Project 6: Manual Strategy
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Course: CS7646

Part 1: Technical Indicators

3 different technical indicators were used in this strategy: SMA, Bollinger Bands and Stochastic Oscillator.

Indicator 1: Simple Moving Average (SMA)

Simply put, SMA is the average price of the adjusted stock price for a given window of time. As such, the following expression is used to calculate it, where A is the price of an asset at time "n", and "n" is the number of total periods.

$SMA = (A_1 + A_2 + \ldots + A_n) / n$

As shown in ***Figure 1.1,*** It is widely believed that SMA often serve as support or resistance levels. This means that when the price of the stock moves lower towards the SMA from a higher price, it is often met by a growing number of buyers, which acts as a support to stop the stock from further going down in price. Vice-versa, if the price of the stock moves higher towards the SMA form a lower price, it is often met by a growing number of sellers, which makes the price "resistant" from going up. In ***Figure 1.1***, numerous instances can be seen where in most cases, price looks to be "bouncing" off the SMA. But when the price does penetrate deep enough through the SMA, the price falls or rises rapidly in the direction it penetrated towards the SMA.

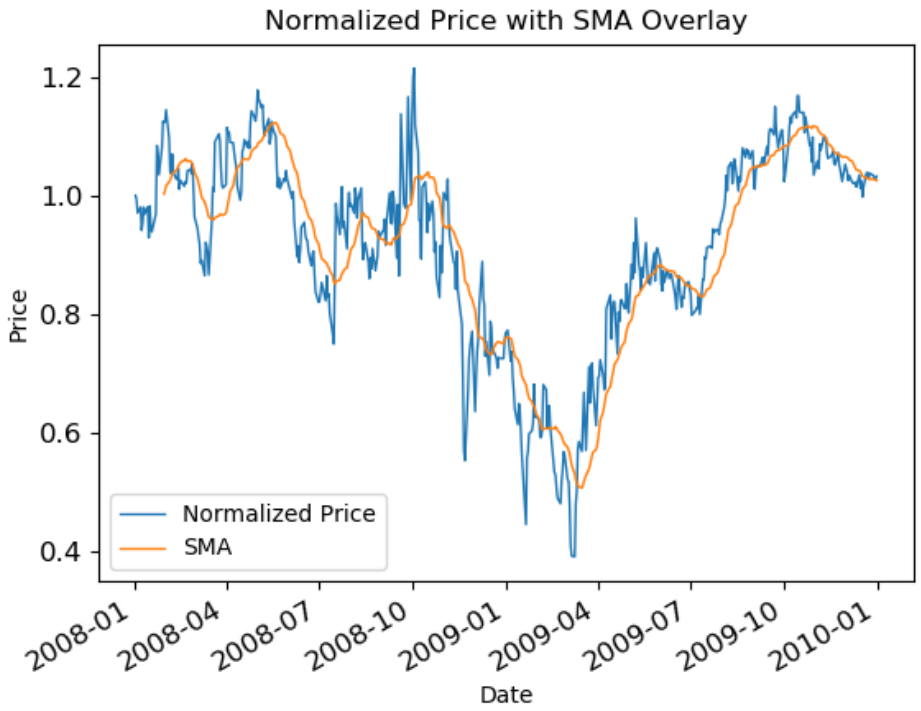

Figure 1.1

Indicator 2: Bollinger Bands:

Bollinger Bands consist of 2 lines above and below the SMA. In ***Figure 1.2*** below, the upper line (shown in green) represents the price which is 2 standard deviations above the SMA (shown in orange). The lower line (shown in red) represents the prices which is 2 standard deviations below the SMA (shown in orange). Therefore, the upper and lower Bollinger bands are calculated using this expression, where "n" is the number of days in the given window of timeframe and "std" is the standard deviations during the "n" number of days in the given window.

Upper Band = $SMA_n + 2*std_n$

Lower Band = $SMA_n - 2*std_n$

Given that the probability that the price is two standard deviations away from the SMA is significantly low, reaching the bands are often seen as a trade signal. When the price of the stock crosses the upper band from below and crosses back from above, it is a sell signal. Similarly, when the price of the stock crosses the lower band from above and then crosses back from below, it is a buy signal.

