PROJECT REPORT

FINANCIAL TRADING STRATEGY

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Contents

1 INTRODUCTION

This project aims at building a model that will ideally always output successful bids in the stock market. For that, it builds a model which gives better results when constantly trained in a sliding-time window. The goal is to design a simple financial trading strategy that will be profitable and that will provide a good risk-adjusted measure of return.

2 DATA SETS

Two datasets will be used here to test the strategy:

- The American Electric Company (AEP) dataset from Quandl

Open	High	Low	Close	Volume	Ex-Dividend
32.00	32.00	31.12	31.44	396900	0
31.38	31.94	31.38	31.81	325500	0
31.94	33.13	31.88	33.00	392200	0
32.75	33.69	32.75	33.19	433000	0
33.38	33.75	33.06	33.63	250500	0
33.63	33.81	33.44	33.50	307700	0

- The Chesapeake Energy Corporation (CHK) from Quandl.

Open	High	Low	Close	Volume	Ex-Dividend
2.31	2.38	2.25	2.25	369700	0
2.19	2.25	2.06	2.06	719400	0
2.12	2.19	1.94	2.06	807100	0
1.94	2.12	1.94	2.12	444900	0
2.06	2.12	2.06	2.06	207400	0
2.06	2.12	2.06	2.12	166700	0

An initial exploration of the AEP dataset reveals 5 important fields:

- The date
- The Open price
- The High price
- The Low price
- The Close price.

Some of the issues encountered with the data:

- The presence of the adjusted closing price was confusing for some methods in the packages Quandstrat and xts, as those methods kept throwing errors. I had to remove

the adjusted closing price from my data sets and just keep the closing price
- Some functions and arguments were not found because the Quandstrat package is not yet stable.

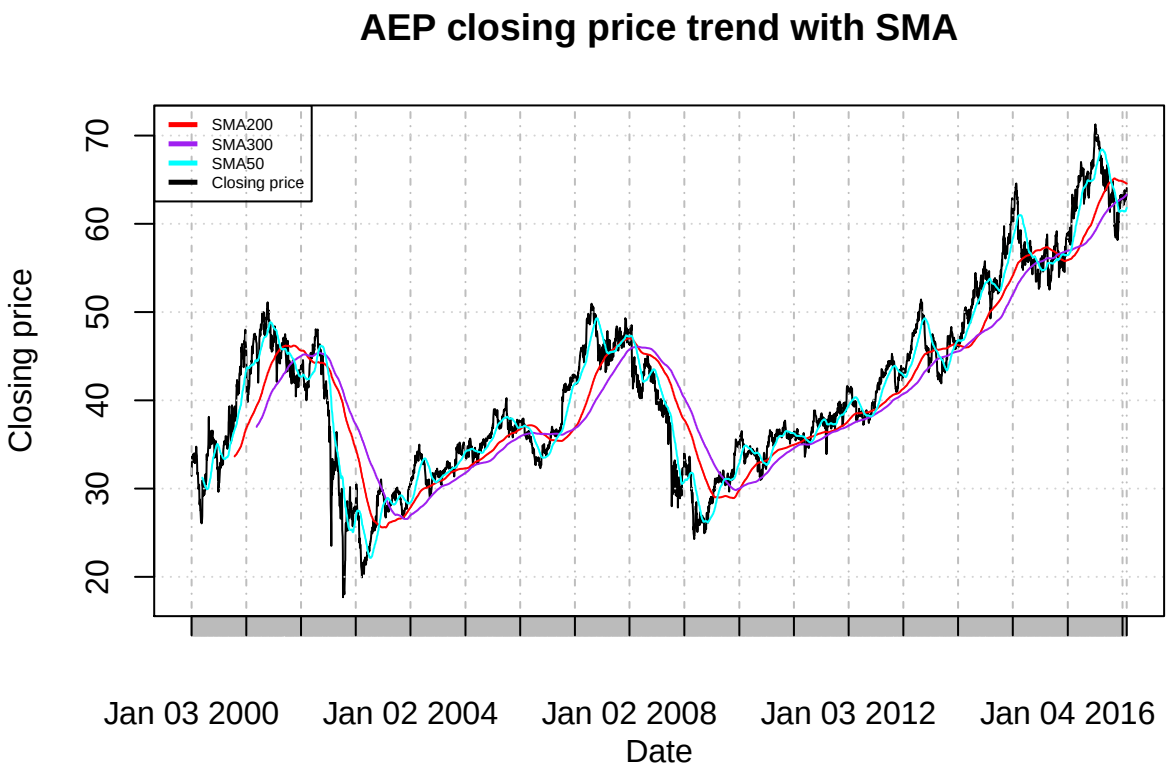
3 PRELIMINARY EXPLORATION

Indicators are transformations of market data that give an insight into the overall market behavior by measuring current conditions and/or forecasting trends. Among others, there are trend-following indicators which depict the general price direction, and oscillators used to discover on a scale of 0 to 100 short-term overbought (above 70 to 80) or oversold (below 30 to 20) conditions . Combining trend-following indicators and oscillator/reversion indicators gives more insight into the data for this project. The preliminary oscillator used is an RSI (Relative Strength Index) with a 3-days lookback period. The preliminary trend indicators are 3 SMA (Simple Moving Average). After applying those indicators to the stocks, there are some periods of time during which none of the indicators seem to be right.

