Assignment 2

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Bond University
Financial Trading Systems

Contents

Exchange Traded Funds

ETFs are an investment fund that tracks a particular set of stocks, markets, or index's. They are traded on stock exchanges the same way as a regular security. Most ETFs in Australia are passive, meaning that they simply track the performance of a group of stocks, there are also less common Active ETFs. Fund managers in charge of Active ETFs attempt to outperform the underlying set of securities (ASIC, 2017). For this report we will only be using passive ETFs.

According to the ETF investment strategy guide published by VanEck Investments, ETFs have five key benefits (VanEck Investments Limited):
1. Liquidity. ETFs are highly liquid instruments meaning they are easy to purchase and sell.
2. Transparency - Investors know exactly which stocks are being held in their portfolios and how each is performing in the market.
3. Low cost - Compared to investing in an actively managed fund, passive ETFs are relatively low cost investments as they only track an index and do not attempt to outperform which lowers the management costs.
4. Flexibility - Since ETFs are traded on a stock exchange such as the ASX, investors can more easily adjust their risk exposure to a certain industry by simply selling their shares.
5. Taxation Advantages - ETFs have lower taxes since they are instruments traded on a stock exchange, as opposed to managed funds.

Momentum Trading

Momentum trading has been present in the ASX since its inception and only suffered from a brief suspension during the global financial crisis (Vanstone & Hahn, 2015). Momentum trading suggests that purchasing winning stocks and selling losers will generate a significant positive return (Jegadeesh & Titman, 1993).

Strategy

To test the momentum theory we will use two momentum indicators, Gerald Appeal's moving average convergence divergence (MACD) and J. Welles Wilder's relative strength indicator (RSI). We will begin by analysing each strategy using only a long position with with transaction costs. We will then take the better performing strategy and attempt to optimize it to increase returns.

Moving Average Convergence Divergence (MACD)

The MACD strategy works by subtracting two exponential moving averages (EMAs) from one another and using a third EMA as a signal line. When the MACD line crosses above zero it indicates that in instrument is trending upwards, alternatively when it crosses below zero it indicates that the instrument is trending downwards. Using Quantsrat we can examine if it would be a successful trading strategy to use this information for entry and exit points. We will first test the strategy by only going long when the MACD crosses above zero.

Relative Strenght Index (RSI)

The RSI is a measure of the speed and change of an instrument's price movements. The strategy states that when an instrument's RSI is below 30 it is being oversold and its price is expected to increase as it is being undervalued, alternatively when it has an RSI above 70 it is being overbought and its price is expected to

drop as it is overvalued. The 70/30 markers can be adjusted to suit different trading strategies but we will use these markers as they were the ones first established by Wilder is his book 'New Concepts in Technical Trading Systems (1978)'. We will calculate RSI over a 14 day period and will long an instrument if its RSI falls below 30 and short if it rises above 70. As with our MACD strategy will only look at going long for our first analysis to obtain a baseline result.

Instruments

Seven different ETFs were used for the analysis in order to rule out any industry specific factors, they are:
IOZ: Tracks the movements of the S&P/ASX 200. This ETF is being used to examine how our trading strategies work on large cap stocks.
MVB: Tracks the MVIS Australian banks index. We are using this ETF to examine the performance of our strategies on Australia's largest banking institutions.
MVR: Tracks the MVIS Australia Energy & Mining Index. This ETF is being used as the energy and mining sector are heavily reliant on commodity prices and will tell us how well our strategies work on this highly volatile market.
QFN: Tracks financial companies in the ASX 200. Where MVB tracks only banks, QFN also tracks insurance companies which make up 10.4% of the total tracked sectors.
QRE: Tracks the resources sector, specifically metals. Since MVR only tracks the mining companies themselves, QRE is being included to introduce exposure the the underlying commodity pricing.
VLC: Tracks the performance of the largest companies in Australia. This ETF is being included to contrast VSO.
VSO: Tracks the performance of the smallest companies in Australia. Since most of the ETFs being used track mainly the larger companies, VSO will demonstrate how the trading strategies perform for small cap stocks.

Transaction Costs

Since this strategy is being viewed from the perspective of an everyday investor, we will be using transaction costs that mimic what they would be paying in the real world. We have chosen to use Commonwealth Bank's brokerage fee schedule which is as follows:
$10.00 (Up to and including $1,000)
$19.95 (Over $1,000 up to $10,000 (inclusive))
$29.95 (Over $10,000 up to $25,000 (inclusive))
0.12% (Over $25,000)
(Commonwealth Bank of Australia, n.d.)

Step 1: Testing initialisation

In this step we will prepare all the data we will need for the testing

1A Global Variables

Define our currency, date range, timezone, and starting capital.

```
suppressMessages(library(quantstrat))
currency('AUD')
```

```
## [1] "AUD"
```

```
#Set the timezone
Sys.setenv(TZ='UTC')
#Set the start, end, and initialisation dates
start = '2000-01-01'
end = '2017-12-31'
init = '1999-12-31'
date_range = '2000::2017'
#Create our portfolio and account names
MACD_port = 'MACD Port'
MACD_acct = 'MACD Account'
MACD_strat_name = 'MACD Strategy'

RSI_port = 'RSI Port'
RSI_acct = 'RSI Account'
RSI_strat_name = 'RSI Strategy'

BH_port = 'Buy and Hold Portfolio'
BH_acct = 'Buy and Hold Account'
#Set our starting capital
starting_cap = 1000000
```

1B Load Data

Load in the ETF data that was sourced from Bloomberg

```
library(INFT361Course)
#Define our directory
symbol_directory = 'C:\\Users\\eoinf\\Documents\\ETF (1)\\'
#symbol_directory = 'D:\\Documents\\ETF\\'
#Get all symbols in that directory
symbol_list = GetCourseDirList(symbol_directory)

#Load in each symbol
for (symbol in symbol_list){
  symbol_name = symbol
  LoadCourseFile(symbol_directory, symbol, dates= date_range)
  #Display which stock has been loaded
  print(sprintf('%s now loaded', symbol_name))
  #Define the instrument as a stock
  stock(symbol_list, currency = 'AUD')
```

```
  symbol = get(symbol)
}
```

```
## [1] "IOZ.csv now loaded"
## [1] "MVB.csv now loaded"
## [1] "MVR.csv now loaded"
## [1] "QFN.csv now loaded"
## [1] "QRE.csv now loaded"
## [1] "VLC.csv now loaded"
## [1] "VSO.csv now loaded"
```

1C Create Portfolios and Accounts

Create our portfolios and accounts

```
#Remove any existing stratagies with the same name to avoid errors
rm.strat(c(MACD_strat_name, RSI_strat_name))
suppressWarnings(rm("account.MACD Account","portfolio.MACD Port",pos=.blotter))
suppressWarnings(rm("account.RSI Account","portfolio.RSI Port",pos=.blotter))
suppressWarnings(rm("account.Buy and Hold Account","portfolio.Buy and Hold Portfolio",pos=.blotter))
suppressWarnings(rm("order_book.MACD Port",pos=.strategy))
suppressWarnings(rm("order_book.RSI Port",pos=.strategy))
suppressWarnings(rm("order_book.Buy and Hold Portfolio",pos=.strategy))

#Create the three portfolios
initPortf(MACD_port, symbol_list, initDate = init, currency = 'AUD')
```

```
## [1] "MACD Port"
```

```
initPortf(RSI_port, symbol_list, initDate = init, currency = 'AUD')
```

```
## [1] "RSI Port"
```

```
initPortf(BH_port, symbol_list, initDate = init, currency = 'AUD')
```

```
## [1] "Buy and Hold Portfolio"
```

```
#Create the three accounts
initAcct(MACD_acct, portfolios = MACD_port, initDate = init, initEq = starting_cap, currency = 'AUD')
```

```
## [1] "MACD Account"
```

```
initAcct(RSI_acct, portfolios = RSI_port, initDate = init, initEq = starting_cap, currency = 'AUD')
```

```
## [1] "RSI Account"
```

```
initAcct(BH_acct, portfolios = BH_port, initDate = init, initEq = starting_cap, currency = 'AUD')
```

```
## [1] "Buy and Hold Account"
```

```
initOrders(portfolio = MACD_port,initDate = init)
initOrders(portfolio = RSI_port,initDate = init)
initOrders(portfolio = BH_port,initDate = init)

#Create the two strategies
strategy(MACD_strat_name, store = TRUE)
MACD_strat = getStrategy(MACD_strat_name)
```

```
strategy(RSI_strat_name, store = TRUE)
RSI_strat = getStrategy(RSI_strat_name)

#Verify that the strategies have been created
summary(MACD_strat)
```

```
##             Length Class  Mode
## name        1      -none- character
## assets      0      -none- NULL
## indicators  0      -none- list
## signals     0      -none- list
## rules       1      -none- list
## constraints 0      -none- NULL
## init        0      -none- list
## wrapup      0      -none- list
## trials      1      -none- numeric
## call        3      -none- call
```

```
summary(RSI_strat)
```

```
##             Length Class  Mode
## name        1      -none- character
## assets      0      -none- NULL
## indicators  0      -none- list
## signals     0      -none- list
## rules       1      -none- list
## constraints 0      -none- NULL
## init        0      -none- list
## wrapup      0      -none- list
## trials      1      -none- numeric
## call        3      -none- call
```

1D Global Functions

Create the functions that will be used for both strategies (Order volume and transaction costs)

```
os_naive_order = function (data, timestamp, orderqty, ordertype, orderside, portfolio, account, symbol,
  #Format the date-timestamp to be in an xts format
  date = format(timestamp, '%Y-%m-%d')
  #Update the portfolio and equity on this date
  updatePortf(Portfolio = portfolio,Symbol = symbol,Dates = date)
  updateAcct(account,Dates = date)
  updateEndEq(account,Dates = date)
  #Find currenty position and equity
  pos = getPosQty(portfolio, Symbol = symbol, Date = date)
  equity = getEndEq(account, date)

  #Get the close price of the instrument on this date
  close_price = getPrice(get(symbol))[date]
  #How large of a position can be taken using the naive approach
  max_position = as.numeric(trunc((equity/length(symbols))/close_price))

  #Only purchase if we have no position
  if (pos == 0)
```

```
    {
    os_naive_order = max_position
  }
  else{
    os_naive_order = 0
  }
}

transaction_costs = function(TxnQty, TxnPrice, Symbol){

  #Find the value of the order
  order_value = abs(TxnQty) * TxnPrice
  #Return the transaction costs
  if(order_value <= 1000)
    return(-10.00)
  if(order_value <=10000)
    return(-19.95)
  if(order_value <= 25000)
    return(-29.95)
  #If greater than 25000
  return(-0.12/100 * order_value)
}
```