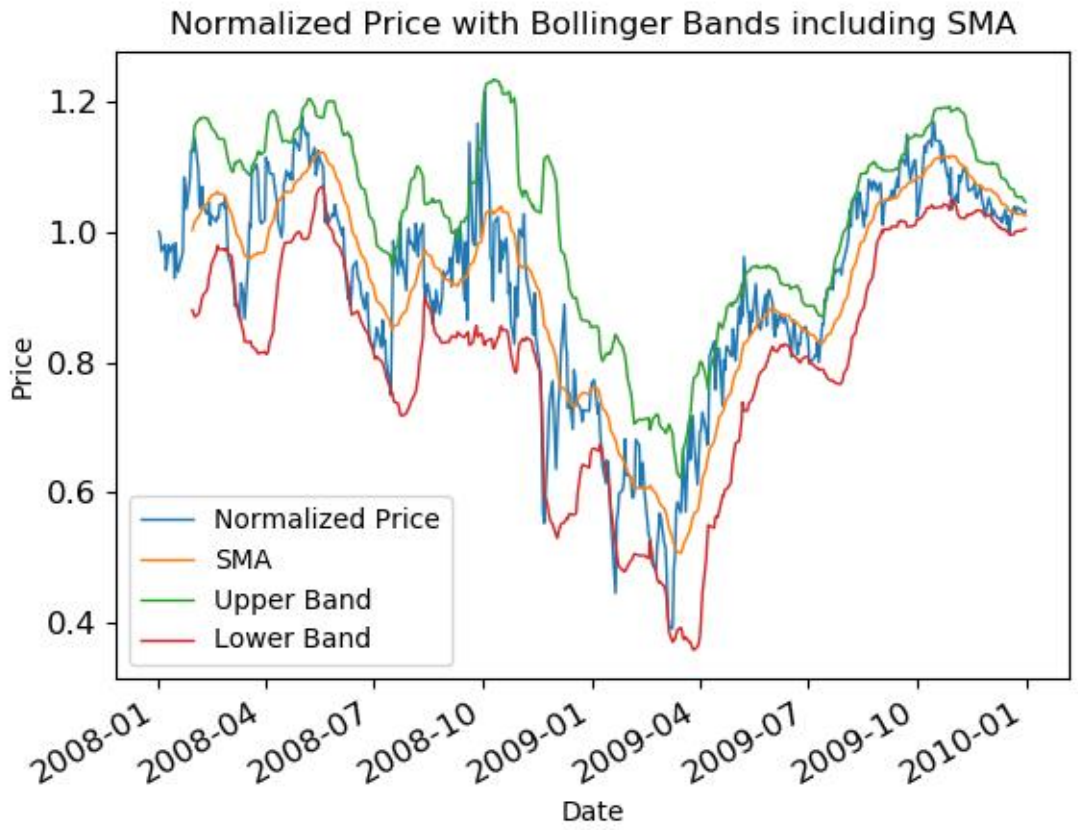

Figure 1.2

Indicator 3: Stochastic Oscillator:

Stochastic Oscillator is a momentum driven indicator which compares the price of a security to a range of its prices over a window of time. It is calculated using this expression, where P is the most recent price, L is the lowest price traded of the "n" number of previous trading sessions, H is the highest price for the same number of sessions:

$K = (P - L_n) / (H_n - L_n) * 100$

The Stochastic oscillator is used to identify overbought and oversold signals. As shown in ***Figure 1.3***, it is thought that stochastic readings (shown in blue) below 20 indicate that a stock has been oversold, and thus a buy signal. It is thought that stochastic readings above 80 indicate that a stock has been overbought, and thus a sell signal.