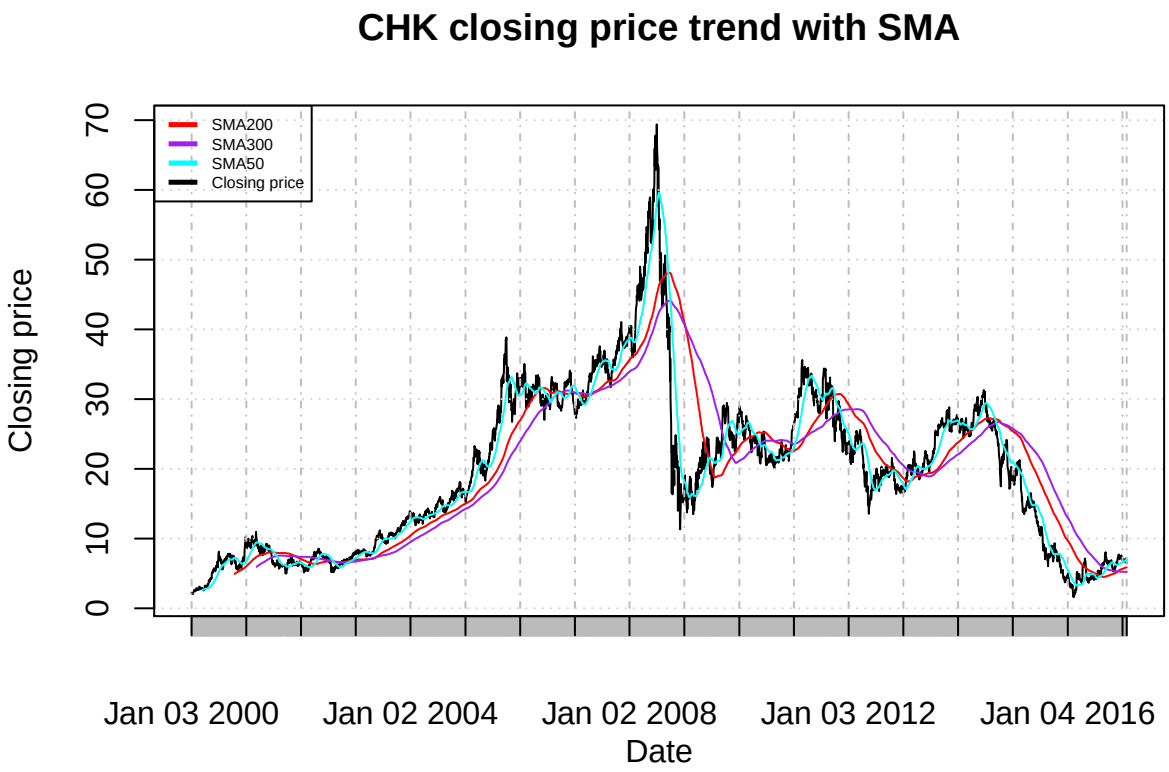
3.1 TREND-FOLLOWING INDICATORS: SIMPLE MOVING AVERAGES

The SMA50 (Simple Moving Average) seems to better mimic the trend of the closing prices for both data sets

- SMA AEP


AEP closing price trend with SMA
SMA200
SMA300
SMA50
Closing price
Closing price
20
30
40
50
60
70
Jan 03 2000
Jan 02 2004
Jan 02 2008
Jan 03 2012
Jan 04 2016
Date

