

CS7646 ML4T Project6 – Manual Strategy

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In this project, an intuitive trading strategy was developed and technical analysis was carried out. The strategy was tested against a stock – JPM using a modified market simulator from previous assignment. There are total four .py files, they are indicators.py, marketsimcode.py, ManualStrategy.py, and BestPossibleStrategy.py.

Part I. Indicators

Three indicators chosen for this project are Bollinger Bands, simple moving average (SMA), and momentum.

1) Bollinger band:

In the indicators.py, a window of 20 was used for calculating the moving average and moving standard deviation, using pandas rolling_mean and rolling_std. Upper band, lower band, and rolling mean are passed to ManualStrategy.py for manual strategy and plotting charts.

2) Simple moving average (SMA):

This indicator also uses a window of 20 and pass the division of price over rolling mean, and then the price, rolling mean, and division were passed into ManualStrategy.py for manual strategy and plotting charts.

3) Momentum:

Momentum is the price of a day divided by the price N days ago and minus 1, where N is the window. Momentum indicator here uses a window of 10. The price and momentum were passed into ManualStrategy.py for manual strategy and plotting charts.

Part II. Best Possible Strategy

Assuming we can see the future, given the order limits, a best strategy was developed.

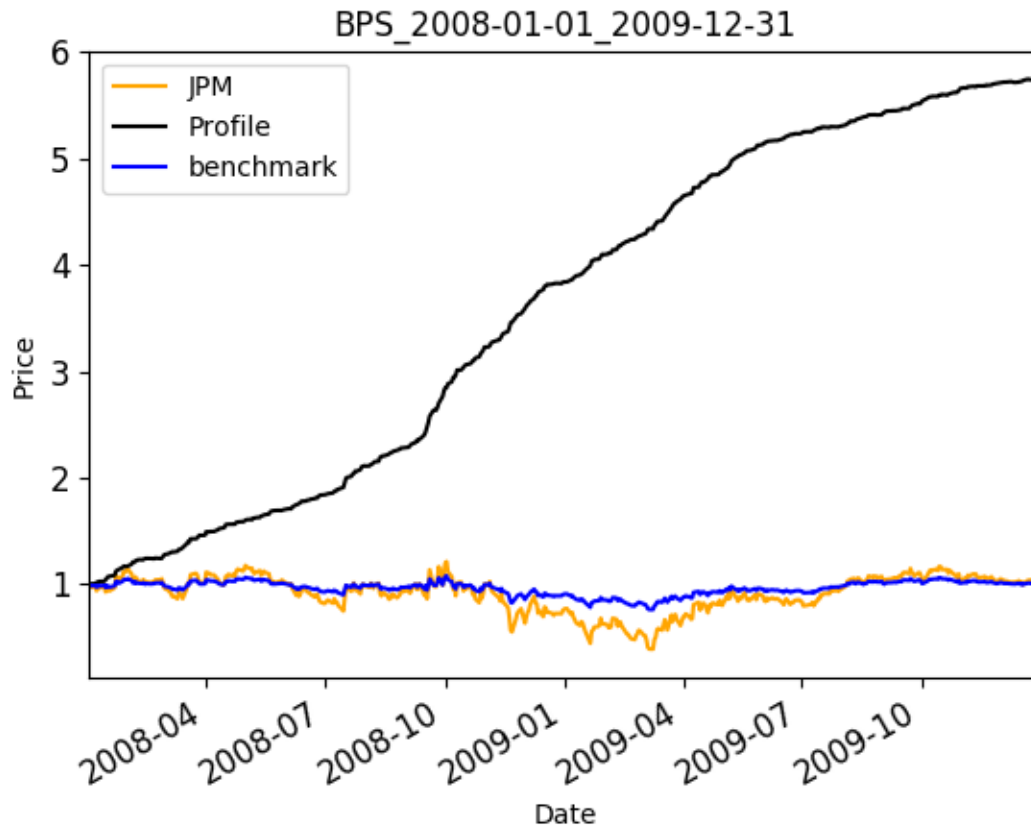
In the testPolicy(), the strategy will trade daily given that no commission and impact are considered. The rule is to compare a day with regard to the day prior to it. If there is a price drop, the strategy shorts, whereas if there is a price rise, the strategy longs. A for loop was used to iterate through the period between 2008-1-1 and 2009-12-31.

During the for loop, a trading list will be updated, and the list will then be formatted into a csv file and saved into the same folder for later on portfolio computation.

A test() function was developed to compute portfolio, plot charts, and print out stats.

The following two plots are the results from 2008-1-1 to 2009-12-31 (in sample) and from 2010-1-1 to 2011-12-31 (out of sample). The plots include the price, profile, and benchmark during those in sample and out of sample periods.

The benchmark is to buy 1000 share of JPM and hold it to the end.



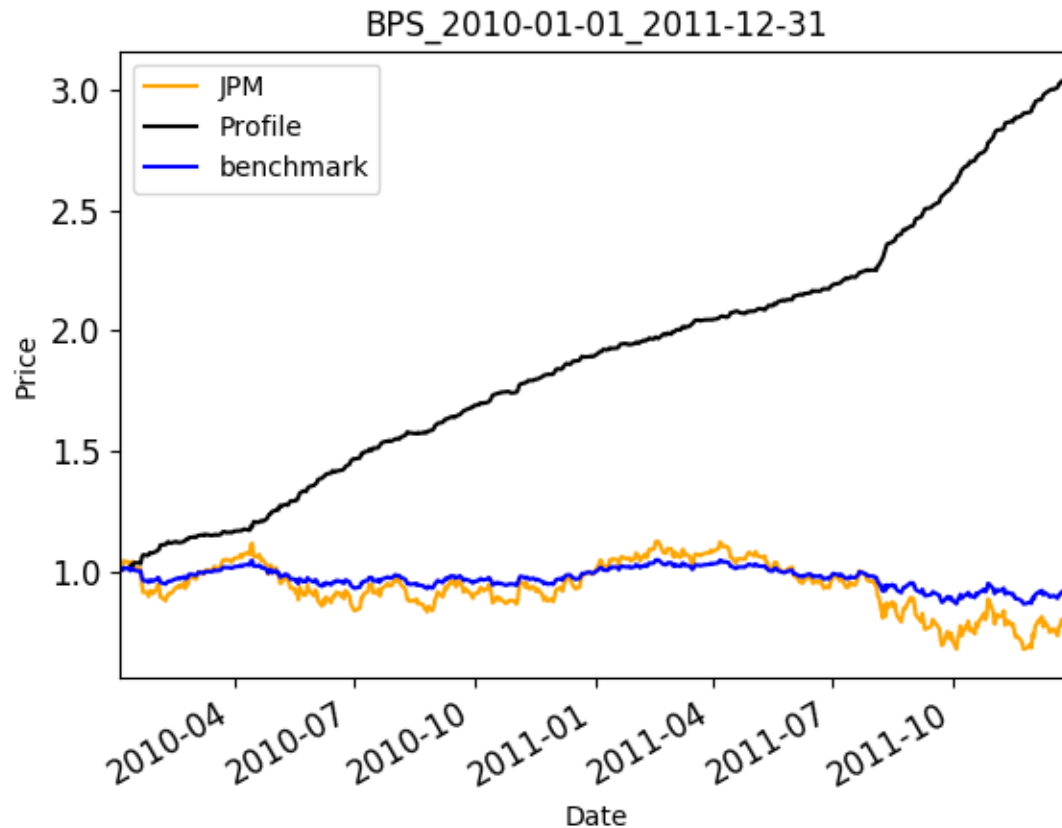
Date Range: 2008-01-02 00:00:00 to 2009-12-29 00:00:00
 Sharpe Ratio of Fund: 11.2961738373
 Cumulative Return of Fund: 4.7428735
 Standard Deviation of Fund: 0.00491854801001
 Average Daily Return of Fund: 0.00349999973643
 Final Portfolio Value: 574287.35