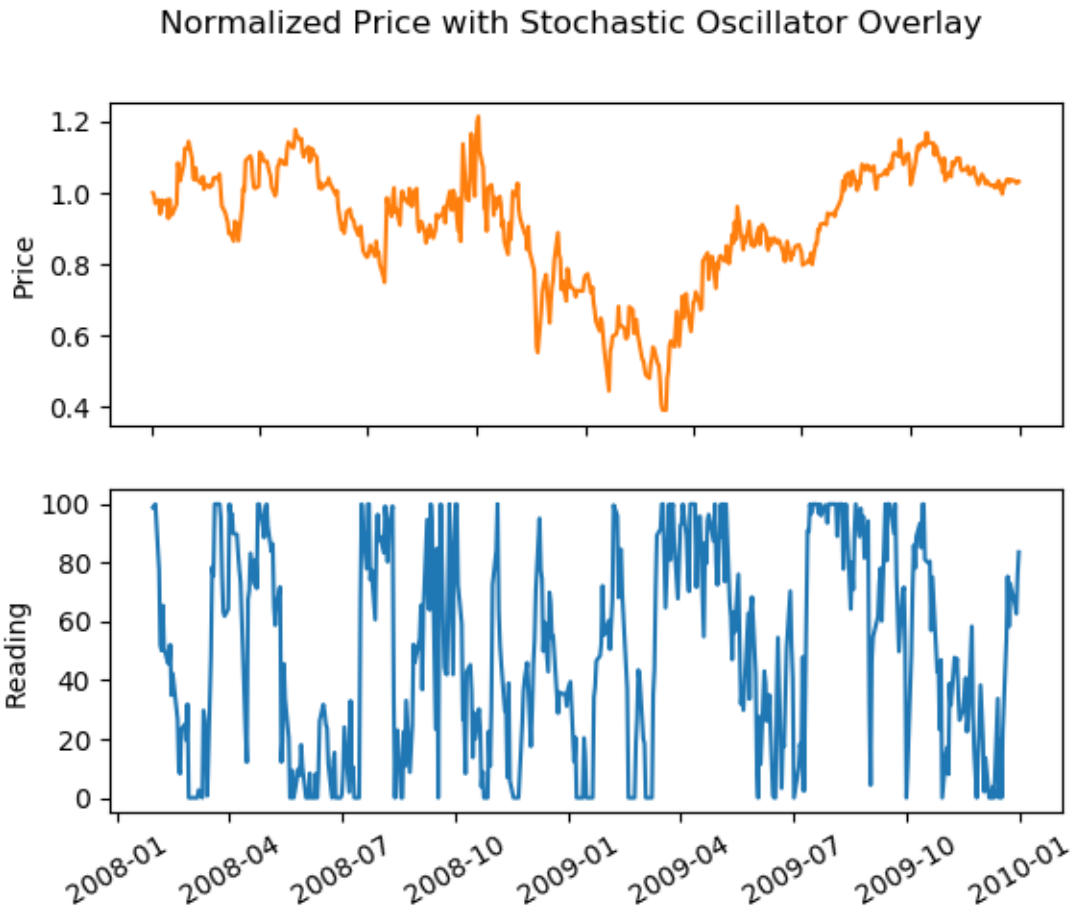

Figure 1.3

Part 2: Theoretically Optimal Strategy

In the theoretically optimal strategy, my assumptions were as follows:

- I have access to future prices of the stock.
- I am constrained by the portfolio size which had to be 0, 1000 shares long or 1000 shares short.
- My orders were also limited due to the set portfolio size.
- Commission: $0, Impact: 0.00.

To implement this strategy, I traversed through each day of the trading day and peeked into the future one day ahead. For each day, depending on the price of the stock the next day and the net holdings, I used the following logic:

- If my net holdings were 0 (which would occur only on the first trading day), if the price of the stock one day in the future was higher, I would buy 1000 shares. If the stock one day in the future was lower, I would short 1000 shares.
- If my net holdings were -1000 shares, meaning I had shorted it the previous day, if the price of the stock one day in the future was higher, I would buy 2000 shares. If the stock one day in the future was lower, I would not make any orders since I was under the constraint of - 1000 shares.
- If my net holdings were 1000 shares, meaning I had bought it the previous day, if the price of the stock one day in the future was lower, I would sell 2000 shares. If the stock one day in the future was higher, I would not make any orders since I was under the constraint of 1000 shares.

As shown in ***Table 2.1***, and ***Figure 2.1,*** the theoretically optimal strategy performed extremely well at 578% cumulative return since it could peek into the future. The benchmark showed only 1.23% cumulative return over the course of the timeframe. Below are the statistics of stock JPM with the date range between 1/1/2010 and 12/31/2011.

	Theoretically Optimal Strategy	**Benchmark**
Sharpe Ratio	13.323	0.160
Cumulative Return	5.7861	0.0123
Average Daily Return	0.0038	0.0002
Standard Deviation	0.0045	0.0170
Final Portfolio Value	$ 678,610.00	$ 101,230.00

Table 2.1

The ***Figure 2.1*** below shows the performance of the two portfolios over the course of the timeframe. The prices have been normalized so that they can be more easily compared. As expected, the figure depicts that the theoretically optimal portfolio performed much better than the benchmark portfolio.

