "all" "41.93" "market" "long"
## 2011-05-02 00:00:00 "215" "45.47" "market" "long"
## 2011-06-01 00:00:00 "all" "43.6" "market" "long"
## 2011-07-01 00:00:00 "233" "41.91" "market" "long"
## 2011-08-01 00:00:00 "all" "40.56" "market" "long"
## 2012-11-01 00:00:00 "262" "37.34" "market" "long"
## 2013-02-01 00:00:00 "all" "41.47" "market" "long"
## 2013-10-01 00:00:00 "239" "44.26" "market" "long"
## 2013-11-01 00:00:00 "all" "45.65" "market" "long"
## 2013-12-02 00:00:00 "230" "46.15" "market" "long"
## 2014-01-02 00:00:00 "all" "46.76" "market" "long"
## 2015-06-01 00:00:00 "229" "46.18" "market" "long"
## 2015-07-01 00:00:00 "all" "44.3" "market" "long"
## 2017-05-01 00:00:00 "244" "43.44" "market" "long"
## 2017-08-01 00:00:00 "all" "45.85" "market" "long"
```

```
## Order.Threshold Order.Status Order.StatusTime
```

```
## 2003-12-01 00:00:00 NA "closed" "2004-01-02 00:00:00"
## 2004-01-02 00:00:00 NA "closed" "2004-02-02 00:00:00"
## 2004-07-01 00:00:00 NA "closed" "2004-08-02 00:00:00"
## 2004-08-02 00:00:00 NA "closed" "2004-09-01 00:00:00"
## 2006-05-01 00:00:00 NA "closed" "2006-06-01 00:00:00"
## 2006-09-01 00:00:00 NA "closed" "2006-10-02 00:00:00"
## 2006-10-02 00:00:00 NA "closed" "2006-11-01 00:00:00"
## 2006-11-01 00:00:00 NA "closed" "2006-12-01 00:00:00"
## 2008-12-01 00:00:00 NA "closed" "2009-01-02 00:00:00"
## 2009-02-02 00:00:00 NA "closed" "2009-03-02 00:00:00"
## 2011-03-01 00:00:00 NA "closed" "2011-04-01 00:00:00"
## 2011-04-01 00:00:00 NA "closed" "2011-05-02 00:00:00"
```

| | | | | | |
|----|------------|----------|----|----------|-----------------------|
| ## | 2011-05-02 | 00:00:00 | NA | "closed" | "2011-06-01 00:00:00" |
| ## | 2011-06-01 | 00:00:00 | NA | "closed" | "2011-07-01 00:00:00" |
| ## | 2011-07-01 | 00:00:00 | NA | "closed" | "2011-08-01 00:00:00" |
| ## | 2011-08-01 | 00:00:00 | NA | "closed" | "2011-09-01 00:00:00" |
| ## | 2012-11-01 | 00:00:00 | NA | "closed" | "2012-12-03 00:00:00" |
| ## | 2013-02-01 | 00:00:00 | NA | "closed" | "2013-03-01 00:00:00" |
| ## | 2013-10-01 | 00:00:00 | NA | "closed" | "2013-11-01 00:00:00" |
| ## | 2013-11-01 | 00:00:00 | NA | "closed" | "2013-12-02 00:00:00" |
| ## | 2013-12-02 | 00:00:00 | NA | "closed" | "2014-01-02 00:00:00" |
| ## | 2014-01-02 | 00:00:00 | NA | "closed" | "2014-02-03 00:00:00" |
| ## | 2015-06-01 | 00:00:00 | NA | "closed" | "2015-07-01 00:00:00" |
| ## | 2015-07-01 | 00:00:00 | NA | "closed" | "2015-08-03 00:00:00" |
| ## | 2017-05-01 | 00:00:00 | NA | "closed" | "2017-06-01 00:00:00" |
| ## | 2017-08-01 | 00:00:00 | NA | "closed" | "2017-09-01 00:00:00" |

| ## | | Prefer | Order.Set | Txn.Fees | Rule | Time.In.Force |
|----|---------------------|--------|-----------|----------|-------------|---------------|
| ## | 2003-12-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2004-01-02 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2004-07-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2004-08-02 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2006-05-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2006-09-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2006-10-02 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2006-11-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2008-12-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2009-02-02 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2011-03-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2011-04-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2011-05-02 