Benchmark

Date Range: 2008-01-02 00:00:00 to 2009-12-31 00:00:00
 Sharpe Ratio of Fund: 0.153467779119
 Cumulative Return of Fund: 0.010277
 Standard Deviation of Fund: 0.0170421605109
 Average Daily Return of Fund: 0.000164756132726
 Final Portfolio Value: 101027.7

From the above chart, the orange curve is the normalized JPM price. The blue curve is the benchmark, and the black curve is the BPS strategy profile. There is a huge gain with cumulative return of 4.74 with the ability to see through future.

From the stats, Sharpe ratio is very high since the profile/portfolio is fast growing with minimal standard deviation. The cumulative return is ridiculously high, thus daily return is also very high, whereas std is very low.



Date Range: 2010-01-04 00:00:00 to 2011-12-29 00:00:00
 Sharpe Ratio of Fund: 10.803546616
 Cumulative Return of Fund: 2.0421515
 Standard Deviation of Fund: 0.00326792743216
 Average Daily Return of Fund: 0.00222401895215
 Final Portfolio Value: 304215.15

Benchmark

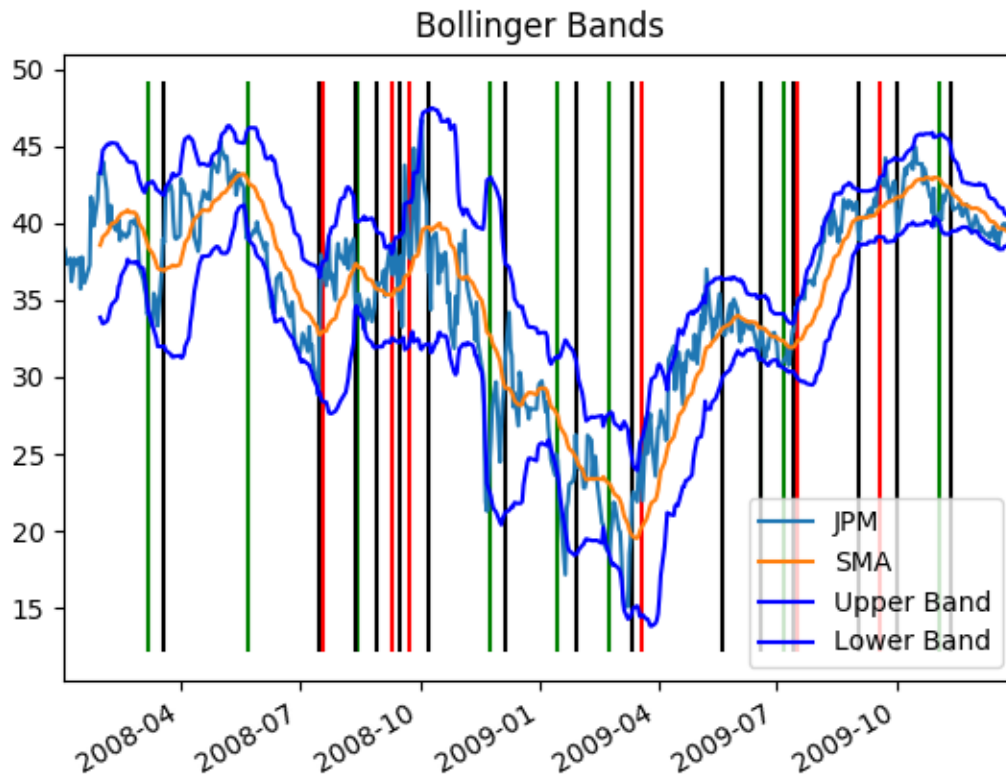
Date Range: 2010-01-04 00:00:00 to 2011-12-30 00:00:00
 Sharpe Ratio of Fund: -0.26478857101
 Cumulative Return of Fund: -0.085543
 Standard Deviation of Fund: 0.00849657505114
 Average Daily Return of Fund: -0.000141723824462
 Final Portfolio Value: 91445.7

From the chart above, profile/portfolio is growing drastically with the ability to know the future and no commission and impact. Profile is much higher than benchmark, where 1000 stocks hold from the beginning.

From the stats, the Sharpe ratio is also very high due to high growth and low standard deviation. The cumulative return is also high, but not as high as 2008-2009, overall, this is due to the less amount of JPM price change during 2010 and 2011.

The ManualStrategy.py implements a set of rules based on the indicators in the indicators.py. The rules were optimized for higher returns within the in sample data, and later on used on the out of sample data.