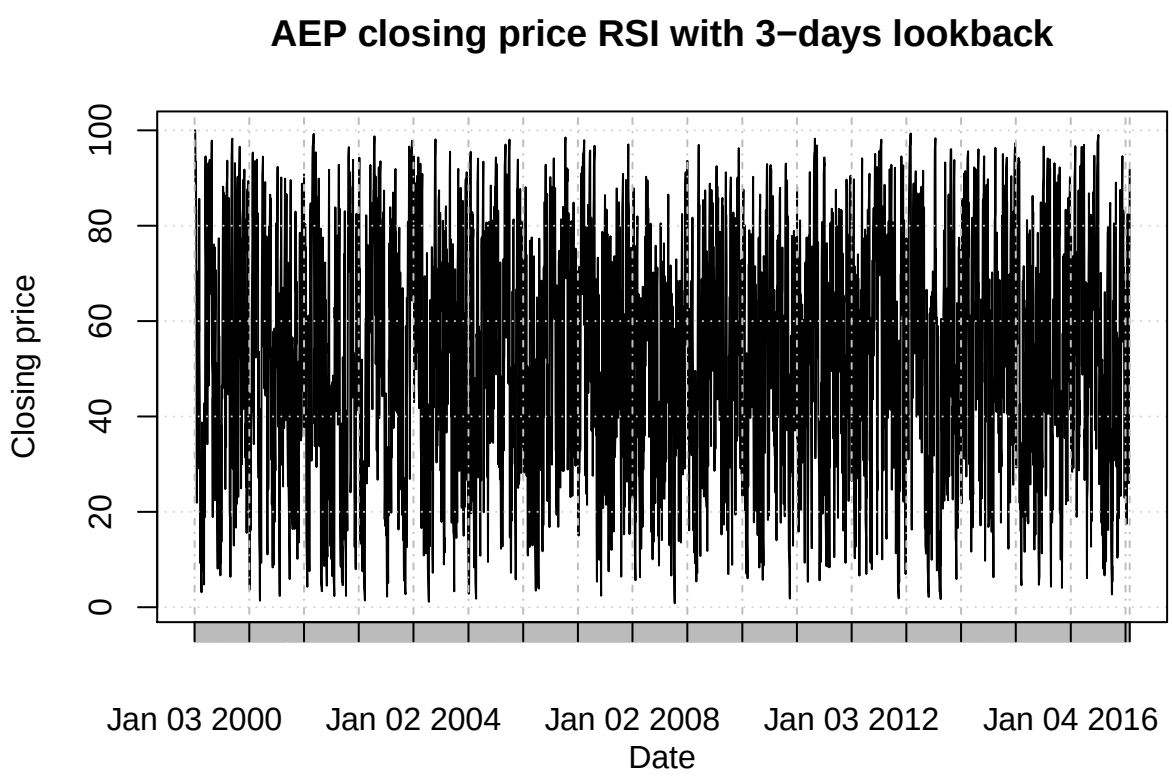
- SMA CHK



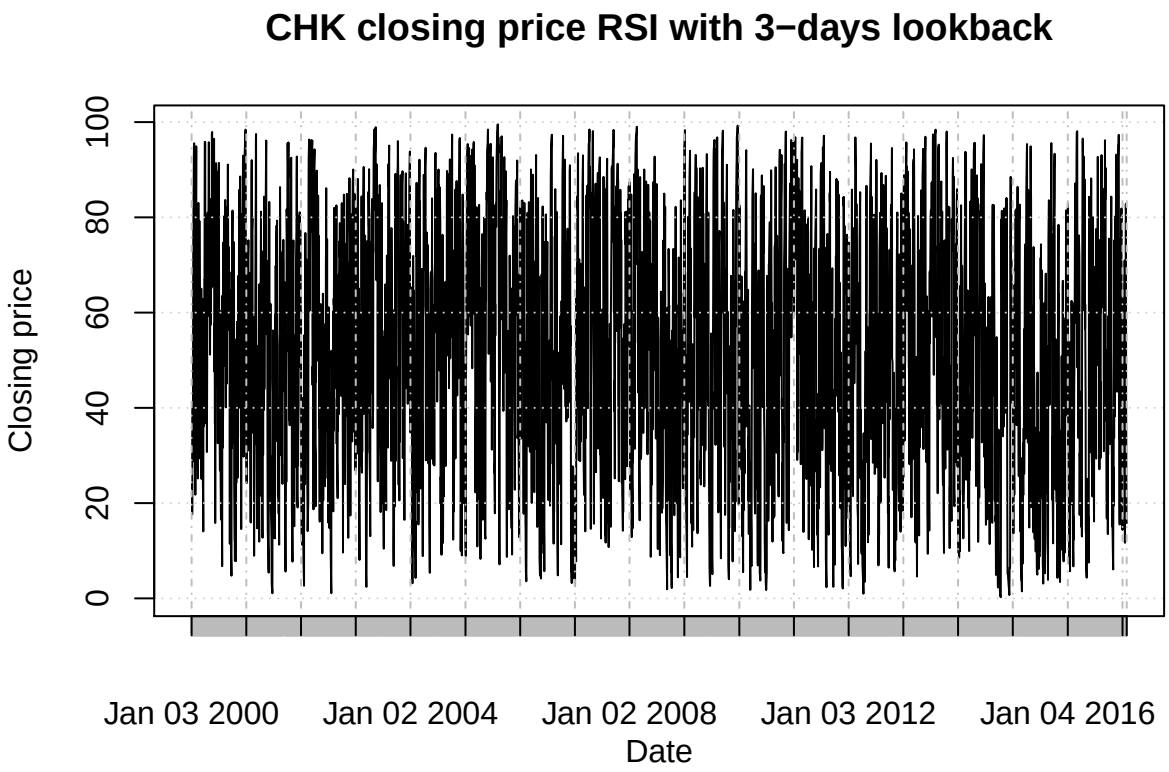
3.2 OSCILLATOR/REVERSION INDICATOR: RSI

An observation of the graphs of the stocks. RSI reveals that there are effectively periods of reversion (2013-09-03 to 2013-9-05 for example) that won't be captured by a trend-following indicator:

- RSI AEP


AEP closing price RSI with 3−days lookback
Closing price
0
20
40
60
80
100
Jan 03 2000
Jan 02 2004
Jan 02 2008
Jan 03 2012
Jan 04 2016
Date

- RSI CHK



4 APPROACH

The main objective is to obtain a profit factor (monetary unit gained per monetary unit lost) above 1 after running the strategy on each of the data sets. The approach here would be to combine both SMA50 and SMA200 with an oscillator to avoid false signals. The trend-following indicators would help catch up trends.
The analysis is done on 16 years, from January 01st, 2000 to December 31st, 2016 . The time is Eastern time and the currency is US dollar.