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2011-06-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2011-07-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2011-08-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2012-11-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2013-02-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2013-10-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2013-11-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2013-12-02 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2014-01-02 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2015-06-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2015-07-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2017-05-01 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2017-08-01 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |

\$GRS\$ILF.csv

| ## | | Order.Qty | Order.Price | Order.Type | Order.Side |
|----|---------------------|-----------|-------------|------------|------------|
| ## | 2004-03-01 00:00:00 | "877" | "12.66" | "market" | "long" |
| ## | 2004-04-01 00:00:00 | "all" | "12.55" | "market" | "long" |

| | | | | | | |
|----|---|----------|-------|----------|-----------------------|--------|
| ## | 2004-08-02 | 00:00:00 | "932" | "11.91" | "market" | "long" |
| ## | 2004-12-01 | 00:00:00 | "all" | "15.07" | "market" | "long" |
| ## | 2005-01-03 | 00:00:00 | "830" | "16.2" | "market" | "long" |
| ## | 2005-06-01 | 00:00:00 | "all" | "17.42" | "market" | "long" |
| ## | 2005-07-01 | 00:00:00 | "798" | "18.61" | "market" | "long" |
| ## | 2006-01-03 | 00:00:00 | "all" | "24.982" | "market" | "long" |
| ## | 2006-03-01 | 00:00:00 | "655" | "28.6" | "market" | "long" |
| ## | 2006-05-01 | 00:00:00 | "all" | "30.61" | "market" | "long" |
| ## | 2006-09-01 | 00:00:00 | "719" | "28.144" | "market" | "long" |
| ## | 2006-10-02 | 00:00:00 | "all" | "28.684" | "market" | "long" |
| ## | 2006-12-01 | 00:00:00 | "620" | "32.618" | "market" | "long" |
| ## | 2007-03-01 | 00:00:00 | "all" | "32.394" | "market" | "long" |
| ## | 2007-06-01 | 00:00:00 | "462" | "42.92" | "market" | "long" |
| ## | 2007-09-04 | 00:00:00 | "all" | "42.538" | "market" | "long" |
| ## | 2007-12-03 | 00:00:00 | "391" | "50.43" | "market" | "long" |
| ## | 2008-08-01 | 00:00:00 | "all" | "50.39" | "market" | "long" |
| ## | 2009-02-02 | 00:00:00 | "818" | "24.5" | "market" | "long" |
| ## | 2009-05-01 | 00:00:00 | "all" | "29.79" | "market" | "long" |
| ## | 2009-07-01 | 00:00:00 | "712" | "35.5" | "market" | "long" |
| ## | 2009-08-03 | 00:00:00 | "all" | "38.87" | "market" | "long" |
| ## | 2009-11-02 | 00:00:00 | "581" | "43.54" | "market" | "long" |
| ## | 2010-02-01 | 00:00:00 | "all" | "43.12" | "market" | "long" |
| ## | 2012-03-01 | 00:00:00 | "454" | "48.96" | "market" | "long" |
| ## | 2012-04-02 | 00:00:00 | "all" | "47.47" | "market" | "long" |
| ## | 2014-05-01 | 00:00:00 | "585" | "38.02" | "market" | "long" |
| ## | 2014-07-01 | 00:00:00 | "all" | "38.3" | "market" | "long" |
| ## | 2014-09-02 | 00:00:00 | "536" | "42.37" | "market" | "long" |
| ## | 2014-11-03 | 00:00:00 | "all" | "36.18" | "market" | "long" |
| ## | 2015-07-01 | 00:00:00 | "760" | "29.77" | "market" | "long" |
| ## | 2015-08-03 | 00:00:00 | "all" | "26.75" | "market" | "long" |
| ## | 2016-04-01 | 00:00:00 | "909" | "24.9" | "market" | "long" |
| ## | 2016-08-01 | 00:00:00 | "all" | "27.71" | "market" | "long" |
| ## | 2016-09-01 | 00:00:00 | "829" | "28.06" | "market" | "long" |
| ## | 2016-10-03 | 00:00:00 | "all" | "28.21" | "market" | "long" |
| ## | 2016-11-01 | 00:00:00 | "750" | "31.02" | "market" | "long" |
| ## | 2016-12-01 | 00:00:00 | "all" | "27.73" | "market" | "long" |
| ## | 2017-03-01 | 00:00:00 | "740" | "31.43" | "market" | "long" |