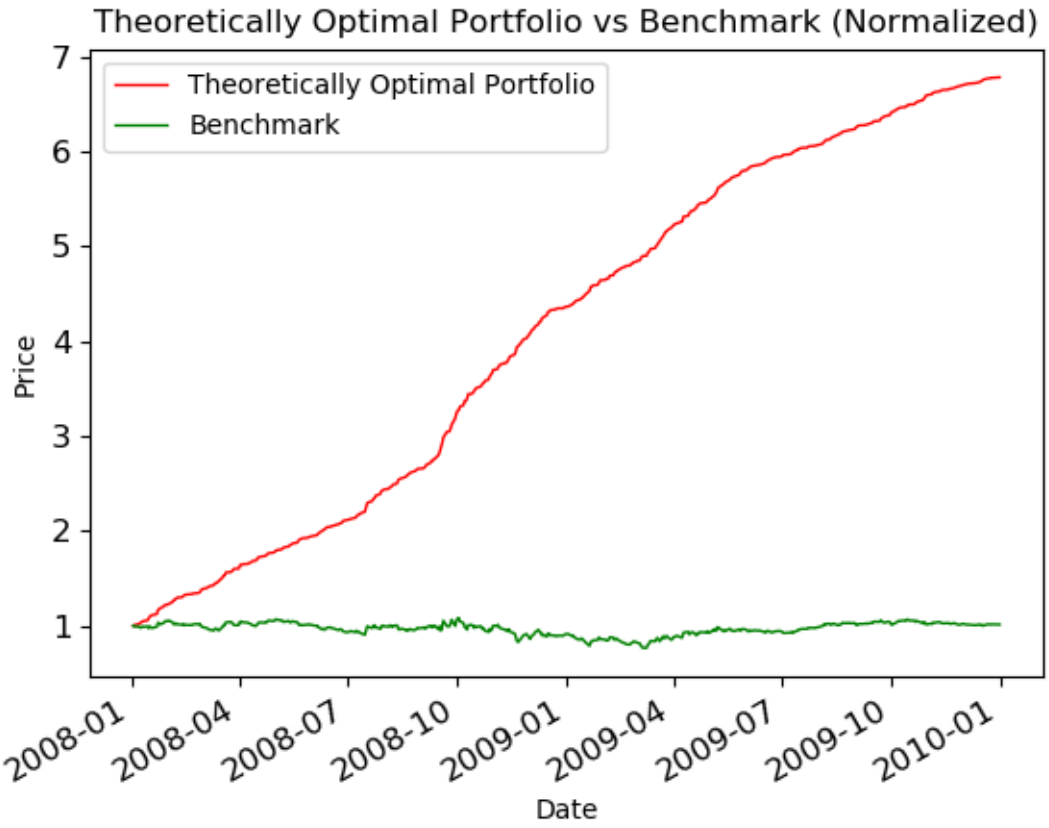
Theoretically Optimal Portfolio vs Benchmark (Normalized)
Theoretically Optimal Portfolio
Benchmark
Price
Date
7
6
5
4
3
2
1
2008-01
2008-04
2008-07
2008-10
2009-01
2009-04
2009-07
2009-10
2010-01

Figure 2.1

Part 3: Manual Rule-Based Trader Strategy

In the manual rule-based trader strategy, my assumptions were as follows:

- I am constrained by the portfolio size which had to be 0, 1000 shares long or 1000 shares short.
- My orders were also limited due to the set portfolio size.
- Commission: $9.95, Impact: 0.005.

To implement this strategy, I created a set of logic involving SMA, Bollinger Bands and Stochastic Oscillator indicators which was used to determine a long or short signal. Like the theoretically optimal strategy, I traversed through each day of the trading day. However, because we cannot peek into the future using this strategy, we compared the given day with the day(s) before (as opposed to after) to calculate the values for the indicators.

First, I used the Bollinger Band indicator

- If the price the day before was higher than the upper band and the price the day of was lower than the upper band, it was considered a sell signal. If my net holdings were 0, I would short 1000 shares. If my net holdings were 1000 shares, I would short 2000 shares. If my net holdings were already -2000 shares, I would do nothing.
- If the price the day before was lower than the lower band and the price the day of was higher than the lower band, it was considered a buy signal. If my net holdings were 0, I would take a long position on 1000 shares. If my net holdings were -1000 shares, I would take a long position on 2000 shares. If my net holdings were already 2000 shares, I would do nothing.