4.1 STRATEGY 1: RSI

"RSI Strategy", the initial strategy for this project, uses simple averages (over 50 days and over 200 days) with a custom RSI_3_4 indicator acting as an average between RSI3 and RSI4 . Signals help interpret how indicators interact with the market and with each other. Those signals are:

- a comparison and a crossover , which show a buy signal when the 50-day simple moving average is above the 200-day simple moving average and show a sell signal when the 50-day simple moving average crosses below the 200-day simple moving average

- a threshold, which an oversold condition, thus a buy opportunity, for RSI_3_4 below 20, and an overbought condition, thus a sell opportunity, for RSI_3_4 above 80
- a combined comparison and threshold to buy when the 50-day simple moving average is above the 200-day simple moving average and RSI_3_4 is less than 20.

```
##
##
## Table: AEP Subset
##
##                    2013-09-03   2013-09-04   2013-09-05
## -----------------  -----------  -----------  -----------
## Open                 43.03000     42.16000     42.19000
## High                 43.13000     42.34000     42.45000
## Low                  42.07000     41.83000     42.07000
## Close                42.16000     42.21000     42.14000
## SMA.SMA200           45.75490     45.76115     45.76425
## SMA.SMA50            44.93140     44.90420     44.86880
## RSI_avg.RSI_3_4      22.85453     26.99133     24.42352
## longfilter            0.00000      0.00000      0.00000
## filterexit                 NA           NA           NA
## longthreshold         0.00000      0.00000      0.00000
## thresholdexit         0.00000      0.00000      0.00000
## longentry             0.00000      0.00000      0.00000
```

```
##
##
## Table: CHK Subset
##
##                    2013-09-03   2013-09-04   2013-09-05
## -----------------  -----------  -----------  -----------
## Open                 26.07000     26.09000     26.18000
## High                 26.41000     26.18000     26.24000
## Low                  26.02000     26.00000     26.02000
## Close                26.16000     26.12000     26.17000
## SMA.SMA200           20.35310     20.40175     20.44950
## SMA.SMA50            23.32000     23.45040     23.57800
## RSI_avg.RSI_3_4      61.91683     58.61329     62.21049
## longfilter            1.00000      1.00000      1.00000
## filterexit                 NA           NA           NA
## longthreshold         0.00000      0.00000      0.00000
## thresholdexit         0.00000      0.00000      0.00000
## longentry             0.00000      0.00000      0.00000
```

Rules help shape trading transactions at signal execution. They generate orders using market data, indicators and signals. This strategy has 2 rules:

- an entry rule of 1 share for the combined comparison and threshold entry signals

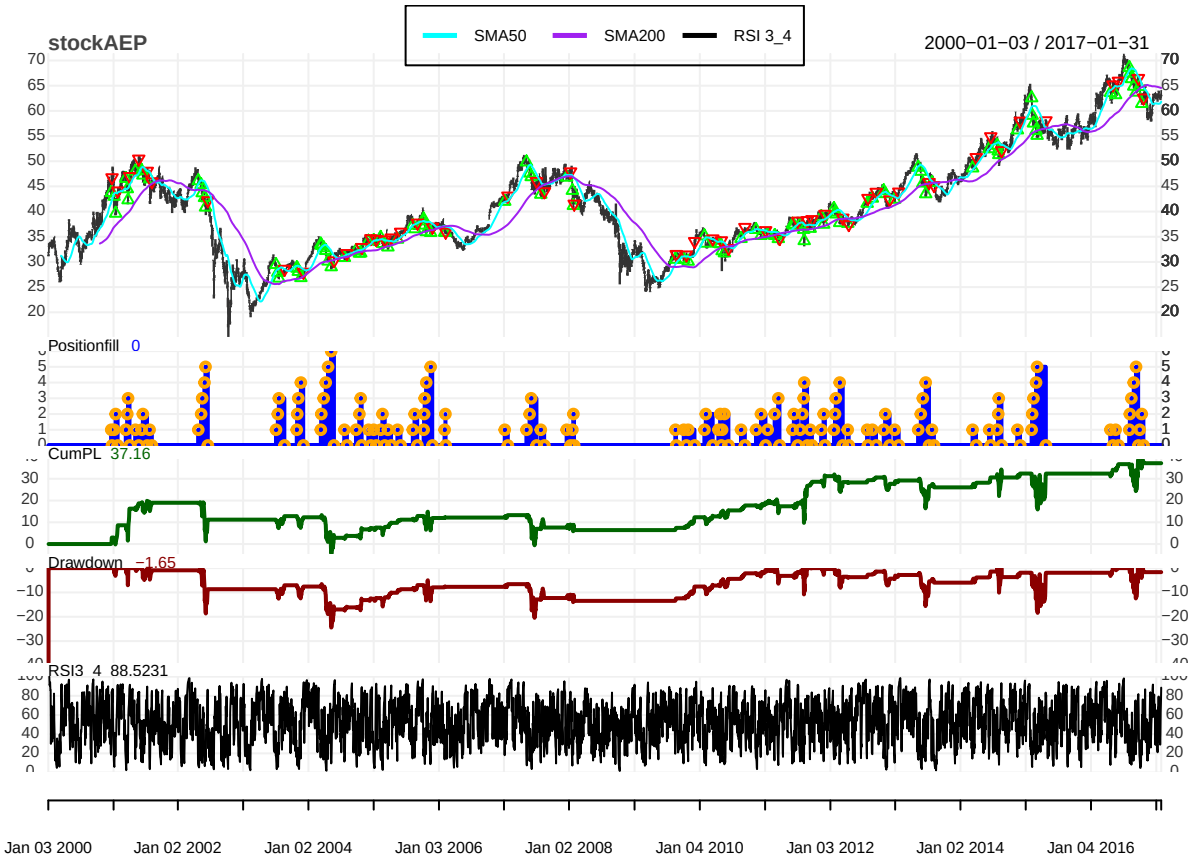
- an exit rule for a treshold above 80.