1) Bollinger band

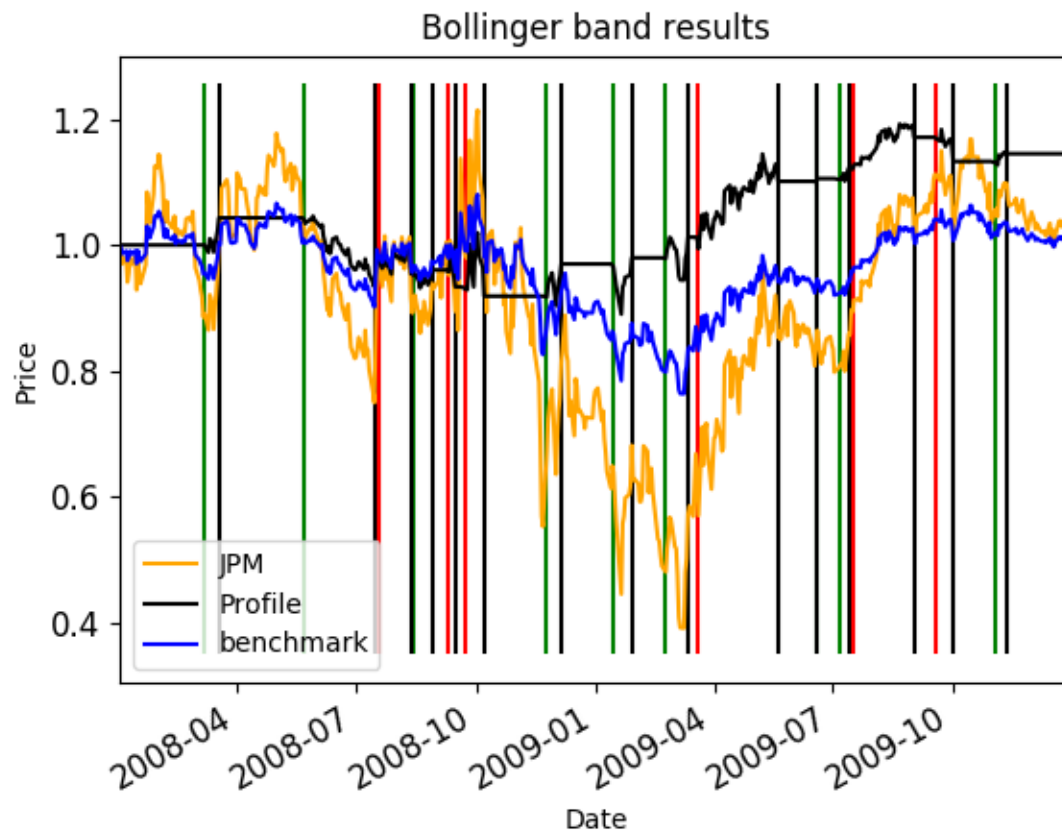


As shown in the above chart, the Bollinger bands (upper and lower) are drawn with blue color during the in sample period from 2008-1-1 to 2009-12-31. The bands are 2 std away from the rolling mean in orange. The light blue is the JPM price in this period.

The green vertical lines are long/buy entry points, and the red vertical lines are short/sell entry points, whereas the black vertical lines are long exits (sell) or short exits (buy).

The long entry points were determined by looping through the period and consider the price where it is lower than the lower band, but becomes higher than the lower band the next day. The long exits/sell off happens when the price is higher than the rolling mean.

The short entry points were determined by looping through the period and consider the price where it is higher than the upper band, but becomes lower than the upper band the next day. The short exits/buy back happens when the price is lower than the rolling mean.



Date Range: 2008-03-07 00:00:00 to 2009-11-11 00:00:00

Sharpe Ratio of Fund: 0.503793850136

Cumulative Return of Fund: 0.144915

Standard Deviation of Fund: 0.0124850270525

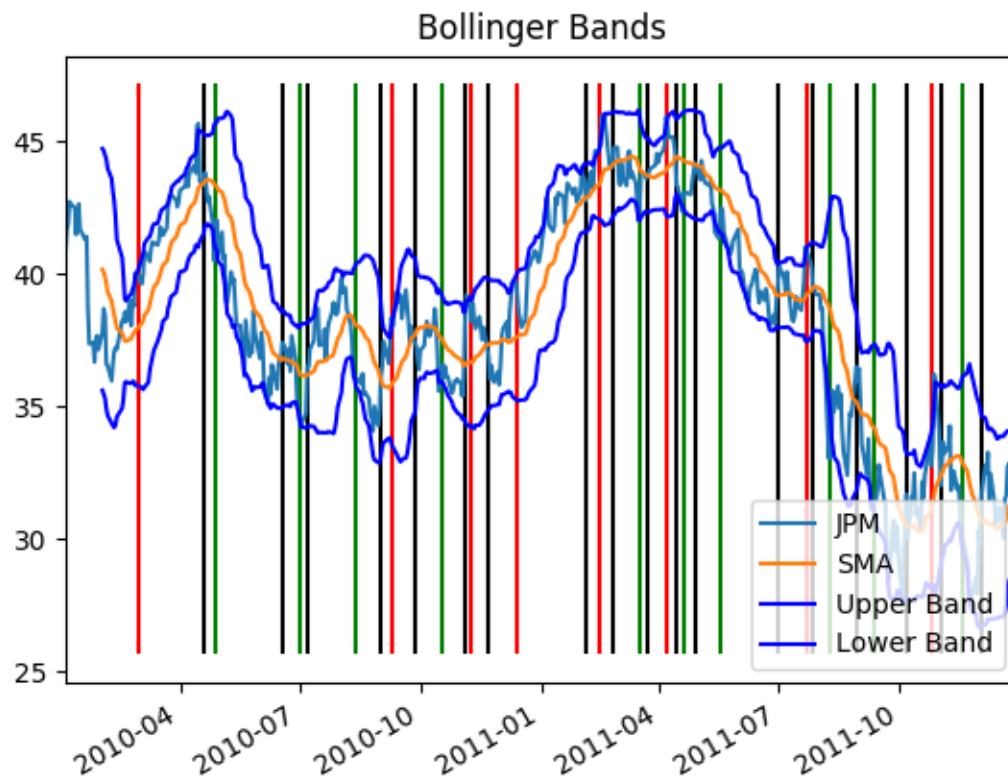
Average Daily Return of Fund: 0.000396225186995