| ## | 2017-05-01 | 00:00:00 | "all" | "31.4" | "market" | "long" |
| ## | 2017-09-01 | 00:00:00 | "659" | "34.92" | "market" | "long" |
| ## | 2017-11-01 | 00:00:00 | "all" | "34.02" | "market" | "long" |
| ## | 2018-02-01 | 00:00:00 | "571" | "38.96" | "market" | "long" |
| ## | 2018-05-01 | 00:00:00 | "all" | "36.5" | "market" | "long" |
| ## | 2018-10-01 | 00:00:00 | "689" | "31.49" | "market" | "long" |
| ## | Order.Threshold Order.Status Order.StatusTime | | | | | |
| ## | 2004-03-01 | 00:00:00 | NA | "closed" | "2004-04-01 00:00:00" | |
| ## | 2004-04-01 | 00:00:00 | NA | "closed" | "2004-05-03 00:00:00" | |

| | | | | | |
|----|------------|----------|--|-------------|-----------------------|
| ## | 2004-08-02 | 00:00:00 | NA | "closed" | "2004-09-01 00:00:00" |
| ## | 2004-12-01 | 00:00:00 | NA | "closed" | "2005-01-03 00:00:00" |
| ## | 2005-01-03 | 00:00:00 | NA | "closed" | "2005-02-01 00:00:00" |
| ## | 2005-06-01 | 00:00:00 | NA | "closed" | "2005-07-01 00:00:00" |
| ## | 2005-07-01 | 00:00:00 | NA | "closed" | "2005-08-01 00:00:00" |
| ## | 2006-01-03 | 00:00:00 | NA | "closed" | "2006-02-01 00:00:00" |
| ## | 2006-03-01 | 00:00:00 | NA | "closed" | "2006-04-03 00:00:00" |
| ## | 2006-05-01 | 00:00:00 | NA | "closed" | "2006-06-01 00:00:00" |
| ## | 2006-09-01 | 00:00:00 | NA | "closed" | "2006-10-02 00:00:00" |
| ## | 2006-10-02 | 00:00:00 | NA | "closed" | "2006-11-01 00:00:00" |
| ## | 2006-12-01 | 00:00:00 | NA | "closed" | "2007-01-03 00:00:00" |
| ## | 2007-03-01 | 00:00:00 | NA | "closed" | "2007-04-02 00:00:00" |
| ## | 2007-06-01 | 00:00:00 | NA | "closed" | "2007-07-02 00:00:00" |
| ## | 2007-09-04 | 00:00:00 | NA | "closed" | "2007-10-01 00:00:00" |
| ## | 2007-12-03 | 00:00:00 | NA | "closed" | "2008-01-02 00:00:00" |
| ## | 2008-08-01 | 00:00:00 | NA | "closed" | "2008-09-02 00:00:00" |
| ## | 2009-02-02 | 00:00:00 | NA | "closed" | "2009-03-02 00:00:00" |
| ## | 2009-05-01 | 00:00:00 | NA | "closed" | "2009-06-01 00:00:00" |
| ## | 2009-07-01 | 00:00:00 | NA | "closed" | "2009-08-03 00:00:00" |
| ## | 2009-08-03 | 00:00:00 | NA | "closed" | "2009-09-01 00:00:00" |
| ## | 2009-11-02 | 00:00:00 | NA | "closed" | "2009-12-01 00:00:00" |
| ## | 2010-02-01 | 00:00:00 | NA | "closed" | "2010-03-01 00:00:00" |
| ## | 2012-03-01 | 00:00:00 | NA | "closed" | "2012-04-02 00:00:00" |
| ## | 2012-04-02 | 00:00:00 | NA | "closed" | "2012-05-01 00:00:00" |
| ## | 2014-05-01 | 00:00:00 | NA | "closed" | "2014-06-02 00:00:00" |
| ## | 2014-07-01 | 00:00:00 | NA | "closed" | "2014-08-01 00:00:00" |
| ## | 2014-09-02 | 00:00:00 | NA | "closed" | "2014-10-01 00:00:00" |
| ## | 2014-11-03 | 00:00:00 | NA | "closed" | "2014-12-01 00:00:00" |
| ## | 2015-07-01 | 00:00:00 | NA | "closed" | "2015-08-03 00:00:00" |
| ## | 2015-08-03 | 00:00:00 | NA | "closed" | "2015-09-01 00:00:00" |
| ## | 2016-04-01 | 00:00:00 | NA | "closed" | "2016-05-02 00:00:00" |
| ## | 2016-08-01 | 00:00:00 | NA | "closed" | "2016-09-01 00:00:00" |
| ## | 2016-09-01 | 00:00:00 | NA | "closed" | "2016-10-03 00:00:00" |
| ## | 2016-10-03 | 00:00:00 | NA | "closed" | "2016-11-01 00:00:00" |
| ## | 2016-11-01 | 00:00:00 | NA | "closed" | "2016-12-01 00:00:00" |
| ## | 2016-12-01 | 00:00:00 | NA | "closed" | "2017-01-03 00:00:00" |
| ## | 2017-03-01 | 00:00:00 | NA | "closed" | "2017-04-03 00:00:00" |
| ## | 2017-05-01 | 00:00:00 | NA | "closed" | "2017-06-01 00:00:00" |
| ## | 2017-09-01 | 00:00:00 | NA | "closed" | "2017-10-02 00:00:00" |
| ## | 2017-11-01 | 00:00:00 | NA | "closed" | "2017-12-01 00:00:00" |
| ## | 2018-02-01 | 00:00:00 | NA | "closed" | "2018-03-01 00:00:00" |