Running this RSI_3_4 strategy on the AEP and the CHK over that trading period, yields profit factors above 1, meaning that the strategy is profitable:

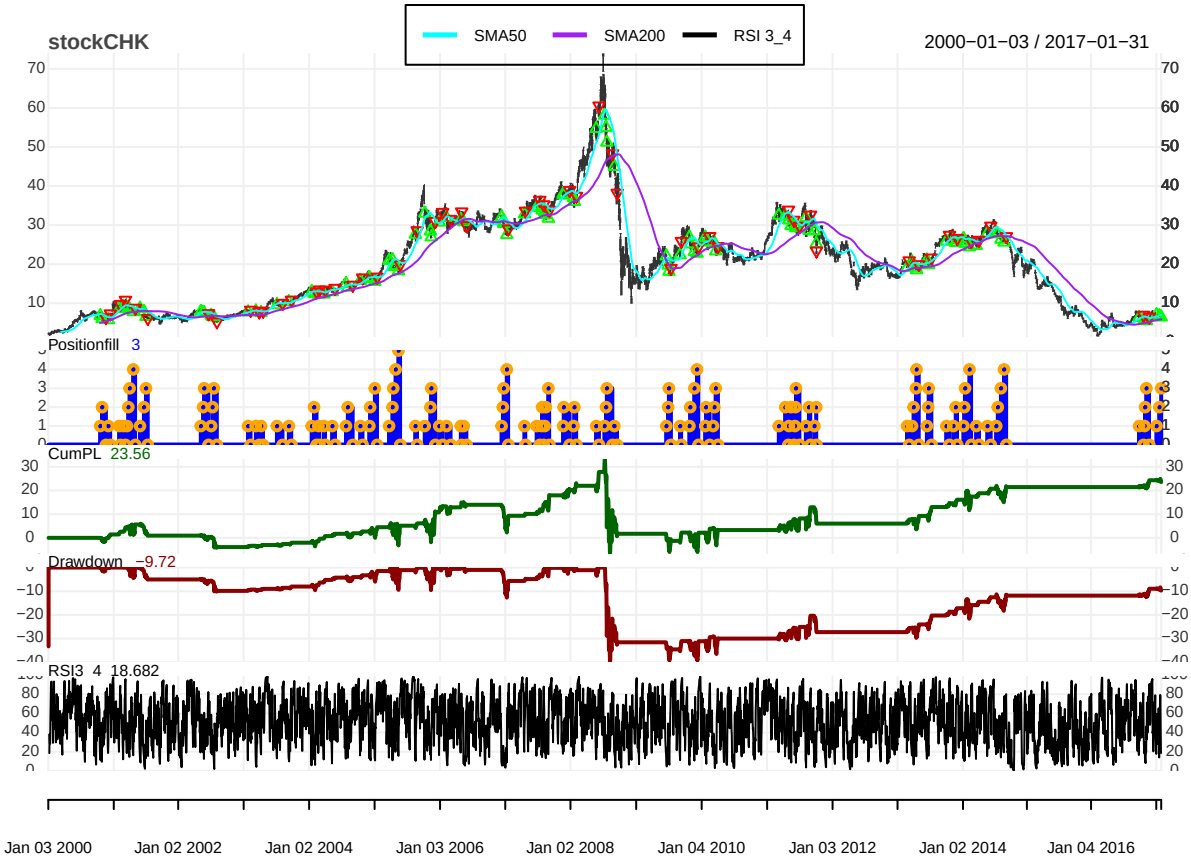
	Symbol	Profit.Factor
stockAEP	stockAEP	1.952576
stockCHK	stockCHK	1.463076

Let's take a look at the system performance for the 2 stocks:

- Stock 1: AEP



- stock 2: CHK



We can further analyze this RSI-3_4 strategy by getting the order book and retrieving the trade statistics:

	stockAEP	stockCHK
Portfolio	RSI strategy	RSI strategy
Symbol	stockAEP	stockCHK
Num.Txns	169	177
Num.Trades	55	58
Net.Trading.PL	37.16	23.56
Avg.Trade.PL	0.6756364	0.4194828
Med.Trade.PL	1.05	1.13
Largest.Winner	7.92	5.86
Largest.Loser	-9.42	-19.36
Gross.Profits	76.17	76.87
Gross.Losses	-39.01	-52.54
Std.Dev.Trade.PL	2.915206	3.585156
Percent.Positive	70.90909	75.86207
Percent.Negative	29.09091	24.13793
Profit.Factor	1.952576	1.463076
Avg.Win.Trade	1.953077	1.747045
Med.Win.Trade	1.500	1.485

	stockAEP	stockCHK
Avg.Losing.Trade	-2.438125	-3.752857
Med.Losing.Trade	-1.15	-1.97
Avg.Daily.PL	0.6756364	0.4194828
Med.Daily.PL	1.05	1.13
Std.Dev.Daily.PL	2.915206	3.585156
Ann.Sharpe	3.679120	1.857404
Max.Drawdown	-24.44	-39.85
Profit.To.Max.Draw	1.5204583	0.5912171
Avg.WinLoss.Ratio	0.8010569	0.4655241
Med.WinLoss.Ratio	1.3043478	0.7538071
Max.Equity	38.81	33.28
Min.Equity	-4.56	-6.57
End.Equity	37.16	23.56

	stockAEP.DailyEndEq	stockCHK.DailyEndEq
Annualized Sharpe Ratio (Rf=0%)	0.1945513	0.1296419

For both instruments, the profit factor (absolute value ratio of gross profits over gross losses) is above 1 . Therefore, this strategy is profitable.

$$Profitfactor = Abs(grossprofits/grosslosses)$$

The Sharpe Ratio is a risk-adjusted measure of return.

$$Sharperatio = (Meanportfolioreturn - Risk - freerate)/Standarddeviationofportfolioreturn$$

With the Quandstart R package, there are ways to get the cash Sharpe Ratio (Sharpe Ratio from profit and loss) and the returns-based Sharpe Ratio (Sharpe Ratio from P&L over initial equity) of a strategy. The annualized returns-based Sharpe Ratios are low, the highest being ~ 0.23 on stock AEP. Let's try to increase the annualized returns-based Sharpe ratio by changing the oscillator of this strategy.

4.2 STRATEGY 2: DVO

Instead of using the RSI_3_4 as the oscillator, let's use a custom DVO with navg = 2 and a percentlookback period of 126 that we call DVO_2_126 . The trend following indicators SMA50 and SMA200 stay the same , as well as the signals, rules and settings of the strategy.

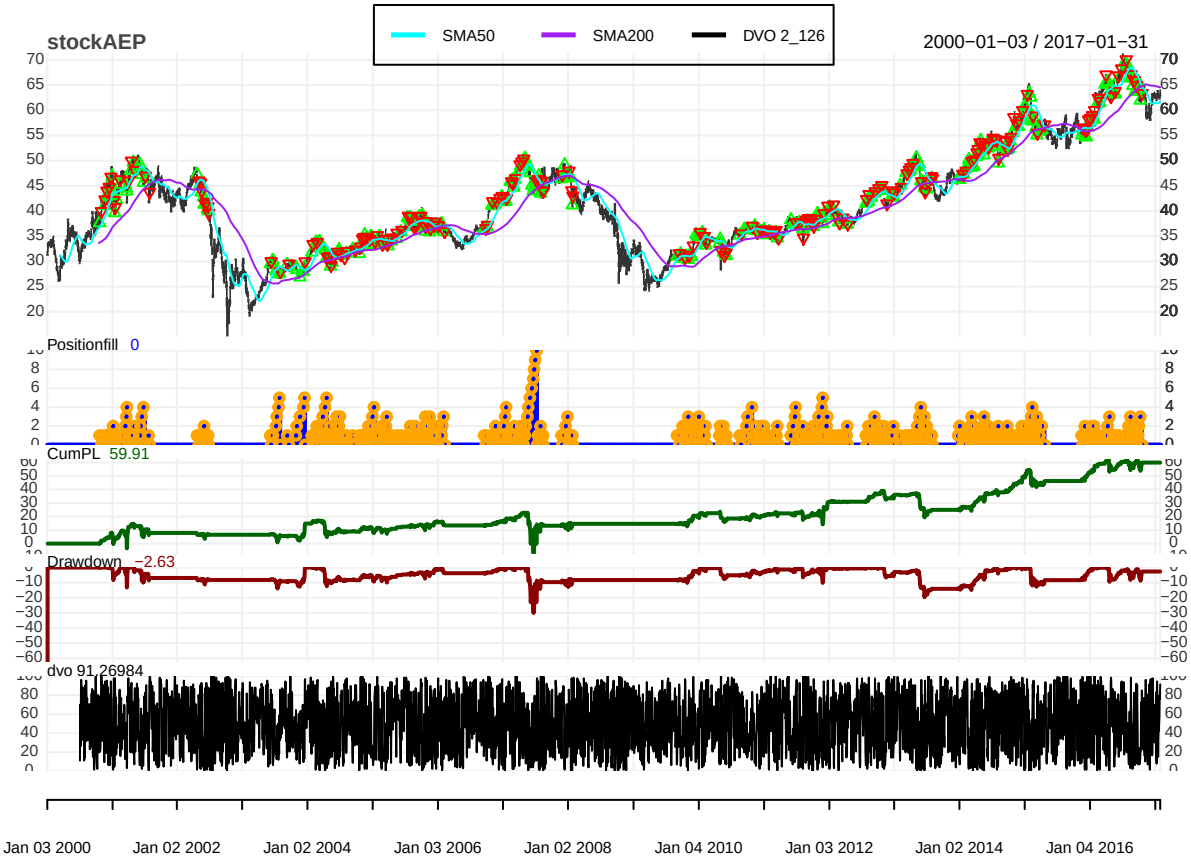
```
##
##
## Table: AEP Subset
##
##                  2013-09-03   2013-09-04   2013-09-05
## --------------  -----------  -----------  -----------
## Open              43.030000     42.16000     42.19000
## High              43.130000     42.34000     42.45000
## Low               42.070000     41.83000     42.07000
## Close             42.160000     42.21000     42.14000
## SMA.SMA200        45.754900     45.76115     45.76425
## SMA.SMA50         44.931400     44.90420     44.86880
## DVO.DVO_2_126      6.349206     15.87302     53.17460
## longfilter         0.000000      0.00000      0.00000
## filterexit               NA           NA           NA
## longthreshold      1.000000      1.00000      0.00000
## thresholdexit      0.000000      0.00000      0.00000
## longentry          0.000000      0.00000      0.00000
```

```
##
##
## Table: CHK Subset
##
##                  2013-09-03   2013-09-04   2013-09-05
## --------------  -----------  -----------  -----------
## Open              26.07000     26.09000      26.1800
## High              26.41000     26.18000      26.2400
## Low               26.02000     26.00000      26.0200
## Close             26.16000     26.12000      26.1700
## SMA.SMA200        20.35310     20.40175      20.4495
## SMA.SMA50         23.32000     23.45040      23.5780
## DVO.DVO_2_126     30.15873     40.47619      53.1746
## longfilter         1.00000      1.00000       1.0000
## filterexit              NA           NA           NA
## longthreshold      0.00000      0.00000       0.0000
## thresholdexit      0.00000      0.00000       0.0000
## longentry          0.00000      0.00000       0.0000
```