Final Portfolio Value: 114491.5

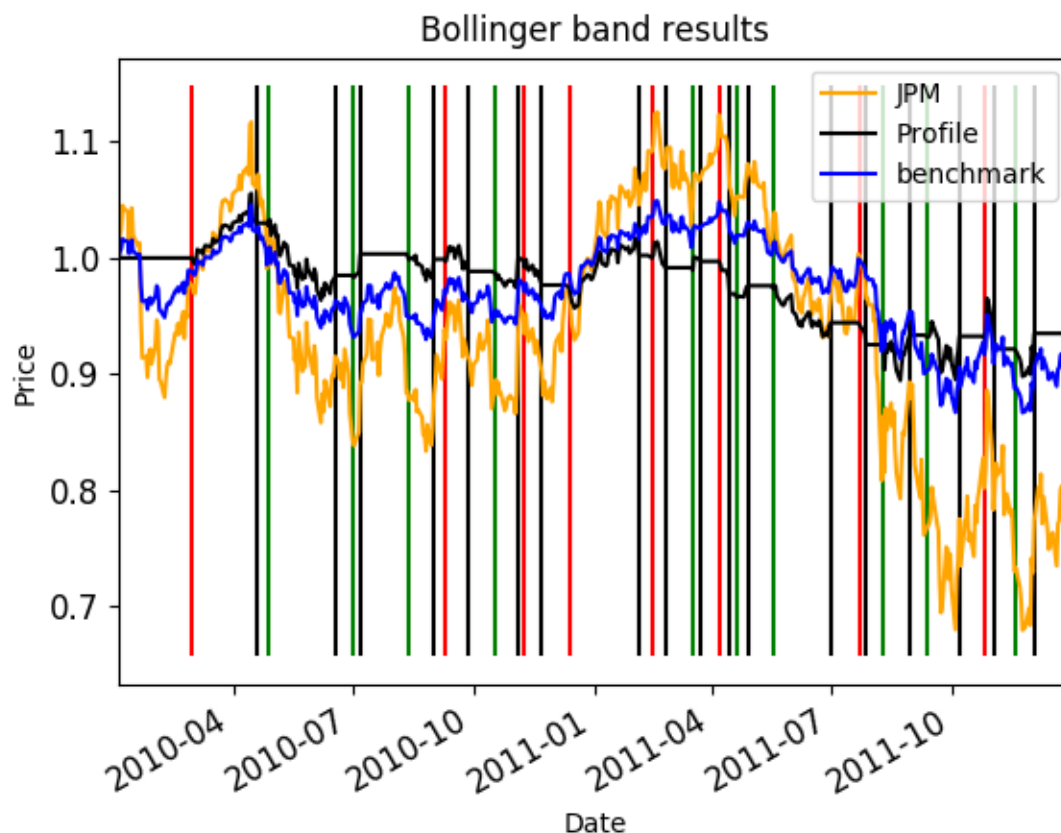
As shown above, the Bollinger band strategy entries were applied to the in sample period and the portfolio/profile was calculated using the `compute_portvals()` in `marketsimcode.py`.

The orange curve is the JPM price during the in sample period. The blue curve is the benchmark – hold 1000 shares of JPM through the period. The black is the profile of the fund with the manual strategy based on the Bollinger band rules.

The Sharpe ratios is around 0.5, with cumulative return of 0.145, and the final portfolio value is 114491.5 (starting at 100000). Overall, 14.5% return.



As shown on the above chart, the same Bollinger band strategy was applied to the out of sample period between 2010-1-1 and 2011-12-31.



Date Range: 2010-03-01 00:00:00 to 2011-12-02 00:00:00

Sharpe Ratio of Fund: -0.325966515997

Cumulative Return of Fund: -0.064979

Standard Deviation of Fund: 0.00635579940755

Average Daily Return of Fund: -0.000130509733385

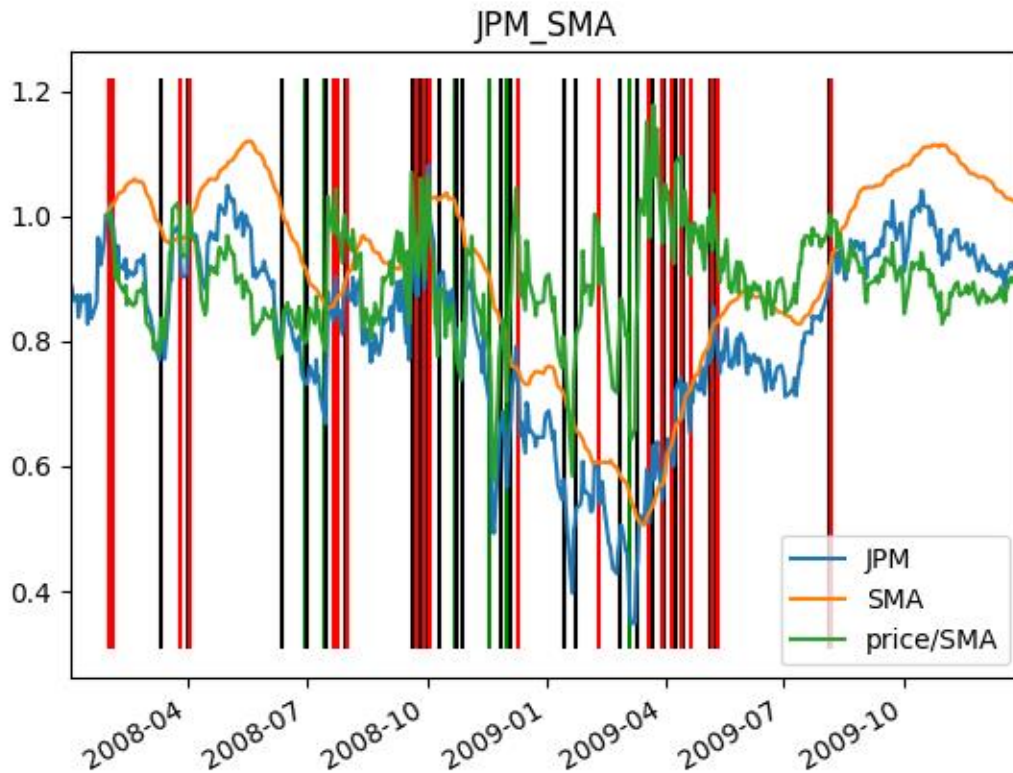
Final Portfolio Value: 93502.1

As shown in the above, the price, benchmark, and profile are plotted with orange, blue, and black color, respectively.

The Sharpe ratio is negative due to negative return. The cumulative return is -0.065, and the final portfolio value is 93502.

The in sample performance is much better than out of sample, because the rules favor the trend of in sample period more. More specifically, the Bollinger band rule was able to avoid the huge dip at 2009-4 and finally make better return, whereas the out of sample has smoother price change and two huge dips. We can see the manual strategy based on Bollinger band is susceptible to price change patterns.