| ## | 2018-05-01 | 00:00:00 | NA | "closed" | "2018-06-01 00:00:00" |
| ## | 2018-10-01 | 00:00:00 | NA | "closed" | "2018-11-01 00:00:00" |
| ## | | | Prefer Order.Set Txn.Fees Rule Time.In.Force | | |
| ## | 2004-03-01 | 00:00:00 | "Open" "ocolong" "txnc" | "enterLONG" | " " |
| ## | 2004-04-01 | 00:00:00 | "Open" "ocolong" "txnc" | "exitLONG" | " " |

```

## 2004-08-02 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2004-12-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2005-01-03 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2005-06-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2005-07-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2006-01-03 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2006-03-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2006-05-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2006-09-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2006-10-02 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2006-12-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2007-03-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2007-06-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2007-09-04 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2007-12-03 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2008-08-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2009-02-02 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2009-05-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2009-07-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2009-08-03 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2009-11-02 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2010-02-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2012-03-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2012-04-02 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2014-05-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2014-07-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2014-09-02 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2014-11-03 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2015-07-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2015-08-03 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2016-04-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2016-08-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2016-09-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2016-10-03 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2016-11-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2016-12-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2017-03-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2017-05-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2017-09-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2017-11-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2018-02-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2018-05-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2018-10-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
##
## $GRS$MDY.csv
## Order.Qty Order.Price Order.Type Order.Side

```

| | | | | | | |
|----|------------|----------|-----------------|--------------|-----------------------|--------|
| ## | 2004-05-03 | 00:00:00 | "103" | "106.95" | "market" | "long" |
| ## | 2004-07-01 | 00:00:00 | "all" | "111.1" | "market" | "long" |
| ## | 2005-06-01 | 00:00:00 | "92" | "122.79" | "market" | "long" |
| ## | 2005-07-01 | 00:00:00 | "all" | "125.46" | "market" | "long" |
| ## | 2007-03-01 | 00:00:00 | "74" | "151.38" | "market" | "long" |
| ## | 2007-04-02 | 00:00:00 | "all" | "154.64" | "market" | "long" |