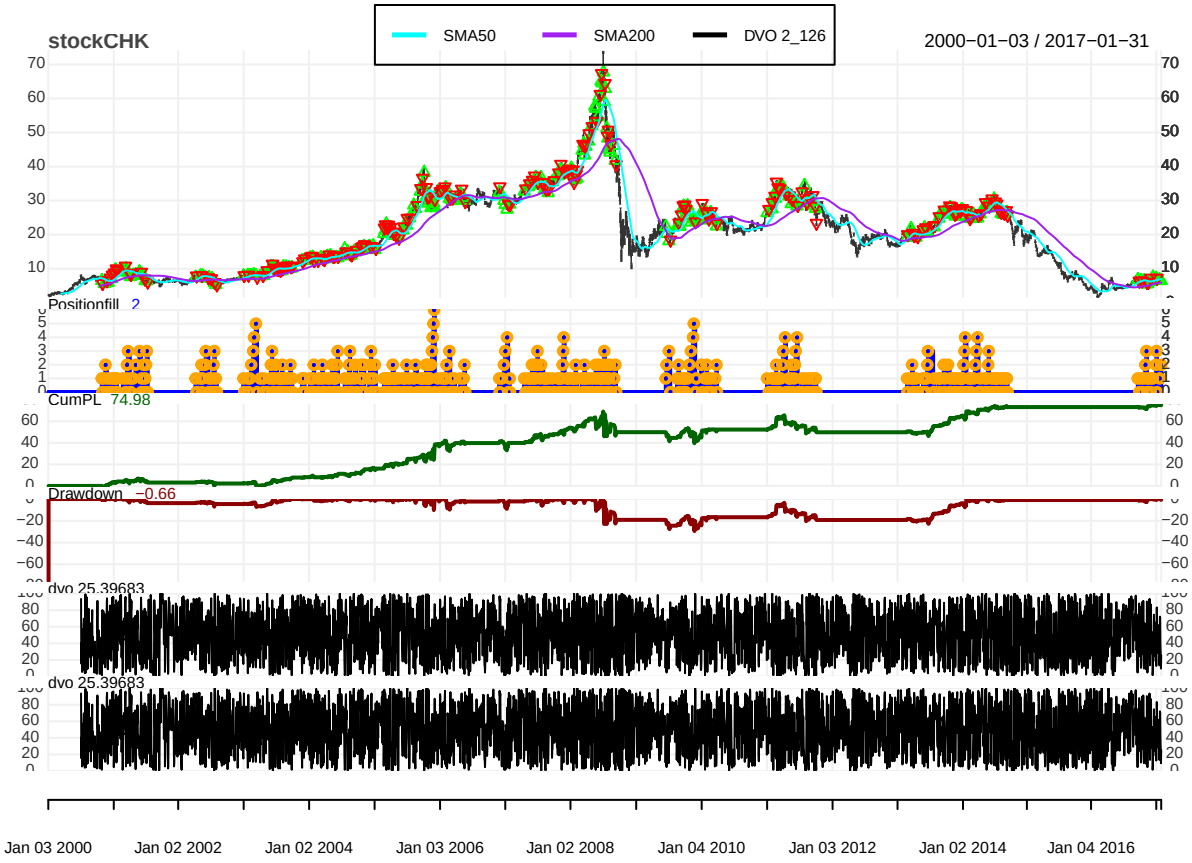
Let's run the DVO strategy.