1E Long Only Indicators, Signals, And Rules

Create the long entry and exit rules for the two strategy's. The short selling and stop loss rules will be added at a later stage

```
#Add the MACD Indicator
add.indicator(strategy = MACD_strat_name, name = 'MACD',arguments = list(x = quote(Cl(mktdata)), nfast =
```

```
## [1] "MACD Strategy"
```

```
#Add the MACD long entry signal
add.signal(MACD_strat_name, name= 'sigThreshold', arguments = list(column = 'signal.MACD_Column', relati
```

```
## [1] "MACD Strategy"
```

```
#Add the MACD long exit signal
add.signal(MACD_strat_name, name= 'sigThreshold', arguments = list(column = 'signal.MACD_Column', relati
```

```
## [1] "MACD Strategy"
```

```
#Add the MACD long entry rule
add.rule(MACD_strat_name, name = 'ruleSignal', arguments = list(sigcol = 'MACD_long_entry', sigval = TRU
```

```
## [1] "MACD Strategy"
```

```
#Add the MACD long exit rule
add.rule(MACD_strat_name, name = 'ruleSignal', arguments = list(sigcol = 'MACD_long_exit', sigval = TRUE
```

```
## [1] "MACD Strategy"
```

```
#Add the RSI Indicator
add.indicator(strategy = RSI_strat_name, name = 'RSI', arguments = list(price = quote(Cl(mktdata)), n =
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long entry signal
add.signal(RSI_strat_name, name = 'sigThreshold', arguments = list(threshold = 30, column = 'EMA.RSI_Co
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long exit signal
add.signal(RSI_strat_name, name = 'sigThreshold', arguments = list(threshold = 70, column = 'EMA.RSI_Co
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long entry rule
add.rule(RSI_strat_name, name = 'ruleSignal', arguments = list(sigcol = 'RSI_long_entry', sigval = TRUE
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long exit rule
add.rule(RSI_strat_name, name = 'ruleSignal', arguments = list(sigcol = 'RSI_long_exit', sigval = TRUE,
```

```
## [1] "RSI Strategy"
```

```
MACD_strat = getStrategy(MACD_strat_name)
RSI_strat = getStrategy(RSI_strat_name)
summary(MACD_strat)
```

```
##             Length Class  Mode
## name        1      -none- character
## assets      0      -none- NULL
## indicators  1      -none- list
## signals     2      -none- list
## rules       3      -none- list
## constraints 0      -none- NULL
## init        0      -none- list
## wrapup      0      -none- list
## trials      1      -none- numeric
## call        3      -none- call
```

```
summary(RSI_strat)
```

```
##             Length Class  Mode
## name        1      -none- character
## assets      0      -none- NULL
## indicators  1      -none- list
## signals     2      -none- list
## rules       3      -none- list
## constraints 0      -none- NULL
## init        0      -none- list
## wrapup      0      -none- list
## trials      1      -none- numeric
## call        3      -none- call
```

Step 2: Test Strategies

In this section we will test the long strategies for both the MACD and RSI indicators

2A Test Long Only MACD

Test MACD

```
#Apply the strategy
applyStrategy(strategy = MACD_strat, portfolios = MACD_port, account = MACD_acct, verbose = FALSE)
#Update the portfolio, account, and equity
updatePortf(MACD_port)
```

```
## [1] "MACD Port"
```

```
updateAcct(MACD_acct)
```

```
## [1] "MACD Account"
```

```
updateEndEq(MACD_acct)
```

```
## [1] "MACD Account"
```

2B Test Long Only RSI

Test RSI

```
#Apply the strategy
applyStrategy(strategy = RSI_strat, portfolios = RSI_port, account=RSI_acct, verbose = FALSE)
#Update the portfolio, account, and equity
updatePortf(RSI_port)
```

```
## [1] "RSI Port"
```

```
updateAcct(RSI_acct)
```

```
## [1] "RSI Account"
```

```
updateEndEq(RSI_acct)
```

```
## [1] "RSI Account"
```

Step 3: Analyse Results

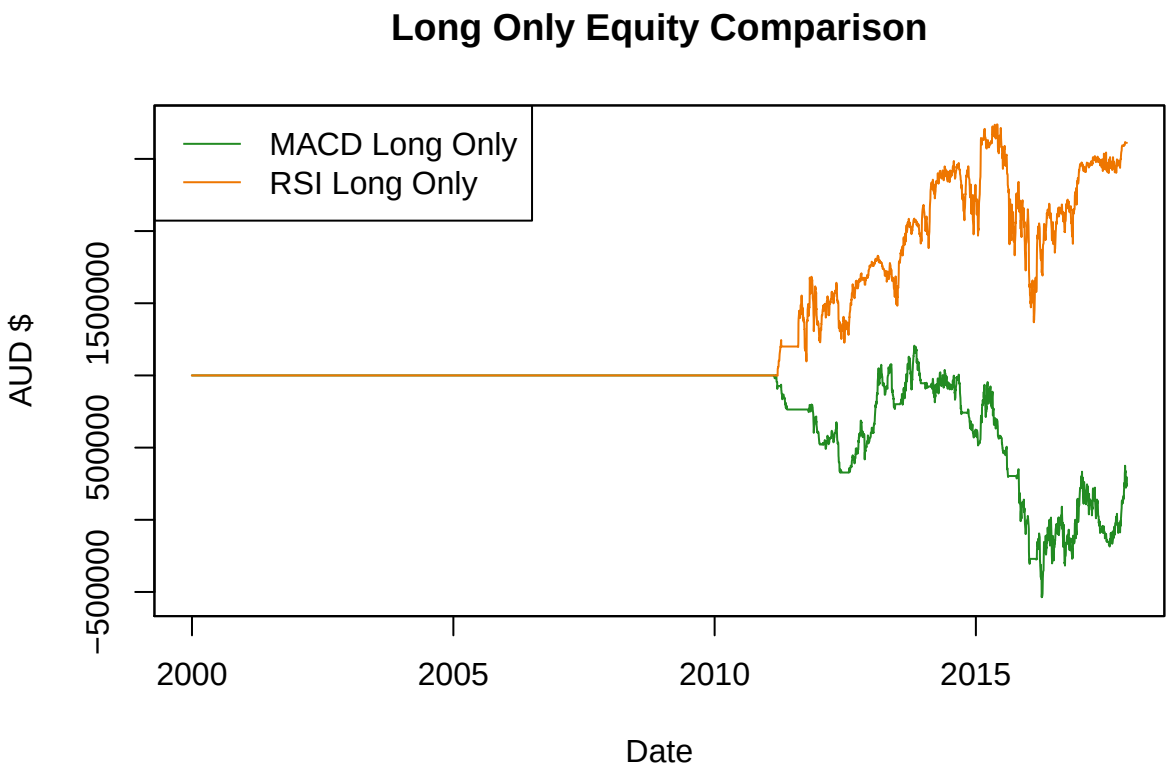
3A Compare Long Only Results

Compare the strategies

```
library(PerformanceAnalytics)
#Find the MACD account equity
MACD_acct_equity = getAccount(MACD_acct)$summary$End.Eq

#Find the RSI account equity
RSI_acct_equity = getAccount(RSI_acct)$summary$End.Eq
#Find the RSI account returns
RSI_returns = Return.calculate(RSI_acct_equity, 'log')
#Rename the column head
colnames(RSI_returns) = 'RSI Strategy'
#Display the performance tables
RSI_perf = table.Arbitrary(RSI_returns, metrics=c("Return.cumulative", "Return.annualized","SharpeRatio
                           metricsNames=c("Cumulative Return", "Annualized Return", "Annualized Sharpe

RSI_perf
```

```
##                          RSI Strategy
## Cumulative Return          0.93016703
## Annualized Return          0.09879138
## Annualized Sharpe Ratio    0.33567396
## Calmar Ratio               0.18324176
```

```
#Merge the two account equities into one dataframe
equ = merge(MACD_acct_equity, RSI_acct_equity, all=FALSE)
#Rename the columns
colnames(equ) = c('MACD Long Only', 'RSI Long Only')
#Create an equity table
plot.zoo(equ,plot.type="single",col=c('forestgreen','darkorange2'),main="Long Only Equity Comparison",xl
#Add a legend
legend(x="topleft",legend=colnames(equ),col=c('forestgreen','darkorange2'),lty=1)
```




```
end_equity = merge(MACD_acct_equity[length(MACD_acct_equity)], RSI_acct_equity[length(RSI_acct_equity)]]
colnames(end_equity) = c('MACD End', 'RSI End')
MACD_profit = MACD_acct_equity[length(MACD_acct_equity)] - 1000000
RSI_profit = RSI_acct_equity[length(RSI_acct_equity)] - 1000000
profits = merge(MACD_profit, RSI_profit)
colnames(profits) = c('MACD Profit', 'RSI Profit')
end_equity
```

```
##            MACD End RSI End
## 2017-11-22 294113.6 2611046
```

```
profits
```

```
##            MACD Profit RSI Profit
## 2017-11-22   -705886.4    1611046
```

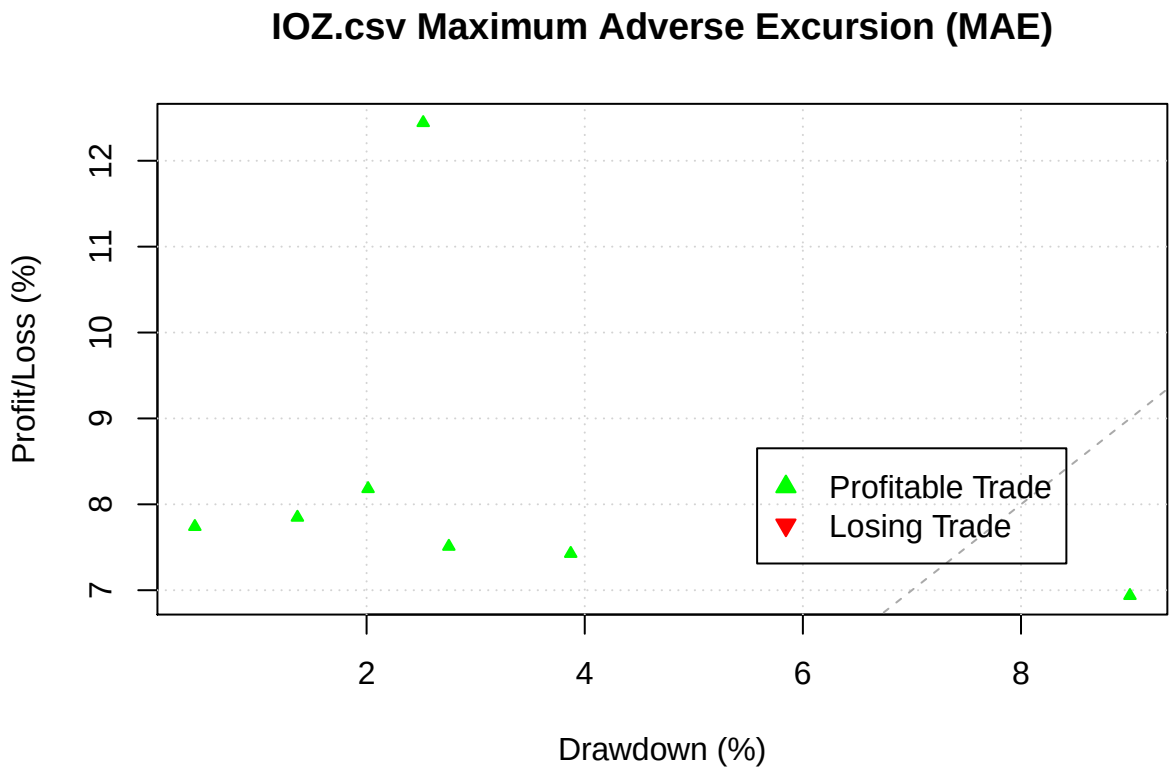
The RSI trading strategy clearly outperforms the MACD from a purely long only approach. Investors would have made 1,611,046 using this approach, opposed to a loss of 705,886. Therefore we will attempt to optimize the RSI strategy.