Second, I used the SMA indicator:

- If the price the day before was higher than the SMA and the price the day of was lower than 99% value of SMA that day, it was considered a sell signal. If my net holdings were 0, I would short 1000 shares. If my net holdings were 1000 shares, I would short 2000 shares. If my net holdings were already -2000 shares, I would do nothing.
- If the price the day before was lower than the SMA and the price the day of was higher than 101% value of SMA, it was considered a buy signal. If my net holdings were 0, I would take a long position on 1000 shares. If my net holdings were -1000 shares, I would take a long position on 2000 shares. If my net holdings were already 2000 shares, I would do nothing.
- The +/- 1% was a personal choice as it performed the highest with the in-sample data compared to other percentages.

Lastly, I used the Stochastic indicator:

- If the stochastic reading was higher than 85, it was considered a sell signal. If my net holdings were 0, I would short 1000 shares. If my net holdings were 1000 shares, I would short 2000 shares. If my net holdings were already -2000 shares, I would do nothing.
- If the stochastic reading was lower than 15, it was considered a buy signal. If my net holdings were 0, I would take a long position on 1000 shares. If my net holdings were -1000 shares, I would take a long position on 2000 shares. If my net holdings were already 2000 shares, I would do nothing.

- The +/- 15 stochastic reading was a personal choice as it performed the highest with the in-sample data compared to other readings.

As shown below in ***Table 3.1*** and **Figure 3.1,** the manual rule-based trader strategy performed much better than the benchmark. The benchmark showed 1.23% cumulative return over the course of the timeframe, whereas the manual rule-based trader strategy showed 11.40% cumulative return. Below are the statistics of stock JPM with the date range between 1/1/2008 and 12/31/2009.

I believe this is an effective strategy due to the multiple checks it goes through to find any opportunities which meet the criteria of a buy-signal. The 68-95-99.7 rule in statistics states that in a normal distribution, 68% of the population fall under 1 standard deviation from the mean, 95% fall under 2 standard deviations and 99.7% fall under 3 standard deviations. Although market data may not always fall under normal distributions, according to professor Balch, it does more so than not. Given this assumption, I believe that the Bollinger Band is a great indicator signaling a general regression to the mean.

In addition to the statistics, I believe that there is a psychological factor to the market. And as such, I believe the support/resistance of the SMA often is a psychological factor which if crossed with enough momentum, could signal a breakthrough in the direction it was headed.

Lastly, statistics and psychology aside, the stochastic indicator signals that the stock is likely oversold or overbought. If an asset is oversold, there are not enough sellers. And according to professor Balch, this would mean that there is a higher demand than supply of the asset, meaning the price is likely to go up.

Using the three indicators which reflect different factors which influence market price, I believe this is a very balanced strategy to decide whether the trader should take a long or short position on the asset.

	Manual Rule-Based Strategy	**Benchmark**
Sharpe Ratio	0.3666	0.160
Cumulative Return	0.1140	0.0123
Average Daily Return	0.0003	0.0002
Standard Deviation	0.0137	0.0170
Final Portfolio Value	$ 111,146.35	$ 101,230.00