2) Simple Moving Average (SMA)



As shown above, the JPM price, SMA, and div(or price/SMA) are plotted in blue, orange, and green color, respectively.

Again, the green vertical line are long entry points, whereas the red is short entry points, and the black is exit points.

The rule is as follows:

For loop (ith day):

If $\text{div}[i-1] \geq 1.0$ and $\text{div}[i] < 1.0$, and not entry:

Start short

If $\text{div}[i-1] < 0.8$ and $\text{div}[i] > 0.8$ and entry:

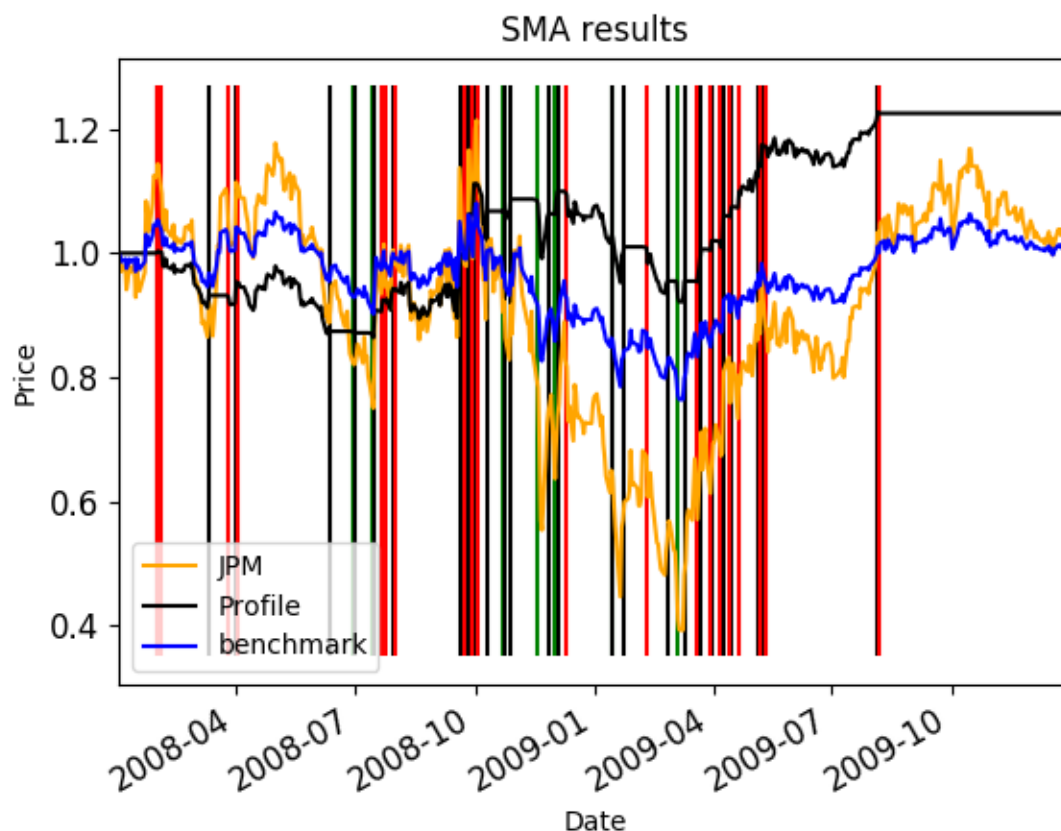
Exit short

If $\text{div}[i-1] > 0.8$ and $\text{div}[i] < 0.8$ and not entry:

Start long

If $\text{div}[i-1] < 1.0$ and $\text{div}[i] > 1.0$ and entry:

Exit long



Date Range: 2008-01-31 00:00:00 to 2009-08-06 00:00:00

Sharpe Ratio of Fund: 0.713158234395

Cumulative Return of Fund: 0.2254335

Standard Deviation of Fund: 0.0140136791068

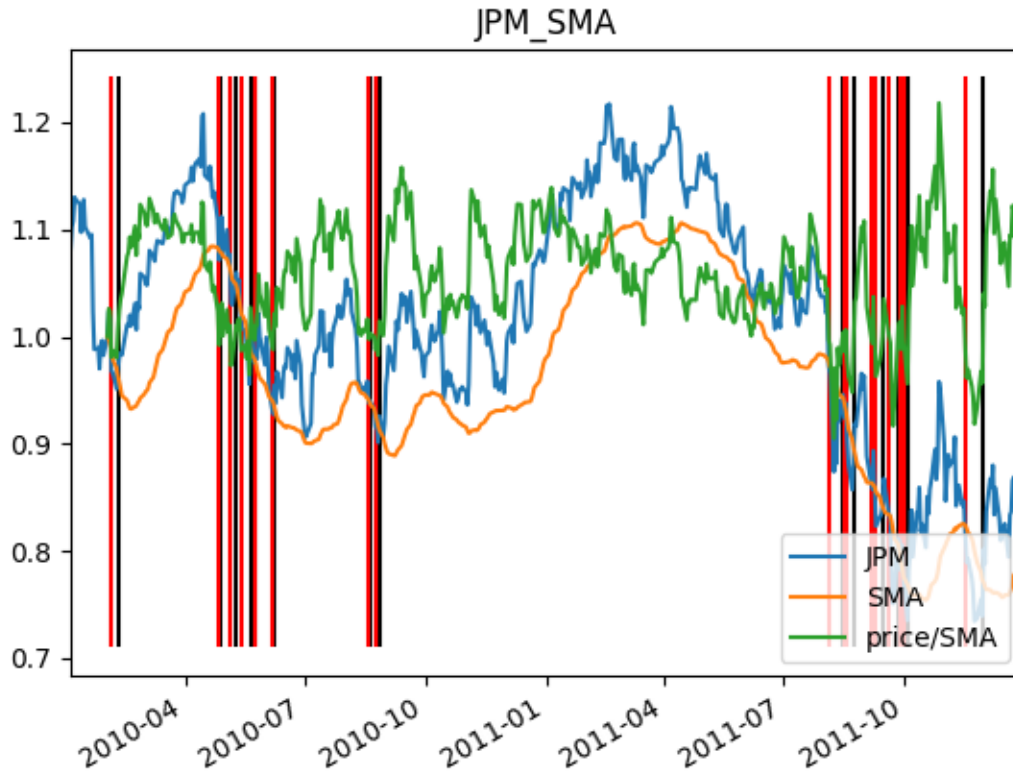
Average Daily Return of Fund: 0.000629560974949

Final Portfolio Value: 122543.35

As shown in the above chart and stats, JPM price, profile, and benchmark are plotted in orange, black, and blue color, respectively.