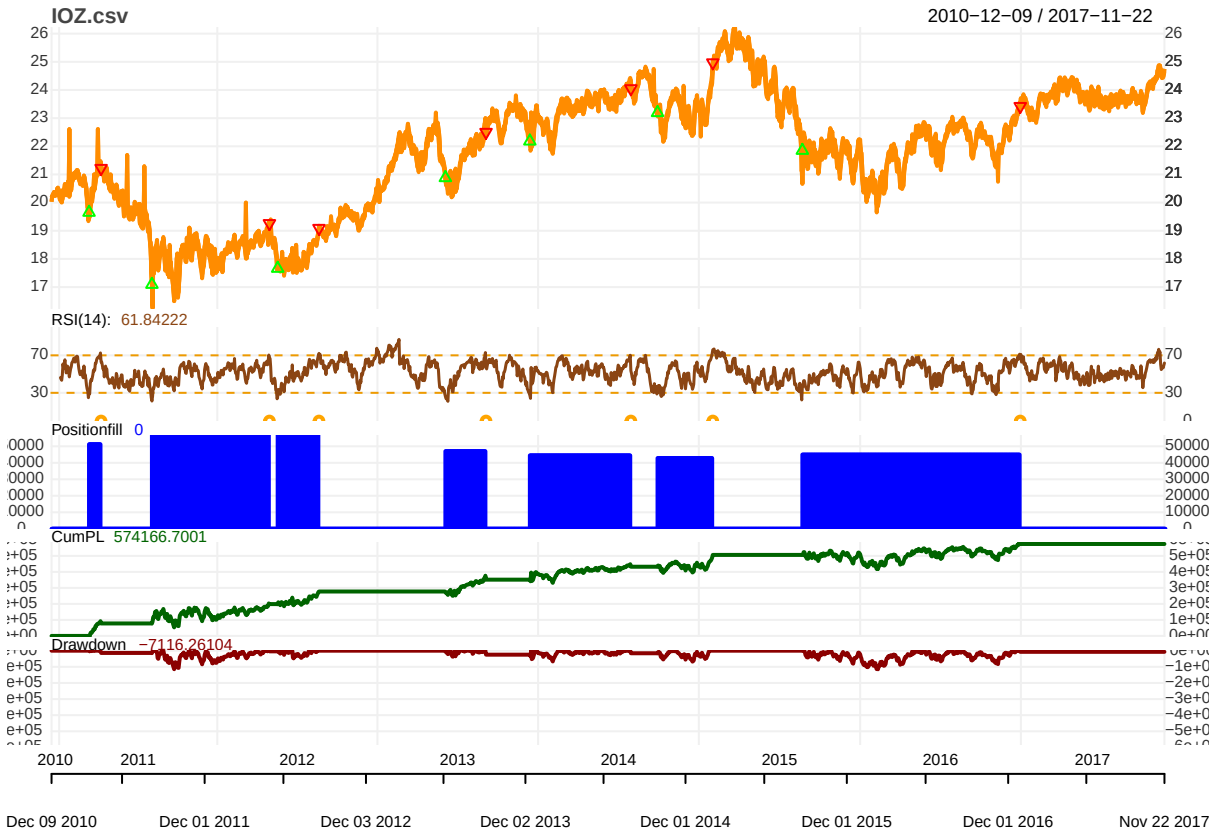
Step 4: Optimize

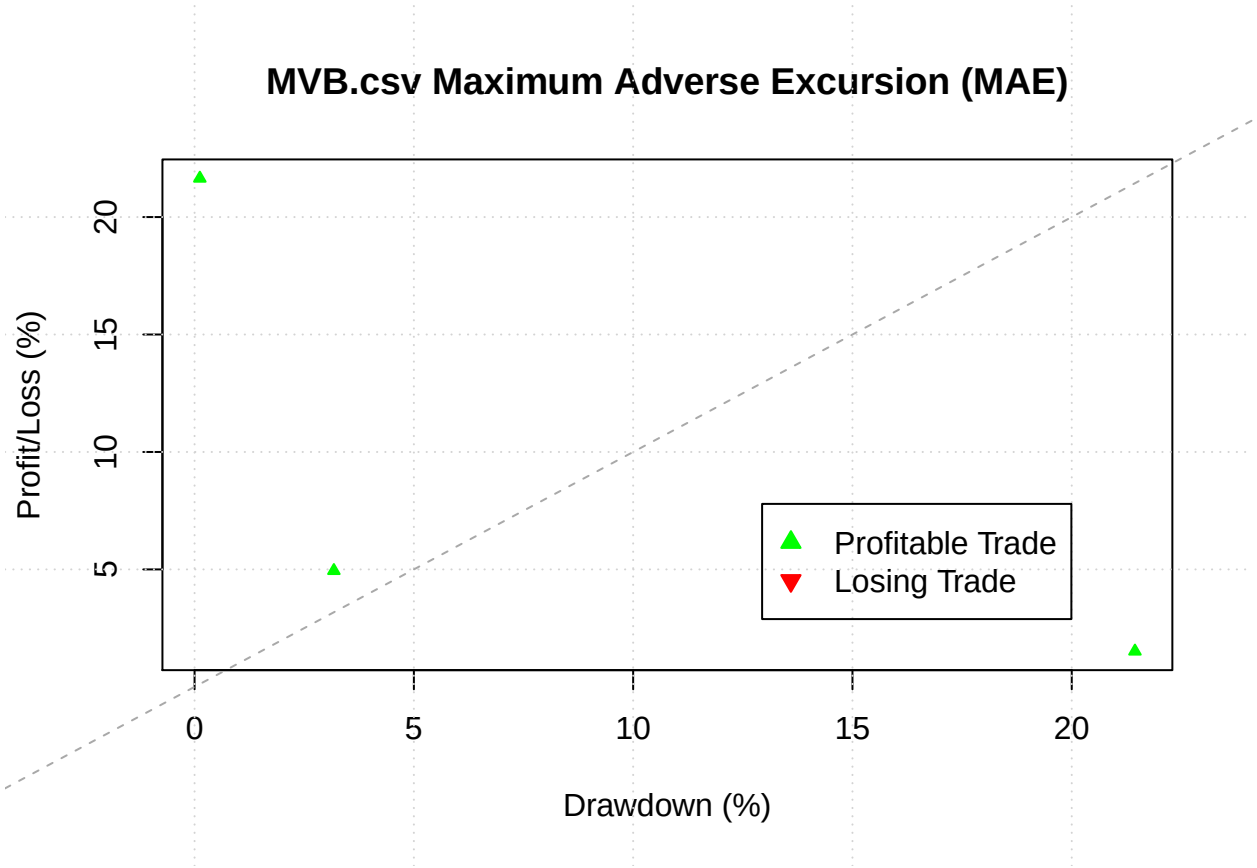
To optimize our RSI trading strategy, we will analyse the effect of adding a stop loss order at a specified percentage below our purchase price. Once we have attempted to optimize our strategy we will compare it against the performance of the long only strategy and the performance of a buy and hold portfolio.

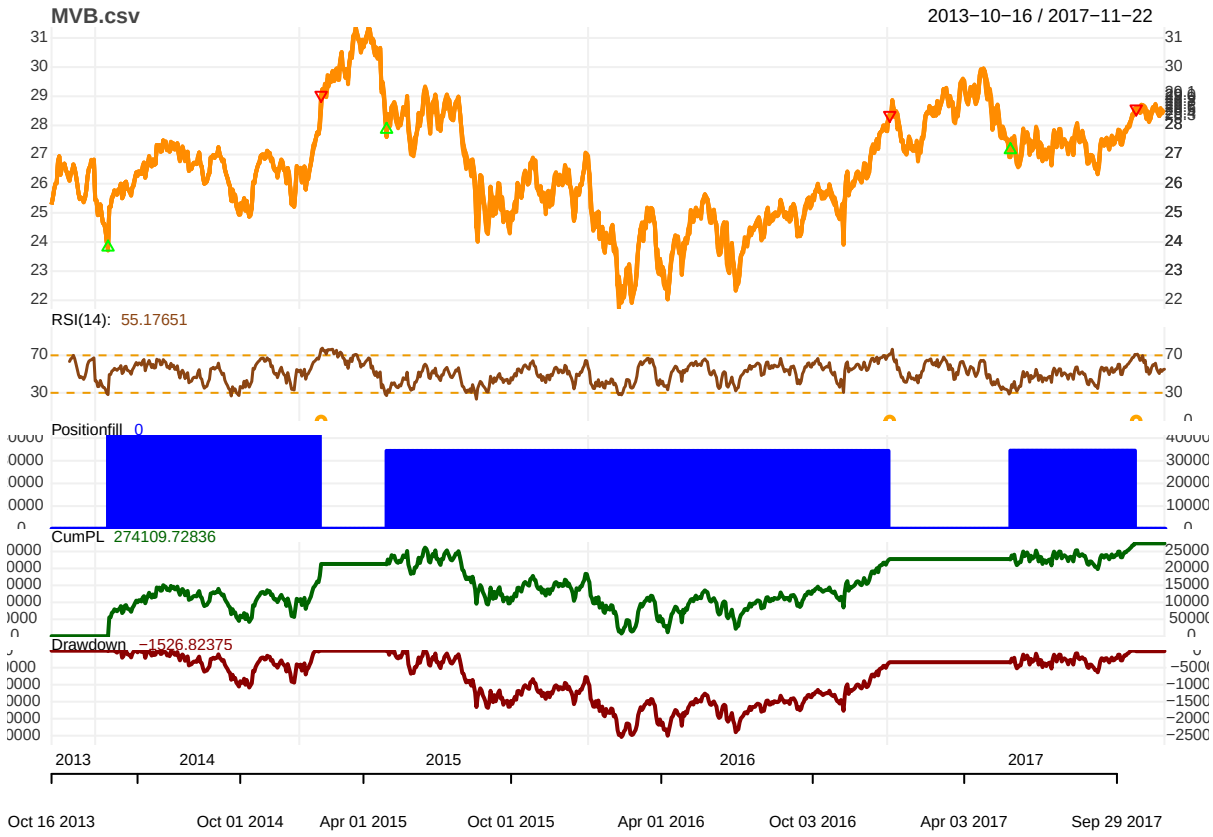
4A What we are trying to improve

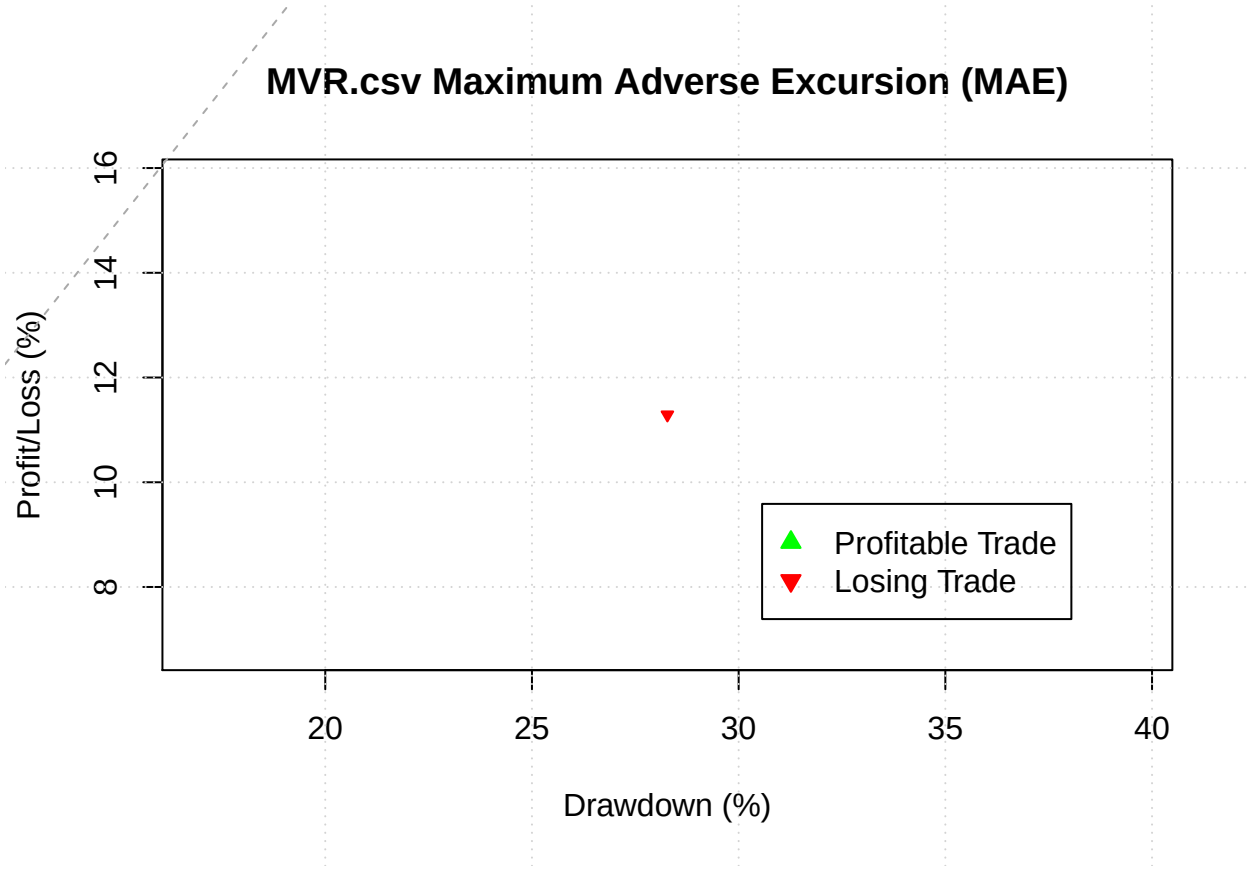
```
par(mfrow=c(1,1))
#Display the maximum adverse excursion and trades for each symbol
for (symbol in symbol_list){
  chart.ME(Portfolio = RSI_port, Symbol = symbol, type = 'MAE', scale = 'percent')
  chart.Posn(RSI_port,Symbol=symbol,type='line', TA = 'add_RSI(n=14)')
}
```