Table 3.1

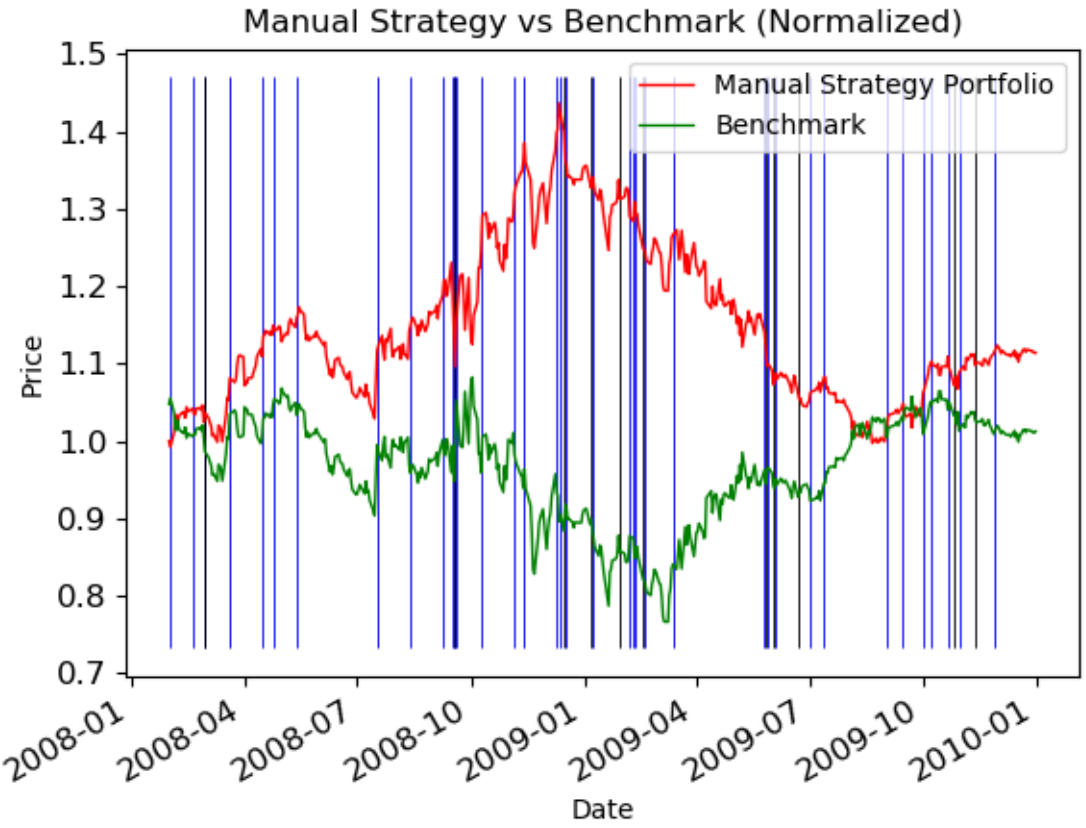
Manual Strategy vs Benchmark (Normalized)
Manual Strategy Portfolio
Benchmark
Price
Date
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
2008-01
2008-04
2008-07
2008-10
2009-01
2009-04
2009-07
2009-10
2010-01

Figure 3.1

Part 4: Comparative Analysis

The manual rule-based strategy based on the three indicators, Bollinger Bands, SMA and Stochastic Oscillator performed very well for the in-sample data. As shown in ***Table 4.1***, the manual strategy had a Sharpe Ratio of 0.3666 over the course of the two years, compared to only 0.160 of the benchmark. We can see that although the standard deviation between the manual strategy and benchmark was not that far off, due to the much large cumulative return at 0.1140 for the manual strategy, the Sharpe Ratio was much higher. As shown in ***Figure 4.1,*** the red line is consistently above the green line, and ends at a higher price.

The manual rule-based strategy did not fare as well in the out-sample data but still performed better than its benchmark. As shown in ***Table 4.1***, the manual strategy had a Sharpe Ratio of -0.073 over the course of the two years, compared to -0.2568 of the benchmark. Again, the standard deviation was not that far apart. However, in the out-of-sample data, the loss indicated by the greater magnitude of the negative number of cumulative returns was much higher in the benchmark. Thus, although the manual strategy did not perform as well as it did in the in-sample data, it still performed better than the benchmark as indicated by the "less negative" Sharpe Ratio. This is also shown in ***Figure 4.2***.

The reason these differences occur is because I formed my manual rule-based strategy by testing various methodologies against the in-sample data. Therefore, of the various indicators I used and the various parameters I used for each indicator; I selected the 3 indicators with the parameters which gave me the highest Sharpe Ratio specifically for the in-sample data. Since the strategy was built on the back of in-sample data, there was no guarantee that it would perform just as well in a totally different set of out-sample data. Although it still performed respectfully, it did not perform as well as it did in the in-sample.

Additionally, as shown in ***Figure 4.2,*** in the out-of-sample data, the stock JPM, which we were using to compare the strategy to the benchmark was trending down. Therefore, the benchmark by default already had a negative cumulative return to begin with. Despite the downtrend, the manual rule-based strategy still performed better than the benchmark, as indicated by the Sharpe Ratio which was less negative, and the Final Portfolio Value which did not lose as much value as the benchmark.