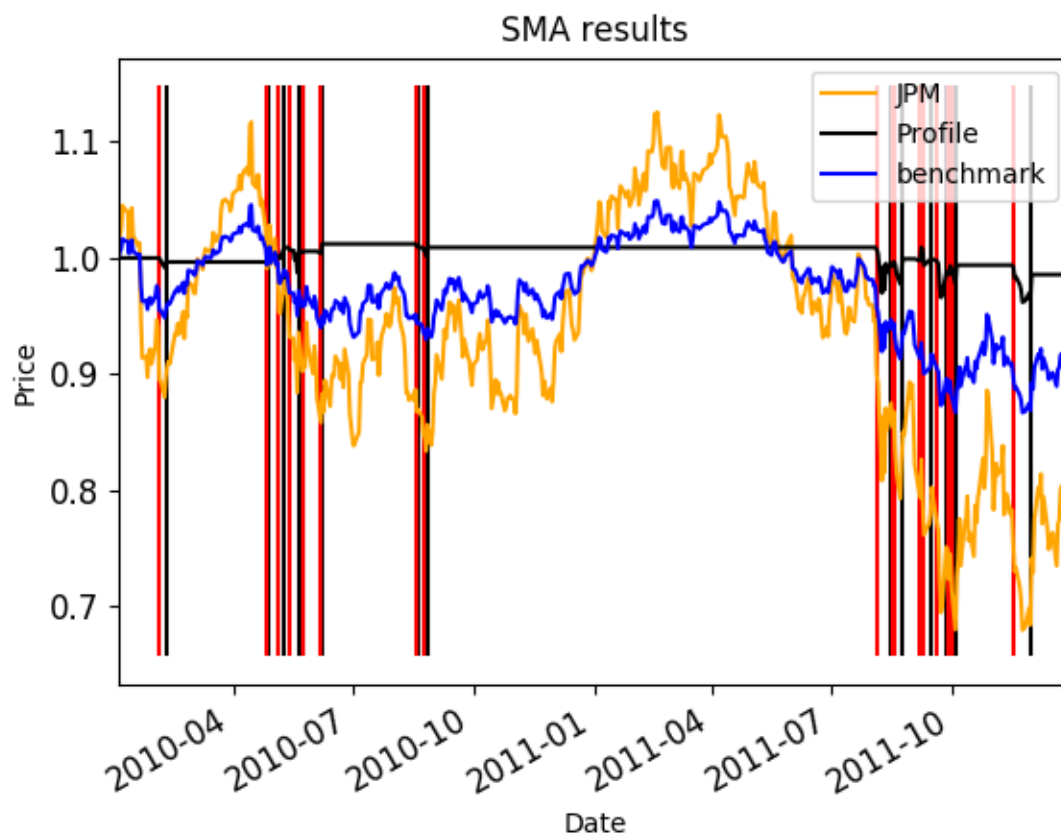
The vertical lines are same as the ones in previous charts, indicating long/short entry/exit points.

The Sharpe ratio is around 0.71, with cumulative return of 0.225. The final portfolio value is 122542. Overall, 22.5% growth during the in sample period. Better than the Bollinger band rules. There are also much more trading than Bollinger band rules.



As shown above, the same SMA rule was also applied to the out of sample period from 2009-1-1 to 2010-12-31. There are less trading in this period compared with in sample SMA results. The trading activities concentrates at the beginning and ending portion of the period due to that there are more drastically changes that trigger the strategy.

Most of the trading activities are short, suggesting sharp decline at the beginning and ending portions.



Date Range: 2010-02-04 00:00:00 to 2011-11-30 00:00:00

Sharpe Ratio of Fund: -0.0978753917285

Cumulative Return of Fund: -0.0143215

Standard Deviation of Fund: 0.00387201168096

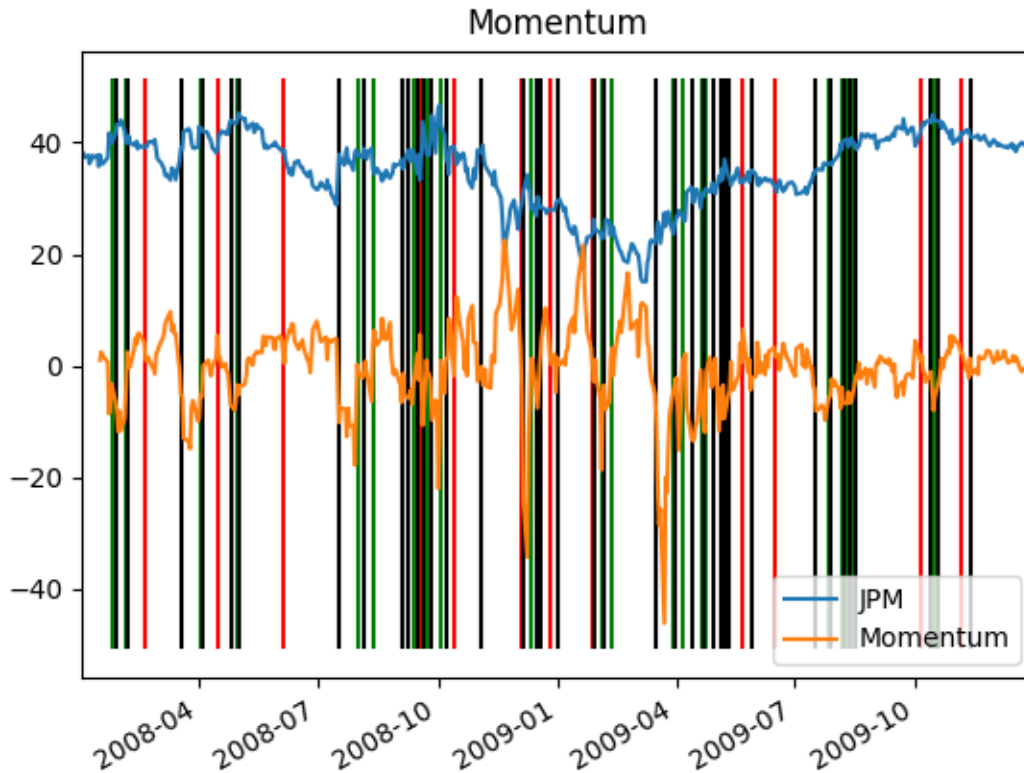
Average Daily Return of Fund: -2.38731596117e-05

Final Portfolio Value: 98567.85

As shown on the above charts and stats, the Sharpe ratio is -0.098 due to negative return, with cumulative return of -0.014. The final portfolio value is 98567.