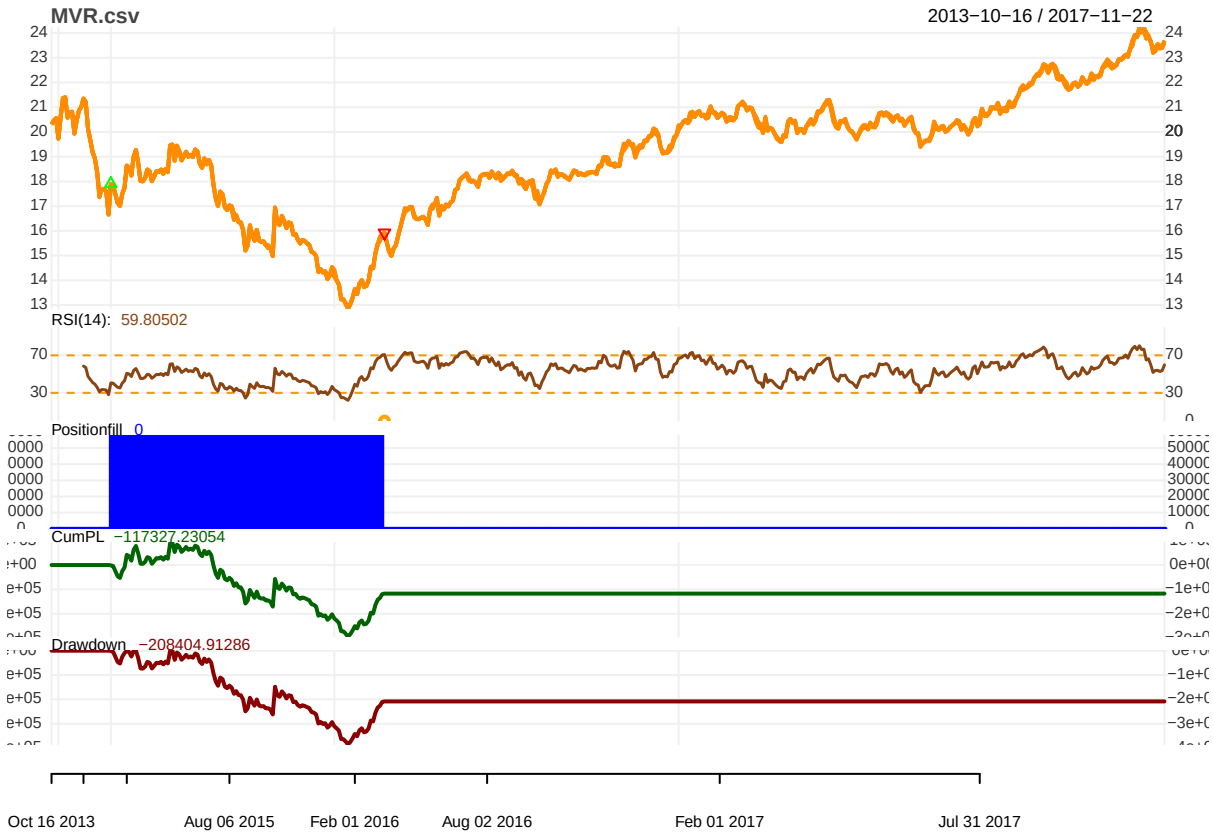


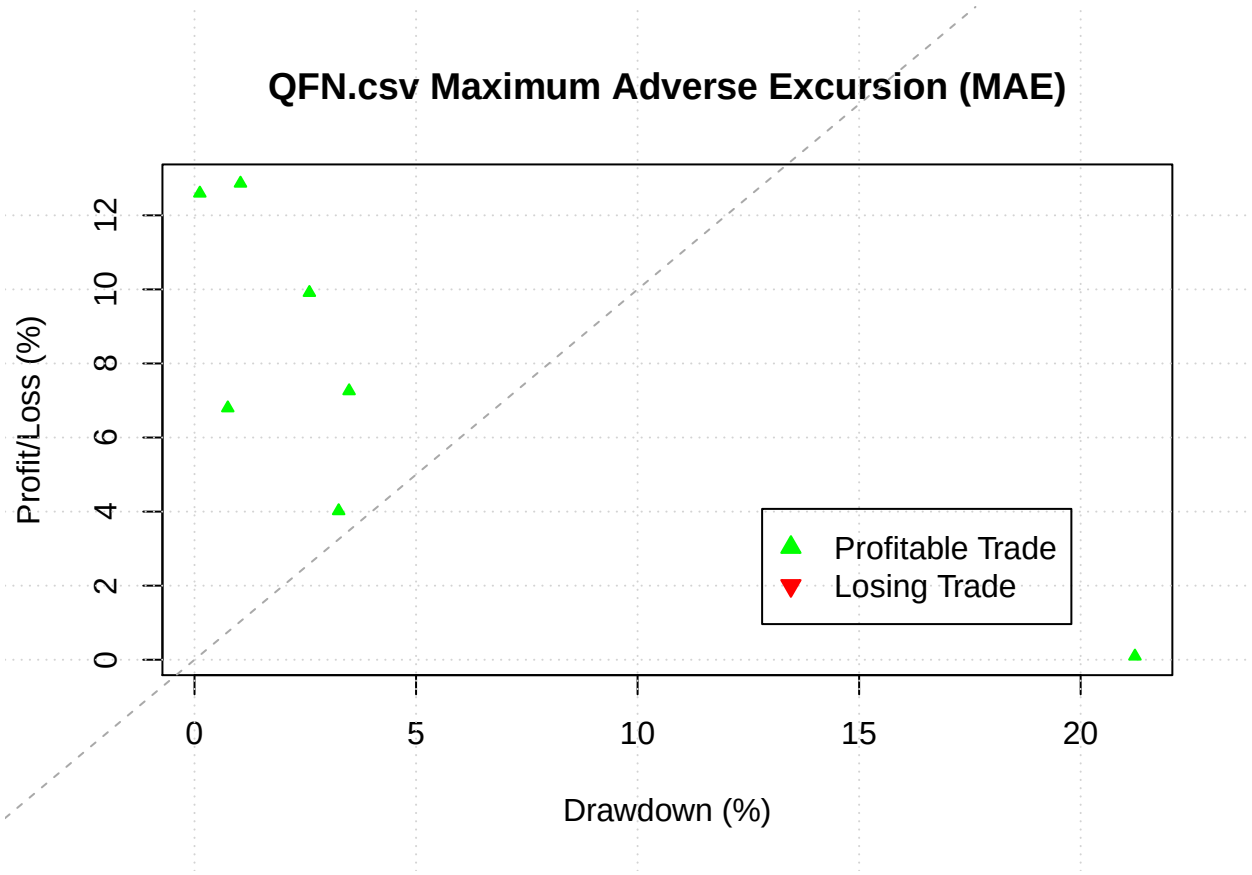

IOZ.csv
2010−12−09 / 2017−11−22
RSI(14): 61.84222
Positionfill 0
CumPL 574166.7001
Drawdown −7116.26104
2010
2011
2012
2013
2014
2015
2016
2017
Dec 09 2010
Dec 01 2011
Dec 03 2012
Dec 02 2013
Dec 01 2014
Dec 01 2015
Dec 01 2016
Nov 22 2017

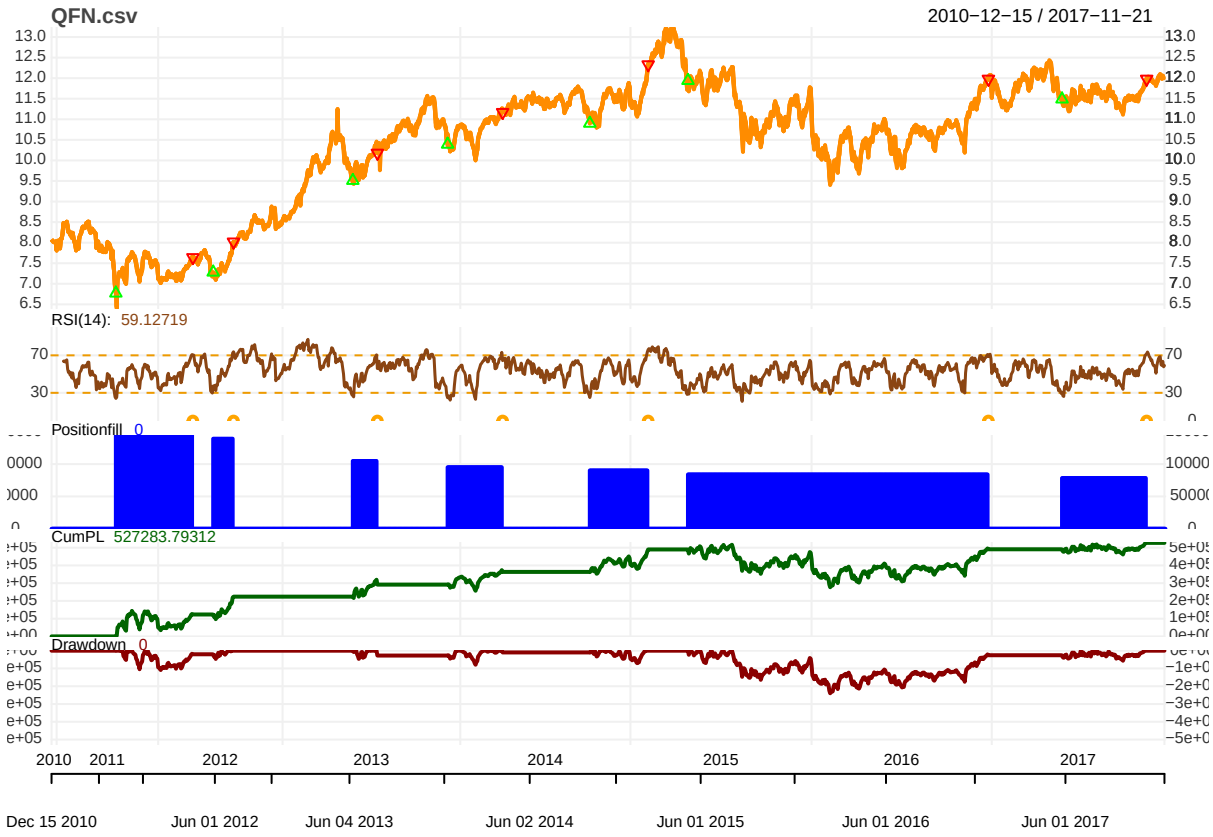

MVB.csv Maximum Adverse Excursion (MAE)
Profit/Loss (%)
5
10
15
20
0
5
10
15
20
Drawdown (%)
Profitable Trade
Losing Trade