Performance of the systems:

- stock 1: AEP


stockAEP
SMA50
SMA200
DVO 2_126
2000−01−03 / 2017−01−31
Positionfill 0
CumPL 59.91
Drawdown −2.63
dvo 91.26984
Jan 03 2000
Jan 02 2002
Jan 02 2004
Jan 03 2006
Jan 02 2008
Jan 04 2010
Jan 03 2012
Jan 02 2014
Jan 04 2016

- stock 2: CHK



Analyzing this DVO strategy, we get the following trade metrics:

	stockAEP	stockCHK
Portfolio	DVO strategy	DVO strategy
Symbol	stockAEP	stockCHK
Num.Txns	501	473
Num.Trades	185	184
Net.Trading.PL	59.91	74.98
Avg.Trade.PL	0.3238378	0.4085326
Med.Trade.PL	0.52	0.47
Largest.Winner	9.06	9.33
Largest.Loser	-11.12	-16.16
Gross.Profits	173.49	176.69
Gross.Losses	-113.58	-101.52
Std.Dev.Trade.PL	2.352974	2.522341
Percent.Positive	70.81081	72.28261
Percent.Negative	29.18919	26.63043
Profit.Factor	1.527470	1.740445
Avg.Win.Trade	1.324351	1.328496
Med.Win.Trade	0.98	0.91
Avg.Losing.Trade	-2.103333	-2.071837

	stockAEP	stockCHK
Med.Losing.Trade	-1.21	-0.92
Avg.Daily.PL	0.3238378	0.4085326
Med.Daily.PL	0.52	0.47
Std.Dev.Daily.PL	2.352974	2.522341
Ann.Sharpe	2.184795	2.571125
Max.Drawdown	-30.13	-29.43
Profit.To.Max.Draw	1.988384	2.547740
Avg.WinLoss.Ratio	0.6296440	0.6412167
Med.WinLoss.Ratio	0.8099174	0.9891304
Max.Equity	62.54	75.64
Min.Equity	-7.24	-0.75
End.Equity	59.91	74.98

	stockAEP.DailyEndEq	stockCHK.DailyEndEq
Annualized Sharpe Ratio (Rf=0%)	0.3210269	0.4282121

5 CONCLUSION

On the same period of time, the same instruments/stocks and the strategy settings, the RSI strategy has a higher profit factor compared to the DVO strategy for each of the stocks respectively. However, there are more transactions in the DVO strategy and its annualized sharpe ratios are much better than the ones of the RSI strategy. Therefore, the absolute value of the gross profits over gross losses is higher in the RSI strategy for each respective stok, while the return per unit of risk is better in the DVO strategy.

Nonetheless, is that enough to select one strategy over the other? Would an entry rule with an order sizing functon instead of a single share considerably improve one strategy over the other in terms of profit and risk-adjusted return?

6 GLOSSARY

- **Indicator**:

transformation of market data that gives an insight into the overall market behavior by measuring current conditions and/or forecasting trends.

- **Instrument**:

Market data, stock

- **Profit factor**:

monetary unit gained per monetary unit lost

- **RSI**:

(Relative Strength Index) a type of oscillator (reversion indicator) used to discover on a scale of 0 to 100 short-term overbought (above 70 to 80) or oversold (below 30 to 20) conditions

- **Sharpe Ratio**:

a risk-adjusted measure of return

- **Signal**:

metric that helps interpret how indicators interact with the market and with each other

- **SMA**:

(Simple Moving Average) a type of trend-following indicator which depict the general price direction as a smooth average over a period of time

7 REFERENCES

- Quantitative Trading Strategy Using R: A Step by Step Guide
  https://www.r-bloggers.com/quantitative-trading-strategy-using-r-a-step-by-step-guide/
- Investopedia 4 most common indicators
  http://www.investopedia.com/articles/active-trading/041814/four-most-commonlyused-indicators-tre
  asp
- Oscillators
  http://www.investopedia.com/terms/o/oscillator.asp
- Momentums
  http://www.investopedia.com/terms/m/momentum.asp
- Sharpe Ratio *http://www.investopedia.com/terms/s/sharperatio.asp?ad=dirN&qo=*
  investopediaSiteSearch&qsrc=0&o=40186
- Understanding profit metrics
  http://www.investopedia.com/articles/investing/062113/understanding-profit-metrics-gross-operating
  asp?ad=dirN&qo=investopediaSiteSearch&qsrc=0&o=40186
- Trend Vigor Part III: ATR position sizing, Annualized Sharpe above 1.4, and Why Leverage Is Pointless
  https://www.r-bloggers.com/trend-vigor-part-iii-atr-position-sizing-annualized-sharpe-above-1-4-and-