The portfolio is almost straight line, suggesting the shares were not held for a long time. However, the profile with SMA strategy is still quite higher than benchmark, attributing to the fact the price dropped significantly in the second half of 2011.

3) Momentum



As shown above, momentum was used a strategy to guide long/short activities. Blue color curve is JPM price, whereas yellow orange curve is momentum with a window of 10. Momentum was normalized with regard to the first point, but price was not normalized, because it is better to make the comparison between the two curves visually.

Again, the red and green vertical lines are short and long entry points, whereas black vertical lines are short/long exit points.

There are more long entries than short entries in this period based on the momentum rule.

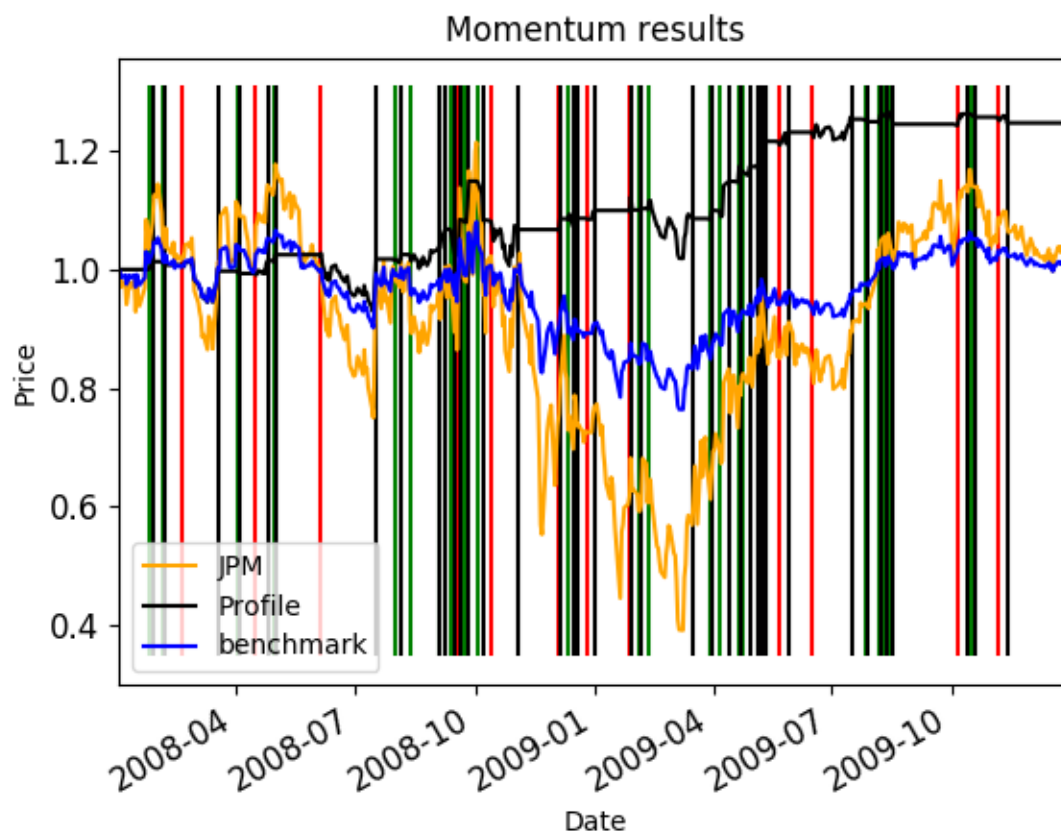
The momentum rule is as follows:

For loop:

```

if momentum1[i-1] > 3.0 and momentum1[i] < 2.8 and not entry:
    Start short (-1000)
if momentum1[i-1] < -2.0 and entry:
    Exit short (0)
if momentum1[i-1] < -6.0 and momentum1[i] > -6.0 and not entry:
    Start long (1000)
if momentum1[i-1] > 5.0 and momentum1[i-1] < 5.0 and entry:
    Exit long (0)

```



Date Range: 2008-01-25 00:00:00 to 2009-11-12 00:00:00

Sharpe Ratio of Fund: 0.870557119712

Cumulative Return of Fund: 0.247051

Standard Deviation of Fund: 0.00969816232146

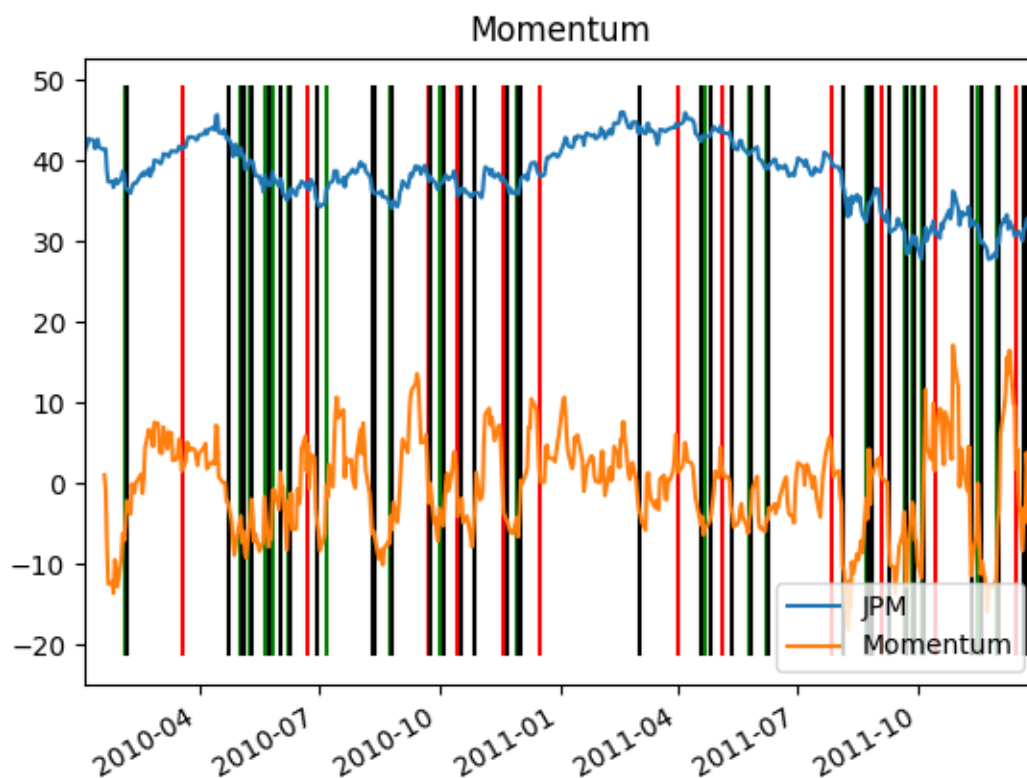
Average Daily Return of Fund: 0.000531846676957