| ## | 2008-08-01 | 00:00:00 | "77" | "146.17" | "market" | "long" |
| ## | 2008-12-01 | 00:00:00 | "all" | "90.94" | "market" | "long" |
| ## | 2010-02-01 | 00:00:00 | "55" | "127.8" | "market" | "long" |
| ## | 2010-08-02 | 00:00:00 | "all" | "140.34" | "market" | "long" |
| ## | 2010-12-01 | 00:00:00 | "46" | "157.43" | "market" | "long" |
| ## | 2011-03-01 | 00:00:00 | "all" | "176.22" | "market" | "long" |
| ## | 2011-04-01 | 00:00:00 | "43" | "180.57" | "market" | "long" |
| ## | 2011-05-02 | 00:00:00 | "all" | "184.84" | "market" | "long" |
| ## | 2011-10-03 | 00:00:00 | "55" | "140.97" | "market" | "long" |
| ## | 2012-03-01 | 00:00:00 | "all" | "178.43" | "market" | "long" |
| ## | 2012-04-02 | 00:00:00 | "48" | "180.47" | "market" | "long" |
| ## | 2012-08-01 | 00:00:00 | "all" | "171.82" | "market" | "long" |
| ## | 2013-02-01 | 00:00:00 | "41" | "199.69" | "market" | "long" |
| ## | 2013-10-01 | 00:00:00 | "all" | "225.99" | "market" | "long" |
| ## | 2014-01-02 | 00:00:00 | "38" | "243.31" | "market" | "long" |
| ## | 2014-04-01 | 00:00:00 | "all" | "251.25" | "market" | "long" |
| ## | 2014-11-03 | 00:00:00 | "37" | "258.71" | "market" | "long" |
| ## | 2015-05-01 | 00:00:00 | "all" | "273.68" | "market" | "long" |
| ## | 2015-08-03 | 00:00:00 | "37" | "273.95" | "market" | "long" |
| ## | 2016-01-04 | 00:00:00 | "all" | "249.92" | "market" | "long" |
| ## | 2016-02-01 | 00:00:00 | "42" | "238.03" | "market" | "long" |
| ## | 2016-04-01 | 00:00:00 | "all" | "260.75" | "market" | "long" |
| ## | 2016-08-01 | 00:00:00 | "38" | "283.93" | "market" | "long" |
| ## | 2016-09-01 | 00:00:00 | "all" | "285.26" | "market" | "long" |
| ## | 2016-12-01 | 00:00:00 | "36" | "297.66" | "market" | "long" |
| ## | 2017-03-01 | 00:00:00 | "all" | "317.83" | "market" | "long" |
| ## | 2017-12-01 | 00:00:00 | "32" | "346.06" | "market" | "long" |
| ## | 2018-02-01 | 00:00:00 | "all" | "354.28" | "market" | "long" |
| ## | 2018-05-01 | 00:00:00 | "34" | "339.88" | "market" | "long" |
| ## | 2018-10-01 | 00:00:00 | "all" | "368.93" | "market" | "long" |
| ## | | | Order.Threshold | Order.Status | Order.StatusTime | |
| ## | 2004-05-03 | 00:00:00 | NA | "closed" | "2004-06-01 00:00:00" | |
| ## | 2004-07-01 | 00:00:00 | NA | "closed" | "2004-08-02 00:00:00" | |
| ## | 2005-06-01 | 00:00:00 | NA | "closed" | "2005-07-01 00:00:00" | |
| ## | 2005-07-01 | 00:00:00 | NA | "closed" | "2005-08-01 00:00:00" | |
| ## | 2007-03-01 | 00:00:00 | NA | "closed" | "2007-04-02 00:00:00" | |
| ## | 2007-04-02 | 00:00:00 | NA | "closed" | "2007-05-01 00:00:00" | |
| ## | 2008-08-01 | 00:00:00 | NA | "closed" | "2008-09-02 00:00:00" | |
| ## | 2008-12-01 | 00:00:00 | NA | "closed" | "2009-01-02 00:00:00" | |
| ## | 2010-02-01 | 00:00:00 | NA | "closed" | "2010-03-01 00:00:00" | |

| | | | | | | | |
|----|------------|----------|--------|-----------|-----------------------|-------------|---------------|
| ## | 2010-08-02 | 00:00:00 | NA | "closed" | "2010-09-01 00:00:00" | | |
| ## | 2010-12-01 | 00:00:00 | NA | "closed" | "2011-01-03 00:00:00" | | |
| ## | 2011-03-01 | 00:00:00 | NA | "closed" | "2011-04-01 00:00:00" | | |
| ## | 2011-04-01 | 00:00:00 | NA | "closed" | "2011-05-02 00:00:00" | | |
| ## | 2011-05-02 | 00:00:00 | NA | "closed" | "2011-06-01 00:00:00" | | |
| ## | 2011-10-03 | 00:00:00 | NA | "closed" | "2011-11-01 00:00:00" | | |
| ## | 2012-03-01 | 00:00:00 | NA | "closed" | "2012-04-02 00:00:00" | | |
| ## | 2012-04-02 | 00:00:00 | NA | "closed" | "2012-05-01 00:00:00" | | |
| ## | 2012-08-01 | 00:00:00 | NA | "closed" | "2012-09-04 00:00:00" | | |
| ## | 2013-02-01 | 00:00:00 | NA | "closed" | "2013-03-01 00:00:00" | | |