	Manual Rule-Based Strategy (In-Sample)	**Benchmark (In-Sample)**	**Manual Rule-Based Strategy (Out-of-Sample)**	**Benchmark (Out-of-Sample)**
Sharpe Ratio	0.3666	0.160	-0.073	-0.2568
Cumulative Return	0.1140	0.0123	-0.0362	-0.0834
Average Daily Return	0.0003	0.0002	-.0000396	-0.00013
Standard Deviation	0.0137	0.0170	0.0086	0.00848
Final Portfolio Value	$ 111,146.35	$ 101,230.00	$ 96,191.30	$91,660.0

Table 4.1

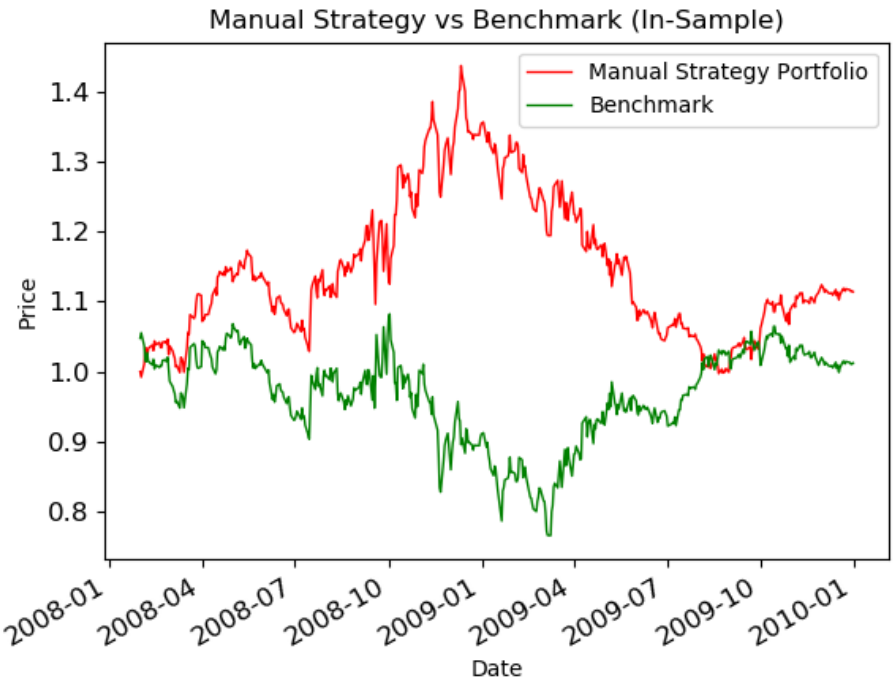

Figure 4.1

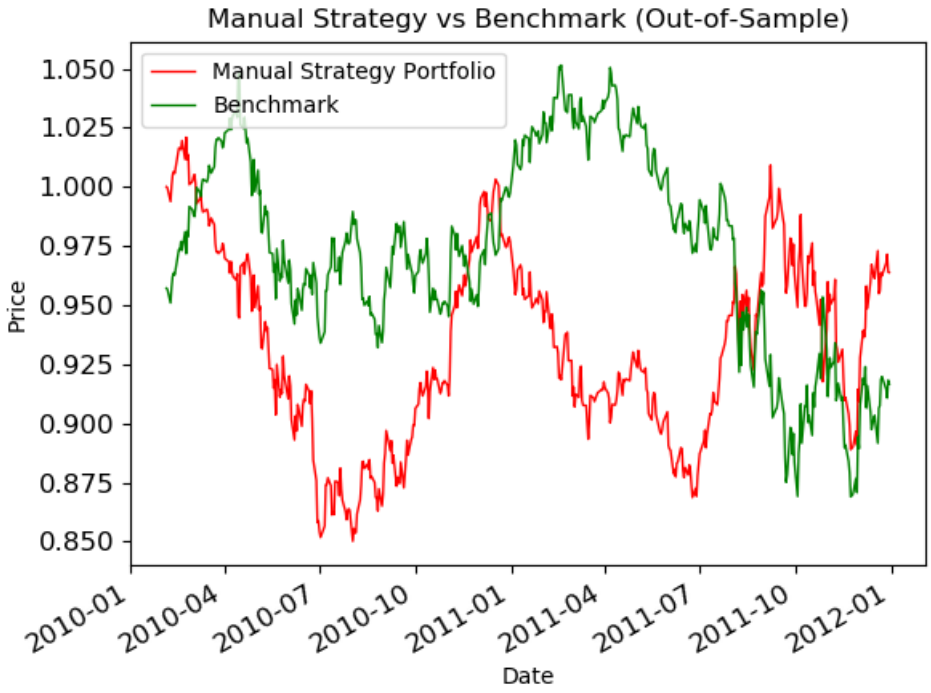

Figure 4.2