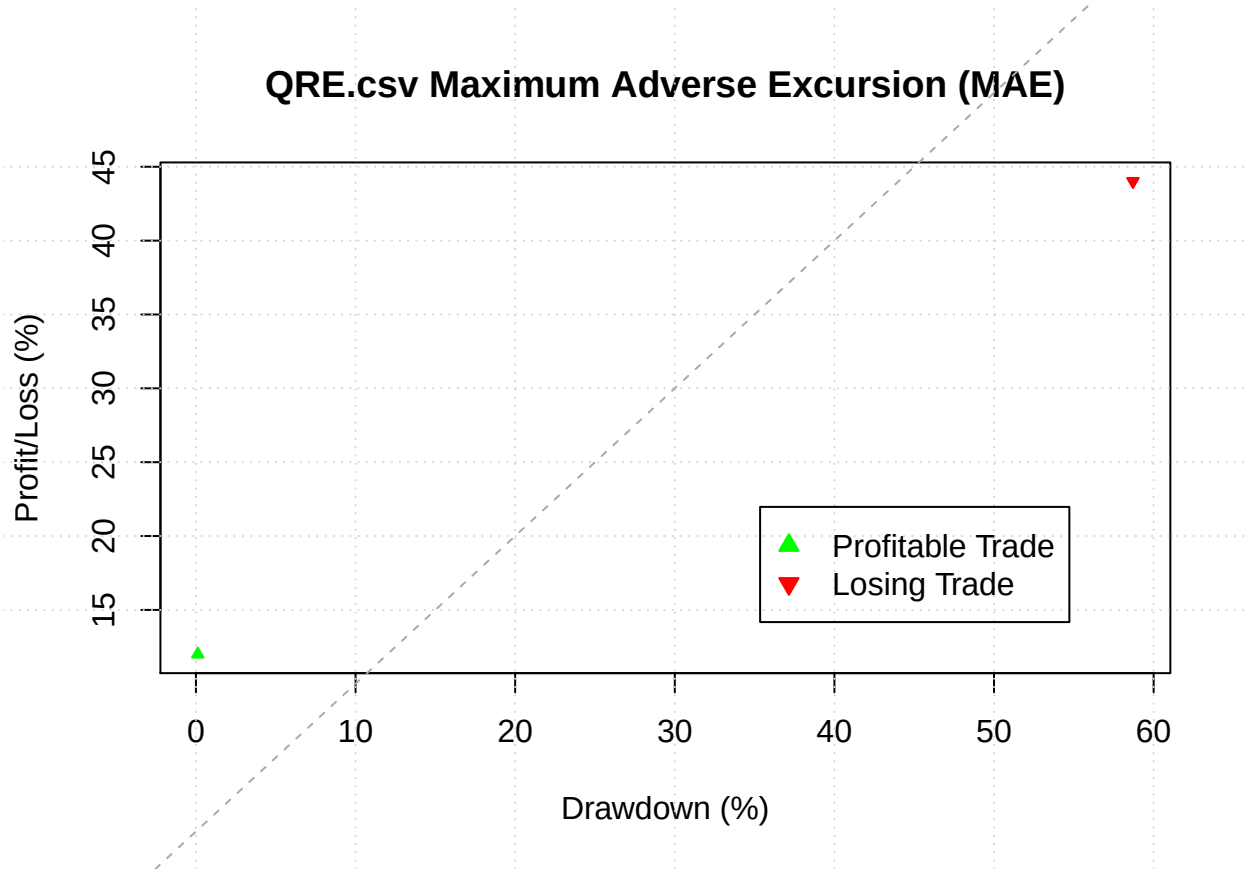

MVB.csv
2013−10−16 / 2017−11−22
RSI(14): 55.17651
Positionfill 0
CumPL 274109.72836
Drawdown −1526.82375
2013
2014
2015
2016
2017
Oct 16 2013
Oct 01 2014
Apr 01 2015
Oct 01 2015
Apr 01 2016
Oct 03 2016
Apr 03 2017
Sep 29 2017


MVR.csv Maximum Adverse Excursion (MAE)
Profit/Loss (%)
16
14
12
10
8
20
25
30
35
40
Drawdown (%)
Profitable Trade
Losing Trade

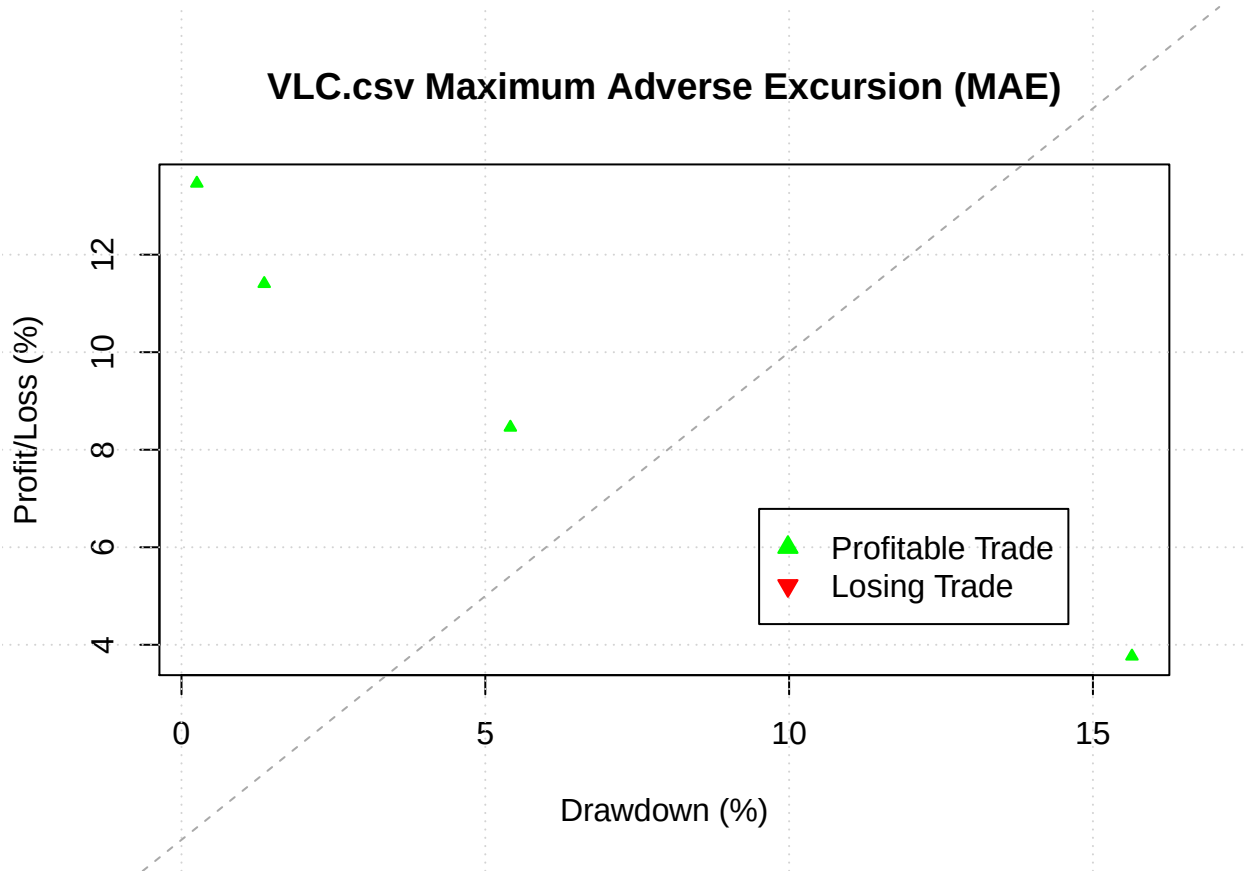

MVR.csv
2013−10−16 / 2017−11−22
RSI(14): 59.80502
Positionfill 0
CumPL −117327.23054
Drawdown −208404.91286
Oct 16 2013
Aug 06 2015
Feb 01 2016
Aug 02 2016
Feb 01 2017
Jul 31 2017

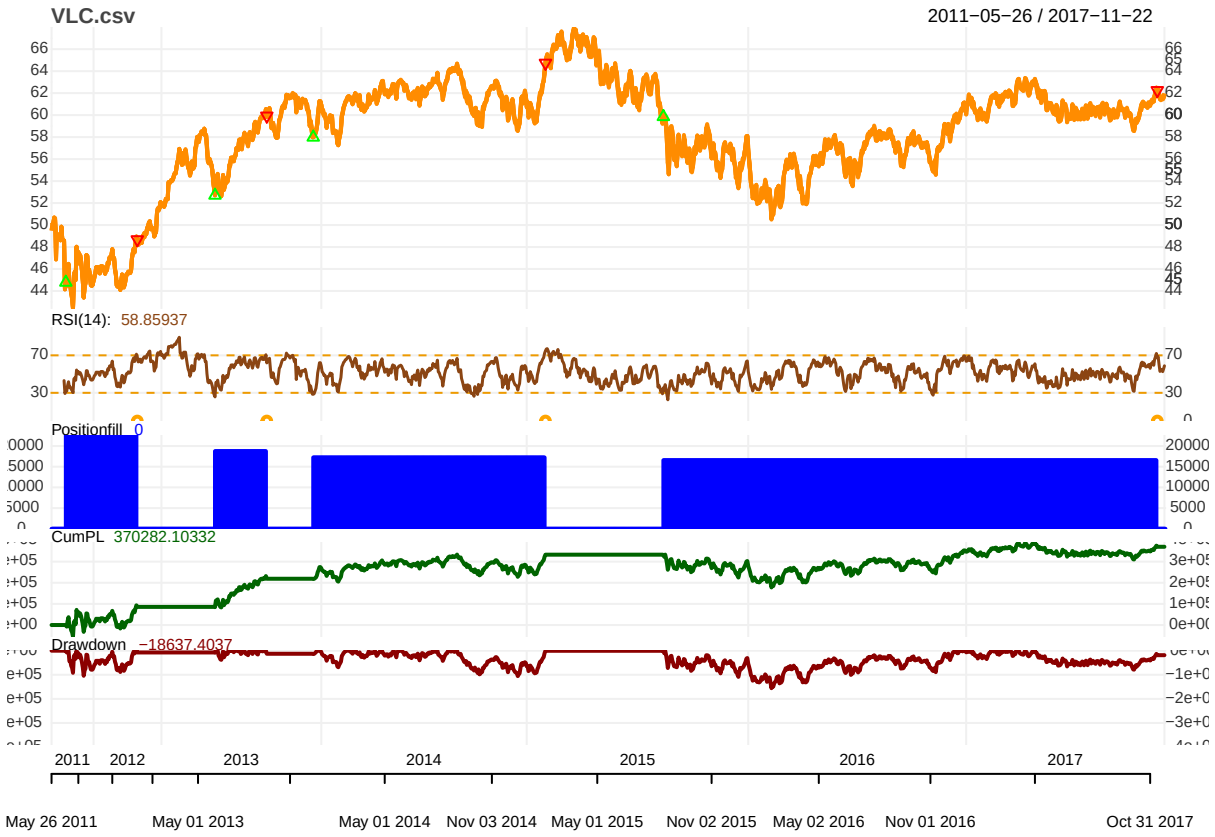

QFN.csv Maximum Adverse Excursion (MAE)
Profit/Loss (%)
0
2
4
6
8
10
12
0
5
10
15
20
Drawdown (%)
Profitable Trade
Losing Trade