Final Portfolio Value: 124705.1

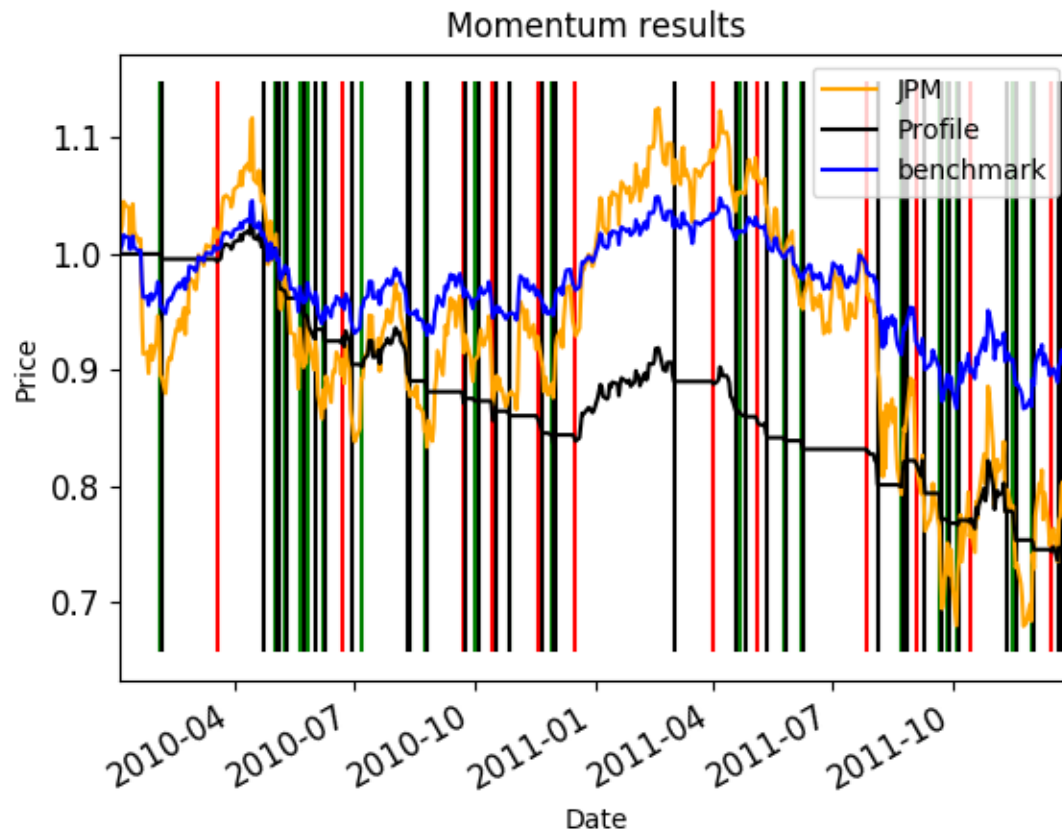
As shown in the above chart and stats, the JPM price, profile, and benchmark are plotted in orange, black, and blue color, respectively. The in sample profile growth is much higher than the benchmark.

The Sharpe ratio is around 0.87, with cumulative return of 0.247. The final portfolio value is 124705.

The strategy made faster growth at the later stage of the period, because it was not affected by the big dip at around the 2009-4, since the momentum rule captured that dip.



In the above chart, the same momentum rules were applied to the out of sample period. There are a little more long entries than short entries. The overall JPM price is not as noisy as the in sample period, this may change the return significantly since the momentum pattern changed a lot.



Date Range: 2010-02-04 00:00:00 to 2011-12-23 00:00:00

Sharpe Ratio of Fund: -1.56242632493

Cumulative Return of Fund: -0.255156

Standard Deviation of Fund: 0.00608453544407

Average Daily Return of Fund: -0.000598861925851

Final Portfolio Value: 74484.4

As shown above, the momentum rules were tested on the out of sample period, the profile is much lower than benchmark.

The Sharpe ratio is at -1.56 due to a negative return, with cumulative return at -0.255. The final portfolio value is 74484.

The momentum rules optimized in sample doesn't generalize well to out of sample period due to momentum pattern difference between the two periods.

Part IV. Comparative Analysis

	Benchmark		BPS		Manual Strategy					
					Bollinger bands		SMA		Momentum	
In/Out of sample	In sample	Out of sample	In sample	Out of sample	In sample	Out of sample	In sample	Out of sample	In sample	Out of sample
Sharpe ratio	0.15346	-0.26478	11.2961	10.8035	0.50379	-0.32596	0.71315	-0.09787	0.87055	-1.56242
Cumulative return	0.01027	-0.08554	4.74287	2.04215	0.14491	-0.06497	0.225433	-0.01432	0.247051	-0.25515
Standard deviation	0.01704	0.00849	0.00491	0.00326	0.01248	0.00635	0.01401	0.00387	0.00969	0.00608
Average daily return	0.00016	-0.00014	0.00349	0.00222	0.00039	-0.00013	0.00062	-2.38e-05	0.00053	-0.00059
Final Portfolio value	101027.7	91445.7	574287.3	304215.1	114491.5	93502.1	122543.3	98567.85	124705.1	74484.4

As shown in the table, a comparison between the bench mark, BPS, and manual strategy is presented as a summary of this project.

In sample returns are higher than out of sample return in all cases, suggesting that manual strategy cannot perform stably regardless of market trends. Three manual strategy are all higher than benchmark within in sample period. Bollinger bands and SMA are also higher than benchmark during out of sample period, however, Momentum rule turned out to be lower in the out of sample results compared with benchmark, due to the fact that momentum rules cannot capture the dips in the out of sample period.

Most of the comparison has been discussed in the previous session. To summarize, all the in sample manual strategy returns are much higher than benchmark. All the portfolio/profile to benchmark comparison plots were normalized to 1.0 with the right color code.