| ## | 2013-10-01 | 00:00:00 | NA | "closed" | "2013-11-01 00:00:00" | | |
| ## | 2014-01-02 | 00:00:00 | NA | "closed" | "2014-02-03 00:00:00" | | |
| ## | 2014-04-01 | 00:00:00 | NA | "closed" | "2014-05-01 00:00:00" | | |
| ## | 2014-11-03 | 00:00:00 | NA | "closed" | "2014-12-01 00:00:00" | | |
| ## | 2015-05-01 | 00:00:00 | NA | "closed" | "2015-06-01 00:00:00" | | |
| ## | 2015-08-03 | 00:00:00 | NA | "closed" | "2015-09-01 00:00:00" | | |
| ## | 2016-01-04 | 00:00:00 | NA | "closed" | "2016-02-01 00:00:00" | | |
| ## | 2016-02-01 | 00:00:00 | NA | "closed" | "2016-03-01 00:00:00" | | |
| ## | 2016-04-01 | 00:00:00 | NA | "closed" | "2016-05-02 00:00:00" | | |
| ## | 2016-08-01 | 00:00:00 | NA | "closed" | "2016-09-01 00:00:00" | | |
| ## | 2016-09-01 | 00:00:00 | NA | "closed" | "2016-10-03 00:00:00" | | |
| ## | 2016-12-01 | 00:00:00 | NA | "closed" | "2017-01-03 00:00:00" | | |
| ## | 2017-03-01 | 00:00:00 | NA | "closed" | "2017-04-03 00:00:00" | | |
| ## | 2017-12-01 | 00:00:00 | NA | "closed" | "2018-01-02 00:00:00" | | |
| ## | 2018-02-01 | 00:00:00 | NA | "closed" | "2018-03-01 00:00:00" | | |
| ## | 2018-05-01 | 00:00:00 | NA | "closed" | "2018-06-01 00:00:00" | | |
| ## | 2018-10-01 | 00:00:00 | NA | "closed" | "2018-11-01 00:00:00" | | |
| ## | | | Prefer | Order.Set | Txn.Fees | Rule | Time.In.Force |
| ## | 2004-05-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2004-07-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2005-06-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2005-07-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2007-03-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2007-04-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2008-08-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2008-12-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2010-02-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2010-08-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2010-12-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2011-03-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2011-04-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2011-05-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2011-10-03 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2012-03-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |
| ## | 2012-04-02 | 00:00:00 | "Open" | "ocolong" | "txnc" | "enterLONG" | "" |
| ## | 2012-08-01 | 00:00:00 | "Open" | "ocolong" | "txnc" | "exitLONG" | "" |

```

## 2013-02-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2013-10-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2014-01-02 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2014-04-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2014-11-03 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2015-05-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2015-08-03 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2016-01-04 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2016-02-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2016-04-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2016-08-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2016-09-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2016-12-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2017-03-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2017-12-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2018-02-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
## 2018-05-01 00:00:00 "Open" "ocolong" "txnc" "enterLONG" ""
## 2018-10-01 00:00:00 "Open" "ocolong" "txnc" "exitLONG" ""
##
##
## attr(,"class")
## [1] "order_book"

```