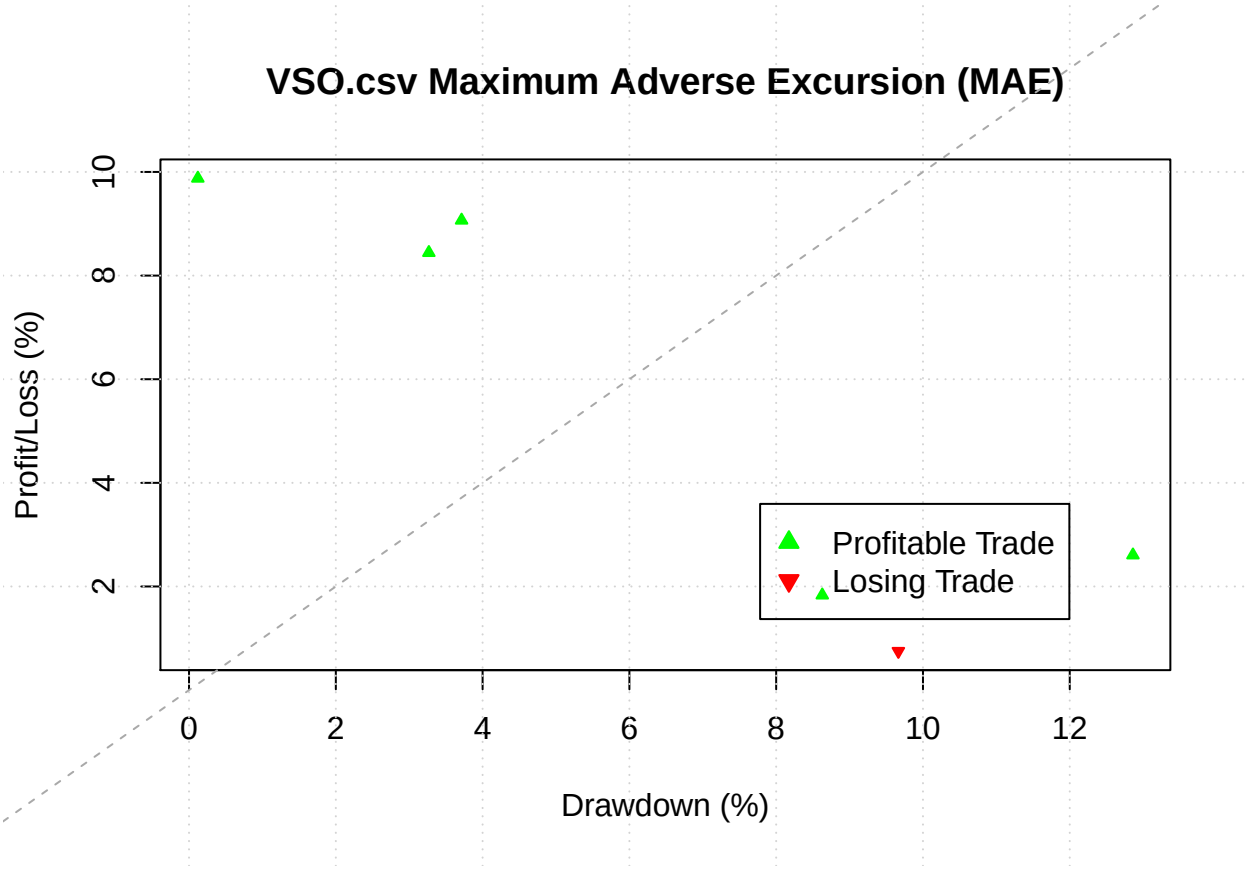

QFN.csv
2010−12−15 / 2017−11−21
RSI(14): 59.12719
Positionfill 0
CumPL 527283.79312
Drawdown 0
2010
2011
2012
2013
2014
2015
2016
2017
Dec 15 2010
Jun 01 2012
Jun 04 2013
Jun 02 2014
Jun 01 2015
Jun 01 2016
Jun 01 2017


QRE.csv Maximum Adverse Excursion (MAE)
Profit/Loss (%)
15
20
25
30
35
40
45
0
10
20
30
40
50
60
Drawdown (%)
Profitable Trade
Losing Trade


QRE.csv
2010−12−15 / 2017−11−22
RSI(14): 59.45276
Positionfill 0
CumPL −305643.72662
Drawdown −476494.34011
2010
2011
2012
2013
2014
2015
2016
2017
Dec 15 2010
Dec 05 2011
Jun 05 2013
Jun 04 2014
Jun 01 2015
Jun 01 2016
Jun 01 2017
Nov 22 2017


VLC.csv Maximum Adverse Excursion (MAE)
Profit/Loss (%)
4
6
8
10
12
0
5
10
15
Drawdown (%)
Profitable Trade
Losing Trade


VLC.csv
2011−05−26 / 2017−11−22
RSI(14): 58.85937
Positionfill 0
CumPL 370282.10332
Drawdown −18637.4037
2011
2012
2013
2014
2015
2016
2017
May 26 2011
May 01 2013
May 01 2014
Nov 03 2014
May 01 2015
Nov 02 2015
May 02 2016
Nov 01 2016
Oct 31 2017


VSO.csv Maximum Adverse Excursion (MAE)
Profit/Loss (%)
2
4
6
8
10
0
2
4
6
8
10
12
Drawdown (%)
Profitable Trade
Losing Trade


```
#Trade stats for each symbol
trade_stats = tradeStats(Portfolio=RSI_port)
#Display results
t(trade_stats)
```

```
##                   IOZ.csv       MVB.csv       MVR.csv       QFN.csv
## Portfolio         "RSI Port"    "RSI Port"    "RSI Port"    "RSI Port"
## Symbol            "IOZ.csv"     "MVB.csv"     "MVR.csv"     "QFN.csv"
## Num.Txns          "14"          " 6"          " 2"          "14"
## Num.Trades        "7"           "3"           "1"           "7"
## Net.Trading.PL    " 574166.7"   " 274109.7"   "-117327.2"   " 527283.8"
## Avg.Trade.PL      "  83211.70"  "  92521.78"  "-116079.97"  "  76503.79"
## Med.Trade.PL      "  79165.19"  "  47431.94"  "-116079.97"  "  72939.31"
## Largest.Winner    "122050.6"    "214452.7"    "     0.0"    "127681.1"
## Largest.Loser     "  -1208.593" "  -1182.206" "-116079.973" "  -1216.706"
## Gross.Profits     "582481.9"    "277565.3"    "     0.0"    "535526.5"
## Gross.Losses      "      0.000" "      0.000" "-116079.973" "      0.000"
## Std.Dev.Trade.PL  " 17620.09"   "106782.01"   NA            " 46037.18"
## Std.Err.Trade.PL  "  6659.766"  " 61650.623"  NA            " 17400.419"
## Percent.Positive  "100.00000"   "100.00000"   "  0.00000"   "100.00000"
## Percent.Negative  "  0.00000"   "  0.00000"   "100.00000"   "  0.00000"
## Profit.Factor     NA            NA            " 0.0000000"  NA
## Avg.Win.Trade     " 83211.70"   " 92521.78"   NA            " 76503.79"
## Med.Win.Trade     " 79165.19"   " 47431.94"   NA            " 72939.31"
## Avg.Losing.Trade  NA            NA            "-116079.973" NA
## Med.Losing.Trade  NA            NA            "-116079.973" NA
```

```
## Avg.Daily.PL       "  83211.70"  "  92521.78"  "-116079.97"  "  76503.79"
## Med.Daily.PL       "  79165.19"  "  47431.94"  "-116079.97"  "  72939.31"
## Std.Dev.Daily.PL   " 17620.09"   "106782.01"   NA            " 46037.18"
## Std.Err.Daily.PL   "  6659.766"  " 61650.623"  NA            " 17400.419"
## Ann.Sharpe         "74.968126"   "13.754542"   NA            "26.379982"
## Max.Drawdown       "-115225.6"   "-253790.8"   "-384977.6"   "-239508.3"
## Profit.To.Max.Draw " 4.9829786"  " 1.0800616"  "-0.3047638"  " 2.2015262"
## Avg.WinLoss.Ratio  NA            NA            NA            NA
## Med.WinLoss.Ratio  NA            NA            NA            NA
## Max.Equity         "581282.96"   "275636.55"   " 91077.68"   "527283.79"
## Min.Equity         "  -4283.893" "  -1182.206" "-293899.898" "  -1177.387"
## End.Equity         " 574166.7"   " 274109.7"   "-117327.2"   " 527283.8"
##                    QRE.csv       VLC.csv       VSO.csv
## Portfolio          "RSI Port"    "RSI Port"    "RSI Port"
## Symbol             "QRE.csv"     "VLC.csv"     "VSO.csv"
## Num.Txns           " 4"          " 8"          "12"
## Num.Trades         "2"           "4"           "6"
## Net.Trading.PL     "-305643.7"   " 370282.1"   " 288175.1"
## Avg.Trade.PL       "-151627.28"  "  93768.90"  "  49129.91"
## Med.Trade.PL       "-151627.28"  " 101110.81"  "  49127.24"
## Largest.Winner     "123459.7"    "134321.4"    "101478.7"
## Largest.Loser      "-426714.260" "  -1217.120" "  -5738.964"
## Gross.Profits      "123459.7"    "375075.6"    "300518.4"
## Gross.Losses       "-426714.260" "      0.000" "  -5738.964"
## Std.Dev.Trade.PL   "389031.73"   " 41637.05"   " 42565.33"
## Std.Err.Trade.PL   "275086.977"  " 20818.523"  " 17377.223"
## Percent.Positive   " 50.00000"   "100.00000"   " 83.33333"
## Percent.Negative   " 50.00000"   "  0.00000"   " 16.66667"
## Profit.Factor      " 0.2893264"  NA            "52.3645815"
## Avg.Win.Trade      "123459.69"   " 93768.90"   " 60103.69"
## Med.Win.Trade      "123459.69"   "101110.81"   " 71477.53"
## Avg.Losing.Trade   "-426714.260" NA            "  -5738.964"
## Med.Losing.Trade   "-426714.260" NA            "  -5738.964"
## Avg.Daily.PL       "-151627.28"  "  93768.90"  "  49129.91"
## Med.Daily.PL       "-151627.28"  " 101110.81"  "  49127.24"
## Std.Dev.Daily.PL   "389031.73"   " 41637.05"   " 42565.33"
## Std.Err.Daily.PL   "275086.977"  " 20818.523"  " 17377.223"
## Ann.Sharpe         "-6.187178"   "35.750259"   "18.322733"
## Max.Drawdown       "-619322.8"   "-155612.1"   "-195675.8"
## Profit.To.Max.Draw "-0.4935128"  " 2.3795202"  " 1.4727172"
## Avg.WinLoss.Ratio  " 0.2893264"  NA            "10.4729163"
## Med.WinLoss.Ratio  " 0.2893264"  NA            "12.4547799"
## Max.Equity         "170850.61"   "388919.51"   "288175.13"
## Min.Equity         "-448472.147" " -54897.620" " -34093.550"
## End.Equity         "-305643.7"   " 370282.1"   " 288175.1"
```

The RSI trading strategy using a long only approach was incredibly successful overall. There were only four trades with a negative return. This makes it very difficult to optimize the strategy since it performed so well. Of the four trades which had a negative return, three had a maximum adverse excursion of more than 25%. We will therefore attempt to optimize the strategy by adding a stop loss at this level.

4B Create new account and portfolio

```
#Remove the existing strategy and account/portfolios
rm.strat(RSI_strat_name)
suppressWarnings(rm("account.RSI Account","portfolio.RSI Port",pos=.blotter))
suppressWarnings(rm("order_book.RSI Port",pos=.strategy))

#Create the portfolio
initPortf(RSI_port, symbol_list, initDate = init, currency = 'AUD')
```

```
## [1] "RSI Port"
```

```
#Create the account
initAcct(RSI_acct, portfolios = RSI_port, initDate = init, initEq = starting_cap, currency = 'AUD')
```

```
## [1] "RSI Account"
```

```
initOrders(portfolio = RSI_port,initDate = init)

#Verify that the strategies have been created
strategy(RSI_strat_name, store = TRUE)
RSI_strat = getStrategy(RSI_strat_name)
summary(RSI_strat)
```

```
##             Length Class  Mode
## name        1      -none- character
## assets      0      -none- NULL
## indicators  0      -none- list
## signals     0      -none- list
## rules       1      -none- list
## constraints 0      -none- NULL
## init        0      -none- list
## wrapup      0      -none- list
## trials      1      -none- numeric
## call        3      -none- call
```

4C Create the New Strategy

Since we removed the strategy in the previous step we now need to recreate it. This is where we add our stop loss to optimize our strategy.

```
#Add the RSI Indicator
add.indicator(strategy = RSI_strat_name, name = 'RSI', arguments = list(price = quote(Cl(mktdata)), n =
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long entry signal
add.signal(RSI_strat_name, name = 'sigThreshold', arguments = list(threshold = 30, column = 'EMA.RSI_Co
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long exit signal
add.signal(RSI_strat_name, name = 'sigThreshold', arguments = list(threshold = 70, column = 'EMA.RSI_Co
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long entry rule
add.rule(RSI_strat_name, name = 'ruleSignal', arguments = list(sigcol = 'RSI_long_entry', sigval = TRUE
```

```
## [1] "RSI Strategy"
```

```
#Add the RSI long exit rule
add.rule(RSI_strat_name, name = 'ruleSignal', arguments = list(sigcol = 'RSI_long_exit', sigval = TRUE,
```

```
## [1] "RSI Strategy"
```

```
#Add the stoploss rule
add.rule(RSI_strat_name, name = 'ruleSignal', arguments = list(sigcol = 'RSI_long_entry', sigval = TRUE
```

```
## [1] "RSI Strategy"
```

```
#Verify that the rules have been added
RSI_strat = getStrategy(RSI_strat_name)
summary(RSI_strat)
```

```
##             Length Class  Mode
## name        1      -none- character
## assets      0      -none- NULL
## indicators  1      -none- list
## signals     2      -none- list
## rules       4      -none- list
## constraints 0      -none- NULL
## init        0      -none- list
## wrapup      0      -none- list
## trials      1      -none- numeric
## call        3      -none- call
```

4D Run the New Strategy

```
applyStrategy(strategy = RSI_strat_name, portfolios = RSI_port, account = RSI_acct, verbose = FALSE)
#Update the portfolio, account, and equity
updatePortf(RSI_port)
```

```
## [1] "RSI Port"
```

```
updateAcct(RSI_acct)
```

```
## [1] "RSI Account"
```

```
updateEndEq(RSI_acct)
```

```
## [1] "RSI Account"
```

Step 5: Pre-Optimized vs Optimized

In this section we will compare the returns of the RSI trading strategy before it was optimized to after. We will do this by looking at ending equity, log returns, Sharpe ratios, CAPM, and the Fama French Three factor model.

5A Equity, Returns, Sharpe Ratios

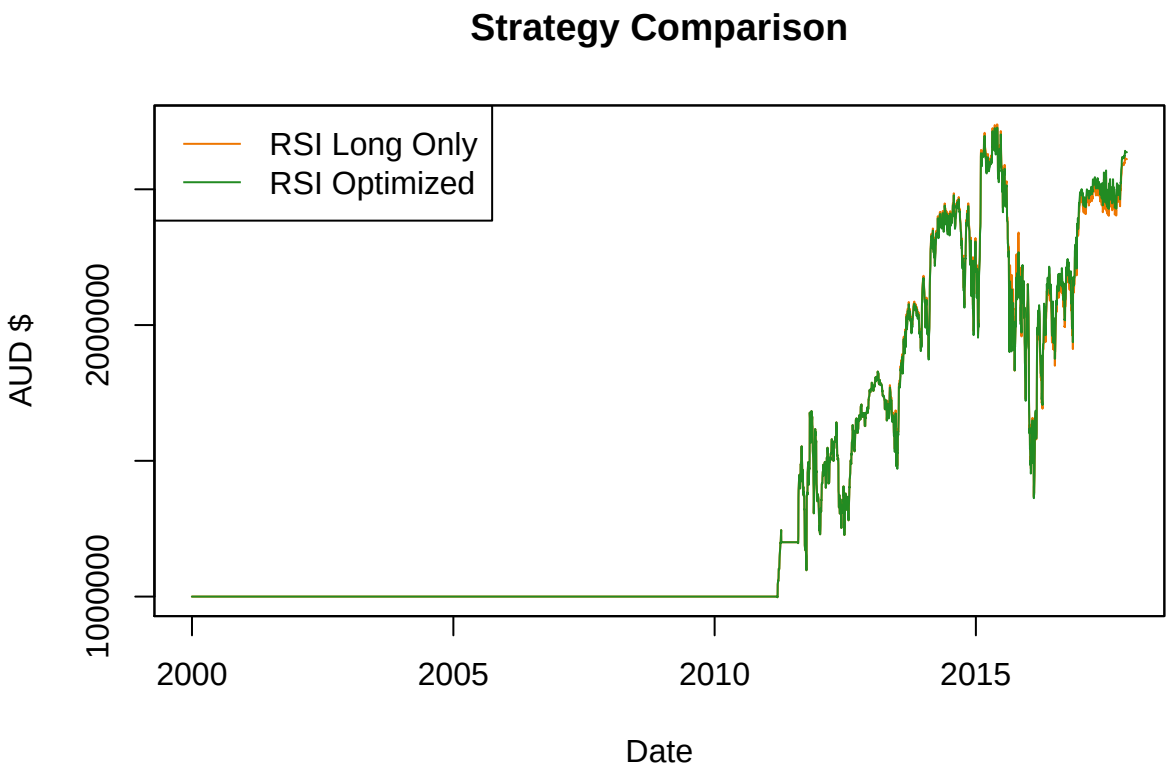
```
#Find the Optimized account equity
RSI_acct_opt_equity = getAccount(RSI_acct)$summary$End.Eq
#Find the Optimized account returns
RSI_opt_returns = Return.calculate(RSI_acct_opt_equity, 'log')
#Rename the column head
colnames(RSI_opt_returns) = 'RSI Optimized Strategy'
#Create the performance table
RSI_opt_perf = table.Arbitrary(RSI_opt_returns, metrics=c("Return.cumulative", "Return.annualized","Sha
                           metricsNames=c("Cumulative Return", "Annualized Return", "Annualized Sharpe

#Display both tables

RSI_perf
```

```
##                          RSI Strategy
## Cumulative Return          0.93016703
## Annualized Return          0.09879138
## Annualized Sharpe Ratio    0.33567396
## Calmar Ratio               0.18324176
```

```
RSI_opt_perf
```

```
##                          RSI Optimized Strategy
## Cumulative Return                     0.9528402
## Annualized Return                     0.1006313
## Annualized Sharpe Ratio               0.3430308
## Calmar Ratio                          0.1873135
```

```
#Create the equity graph
par(mfrow=c(1,1))
#Merge the two account equities into one dataframe
equ = merge(RSI_acct_equity, RSI_acct_opt_equity, all=FALSE)
#Rename the columns
colnames(equ) = c('RSI Long Only', 'RSI Optimized')
#Create an equity table
plot.zoo(equ,plot.type="single",col=c('darkorange2','forestgreen'),main="Strategy Comparison",xlab="Dat
#Add a legend
legend(x="topleft",legend=colnames(equ),col=c('darkorange2','forestgreen'),lty=1)
```




```
end_equity = merge(RSI_acct_equity[length(RSI_acct_equity)], RSI_acct_opt_equity[length(RSI_acct_opt_equ
colnames(end_equity) = c('RSI Long End', 'RSI Optimized End')
RSI_opt_profit = RSI_acct_opt_equity[length(RSI_acct_opt_equity)] - 1000000
RSI_profits_table = merge(RSI_profit, RSI_opt_profit)
colnames(RSI_profits_table) = c('RSI Long Profit', 'RSI Opt Profit')
end_equity
```

```
##            RSI Long End RSI Optimized End
## 2017-11-22      2611046           2636437
```

```
RSI_profits_table
```

```
##            RSI Long Profit RSI Opt Profit
## 2017-11-22         1611046        1636437
```

By adding the stops to our strategy we can see that the overall performance only slightly increases. Ending equity was raised by only 25,391, that is an annualized return of 10.06% compared to the original 9.88%. The strategy's risk adjusted return also increased marginally with the Sharpe ratio now at .34 as opposed to it's original .33.

5B CAPM and Fama French

To determine if either strategy has an abnormal return not explained by market factors, we will use the Fama French Three factor model. The model is used to gauge how much of a strategy's performance could be explained by market factors such as investing in big versus small companies, high growth versus low growth, and the market risk premium. If the strategy returns a positive alpha then it is said to be earning

excess returns. To test this theory we will use the MRP, SMB, and the HML data directly from Kenneth French's webpage.

```
library(quantmod)
#Define the directory
ff_dir = 'C:\\Users\\eoinf\\Documents\\FF3\\'
#ff_dir = 'D:\\Documents\\FF3\\'
#Load the dataset
fama_french = read.csv((paste0(ff_dir, 'FFFactors.csv')))
#Convert to xts
fama_french = as.xts(fama_french[,-1], order.by=as.Date(fama_french$dates))
#Define the index
index(fama_french) = as.yearmon(index(fama_french))

#Conver both RSI strategies to monthly
RSI_monthly = monthlyReturn(RSI_acct_equity, type = "arithmetic")*100
index(RSI_monthly) = as.yearmon(index(RSI_monthly))
RSI_opt_monthly = monthlyReturn(RSI_acct_opt_equity, type = "arithmetic")*100
index(RSI_opt_monthly) = as.yearmon(index(RSI_opt_monthly))

#Create the RSI and Fama French Merged Tables
RSI_fama_french = merge(RSI_monthly, fama_french)
RSI_fama_french = RSI_fama_french[complete.cases(RSI_fama_french),]

RSI_opt_fama_french = merge(RSI_opt_monthly, fama_french)
RSI_opt_fama_french = RSI_opt_fama_french[complete.cases(RSI_opt_fama_french),]

#Compute the excess returns for both strategies
RSI_fama_french$RSI_excess = RSI_fama_french$monthly.returns - RSI_fama_french$rf
RSI_opt_fama_french$RSI_excess = RSI_opt_fama_french$monthly.returns - RSI_fama_french$rf

#Print the head of each column (Should be the same as stops not yet called)
head(RSI_fama_french)
```

```
##          monthly.returns mkt.rf   smb   hml   rf RSI_excess
## Dec 1999        0.000000   7.72  7.15 -8.67 0.44  -0.440000
## Dec 2010        0.000000   6.82  0.70  3.81 0.01  -0.010000
## Jan 2011        0.000000   1.99 -2.47  0.81 0.01  -0.010000
## Feb 2011        0.000000   3.49  1.52  1.09 0.01  -0.010000
## Mar 2011       14.312595   0.45  2.60 -1.55 0.01  14.302595
## Apr 2011        4.992258   2.90 -0.34 -2.51 0.00   4.992258
```

```
head(RSI_opt_fama_french)
```

```
##          monthly.returns mkt.rf   smb   hml   rf RSI_excess
## Dec 1999        0.000000   7.72  7.15 -8.67 0.44  -0.440000
## Dec 2010        0.000000   6.82  0.70  3.81 0.01  -0.010000
## Jan 2011        0.000000   1.99 -2.47  0.81 0.01  -0.010000
## Feb 2011        0.000000   3.49  1.52  1.09 0.01  -0.010000
## Mar 2011       14.312595   0.45  2.60 -1.55 0.01  14.302595
## Apr 2011        4.992258   2.90 -0.34 -2.51 0.00   4.992258
```

5C CAPM Regression

We will now perform a CAPM regression to determine if the strategies have an abnormal return.

```r
#RSI Long CAPM regression
RSI_capm = lm(RSI_excess ~ mkt.rf, data = RSI_fama_french)

#RSI Optimized CAPM regression
RSI_opt_capm = lm(RSI_excess ~ mkt.rf, data = RSI_opt_fama_french)

#Print both regressions
summary(RSI_capm)
```

```
##
## Call:
## lm(formula = RSI_excess ~ mkt.rf, data = RSI_fama_french)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -15.792  -4.634  -0.799   4.138  38.729
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.4480     0.9246  -0.485    0.629
## mkt.rf        1.6314     0.2588   6.304 1.49e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.881 on 80 degrees of freedom
## Multiple R-squared:  0.3319, Adjusted R-squared:  0.3235
## F-statistic: 39.74 on 1 and 80 DF,  p-value: 1.488e-08
```

```r
summary(RSI_opt_capm)
```

```
##
## Call:
## lm(formula = RSI_excess ~ mkt.rf, data = RSI_opt_fama_french)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -16.327  -4.840  -0.841   3.758  38.702
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.4321     0.9250  -0.467    0.642
## mkt.rf        1.6295     0.2589   6.294 1.55e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.884 on 80 degrees of freedom
## Multiple R-squared:  0.3312, Adjusted R-squared:  0.3228
## F-statistic: 39.61 on 1 and 80 DF,  p-value: 1.553e-08
```

Both strategies return a very similar CAPM results. Neither strategy has an alpha value that is statistically different from zero, meaning that neither have an abnormal return. Both strategies also have a similar market beta. The long only and optimized accounts are roughly 60% more sensitive to the market with betas of 1.6314 and 1.6295 respectively.

5D Fama French Three Factor Regression

We will now perform a FF3 regression to determine if the strategies have an abnormal return

```
#RSI Long FF3 regression
RSI_FF3 = lm(RSI_excess ~ mkt.rf + smb + hml, data = RSI_fama_french)

#RSI Optimized FF3 regression
RSI_opt_FF3 = lm(RSI_excess ~ mkt.rf + smb + hml, data = RSI_opt_fama_french)

#Print both regressions
summary(RSI_FF3)
```

```
##
## Call:
## lm(formula = RSI_excess ~ mkt.rf + smb + hml, data = RSI_fama_french)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -15.689  -4.782  -0.764   4.081  38.527
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.47389    0.94931  -0.499    0.619
## mkt.rf       1.64490    0.28699   5.731 1.79e-07 ***
## smb         -0.04415    0.42552  -0.104    0.918
## hml         -0.07106    0.37539  -0.189    0.850
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.979 on 78 degrees of freedom
## Multiple R-squared:  0.3323, Adjusted R-squared:  0.3066
## F-statistic: 12.94 on 3 and 78 DF,  p-value: 6.065e-07
```

```
summary(RSI_opt_FF3)
```

```
##
## Call:
## lm(formula = RSI_excess ~ mkt.rf + smb + hml, data = RSI_opt_fama_french)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -16.171  -4.864  -0.837   3.696  38.514
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.45022    0.94970  -0.474    0.637
## mkt.rf       1.63606    0.28711   5.698 2.06e-07 ***
## smb         -0.01851    0.42569  -0.043    0.965
## hml         -0.07719    0.37555  -0.206    0.838
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.982 on 78 degrees of freedom
## Multiple R-squared:  0.3316, Adjusted R-squared:  0.3058
```

```
## F-statistic:  12.9 on 3 and 78 DF,  p-value: 6.317e-07
```

The Fama French regression results are incredibly similar to those of the CAPM. The alpha values are not statistically different from zero and both strategies have a beta of roughly 1.6. There is also no small minus big company or high growth versus low growth effects due to the instruments being used.

Step 6: Buy and Hold

In this section we will create a buy and hold portfolio using the Australia All Ords and compare it to our Optimized RSI Strategy since it had the highest risk adjusted return.

6A Buy and Hold Portfolio

In this step we will load in the Buy and Hold Portfolio

```
library(INFT361Course)
library(xts)
#The portfolio was created in 1C
#Load in the All Ords
bh_directory = 'C:\\Users\\eoinf\\Documents\\Index\\'
#bh_directory = 'D:\\Documents\\All Ords\\'
bh_symbol = 'XAO.csv'
LoadCourseIndexFile(bh_directory, bh_symbol, dates = date_range)
#Define the All Ords as a stock
stock(bh_symbol, currency = 'AUD')
```

```
## [1] "XAO.csv"
```

```
#Conver to weekly
bh_object = to.weekly(get(bh_symbol), indexAt = 'endof', drop.time = FALSE, OHLC = TRUE)
```

```
## Warning in to.period(x, "weeks", name = name, ...): missing values removed
## from data
```

```
assign(bh_symbol, bh_object)
#Set the starting parameters
BH_object = get(bh_symbol)

#Find the start and finishing dates
first_date = first(time(bh_object))
last_date = last(time(bh_object))

#Find the close price on the first and last day
close_price = as.numeric(Cl(bh_object[first_date,]))
last_close_price = as.numeric(Cl(bh_object[last_date,]))

#Find how much can be bought on the first day
unit_size = as.numeric(trunc(starting_cap/close_price))

#Create the transactio fees (based off the fees above)
first_transaction_fee = -0.12/100 * unit_size
last_transaction_fee = -0.12/100 * unit_size

#Add the transaction for the first day
addTxn(BH_port, Symbol = bh_symbol, TxnDate = first_date, TxnPrice = close_price, TxnQty = unit_size, T
```

```
## [1] "2000-04-07 00:00:00 XAO.csv 314 @ 3182"
```

```
#Add the transaction for the last day
addTxn(BH_port, Symbol = bh_symbol, TxnDate = last_date, TxnPrice = last_close_price, TxnQty = -unit_si
```

```
## [1] "2017-09-07 00:00:00 XAO.csv -314 @ 5689.882"
```

```
#Update the portfolio and account
updatePortf(Portfolio = BH_port)
```

```
## [1] "Buy and Hold Portfolio"
```

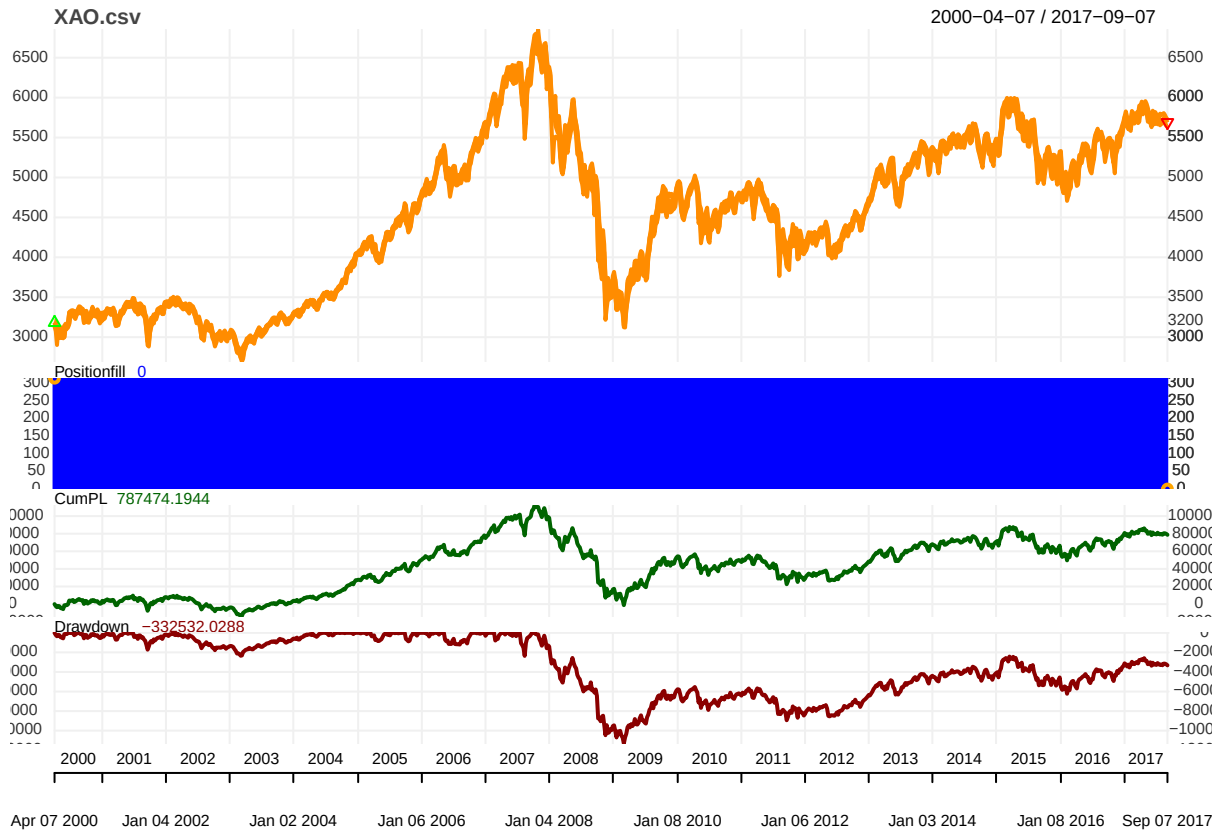
```
updateAcct(BH_acct)
```

```
## [1] "Buy and Hold Account"
```

```
updateEndEq(BH_acct)
```

```
## [1] "Buy and Hold Account"
```

```
#Chart our trades
chart.Posn(BH_port,Symbol=bh_symbol,type="line")
```



6B Buy and Hold Comparison

We will now calculate the returns on the Buy and Hold Portfolio and compare it to the returns of our Optimized RSI strategy. Since both RSI strategies had identical CAPM and Fama French Regression results we used the strategy with the greatest Sharpe Ratio.

```
bh_acct_equity = getAccount(BH_acct)$summary$End.Eq
bh_returns = Return.calculate(bh_acct_equity, 'log')
colnames(bh_returns) = 'Buy and Hold'
bh_perf = table.Arbitrary(bh_returns, metrics=c("Return.cumulative", "Return.annualized","SharpeRatio.a
                          metricsNames=c("Cumulative Return", "Annualized Return", "Annualized Sharpe
```

```
bh_perf
```

```
##                          Buy and Hold
## Cumulative Return           0.45873596
## Annualized Return           0.04191988
## Annualized Sharpe Ratio     0.20075275
## Calmar Ratio                0.07478903
```

```
RSI_opt_perf
```

```
##                          RSI Optimized Strategy
## Cumulative Return                     0.9528402
## Annualized Return                     0.1006313
## Annualized Sharpe Ratio               0.3430308
## Calmar Ratio                          0.1873135
```

```
end_equity = merge(RSI_acct_opt_equity[length(RSI_acct_opt_equity)], bh_acct_equity[length(bh_acct_equi
colnames(end_equity) = c('RSI Opt End', 'Buy and Hold End')
bh_profit = bh_acct_equity[length(bh_acct_equity)] - 1000000
profits_table = merge(RSI_opt_profit, bh_profit)
colnames(profits_table) = c('RSI Opt Profit', 'Buy and Hold Profit')
profits_table
```

```
##            RSI Opt Profit Buy and Hold Profit
## 2017-11-22        1636437            787474.2
```

From the results above it is clear that the RSI Optimized Strategy does outperform the All Ords by quite a significant margin. Where the buy and hold account only had a Sharpe ratio of .04, the RSI strategy's was .34. The difference in profits was also quite large. If an investor had of bought and held the All Ords they would of have made a 787,474 dollar profit, that is 848,962 dollars less than the profit generated by our RSI strategy. In conclusion, it is a relatively safe assumption that using the Optimized RSI trading strategy as documented here, would continue to generate returns greater than the market, for investors over the coming years(assuming no major financial crisis). The strategy appears to work incredibly well with a diversified portfolio of ETFs.

Step 7: References

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