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<div align="center">Manual Strategy Report</div>

Part 1: Technical Indicators

In this section, we present three different technical indicators:

1. Bollinger Bands
2. SMA (Simple Moving Average)
3. Rate of Change (ROC)
4. EWMA (Exponential Weighted Moving Average)

In each section below, we will present a description of how we developed each technical indicator, along with a graph that demonstrates the technical indicator using JPM over January 1, 2008 to December 31 2009.

Bollinger Bands

Bollinger bands were originally created by John Bollinger and they are developed by:

1. Compute the rolling mean.
2. Compute the rolling two standard deviations above and below
3. Plot the rolling mean along with the two lines corresponding to two standard deviations above and below.

The Bollinger bands are useful because they demonstrate that in times of high volatility, the bands will spread out whereas in low volatility, the bands will contract. Below is a plot of the Bollinger bands using JPM. For example, one could use the Bollinger bands to indicate buy or sell. For example, if we see the price touching the lower band and starts to go back up, that could be a signal to buy. Furthermore, if we see the price touching the upper band and starts to go back down, we'd want to sell.

JPM Bollinger Bands
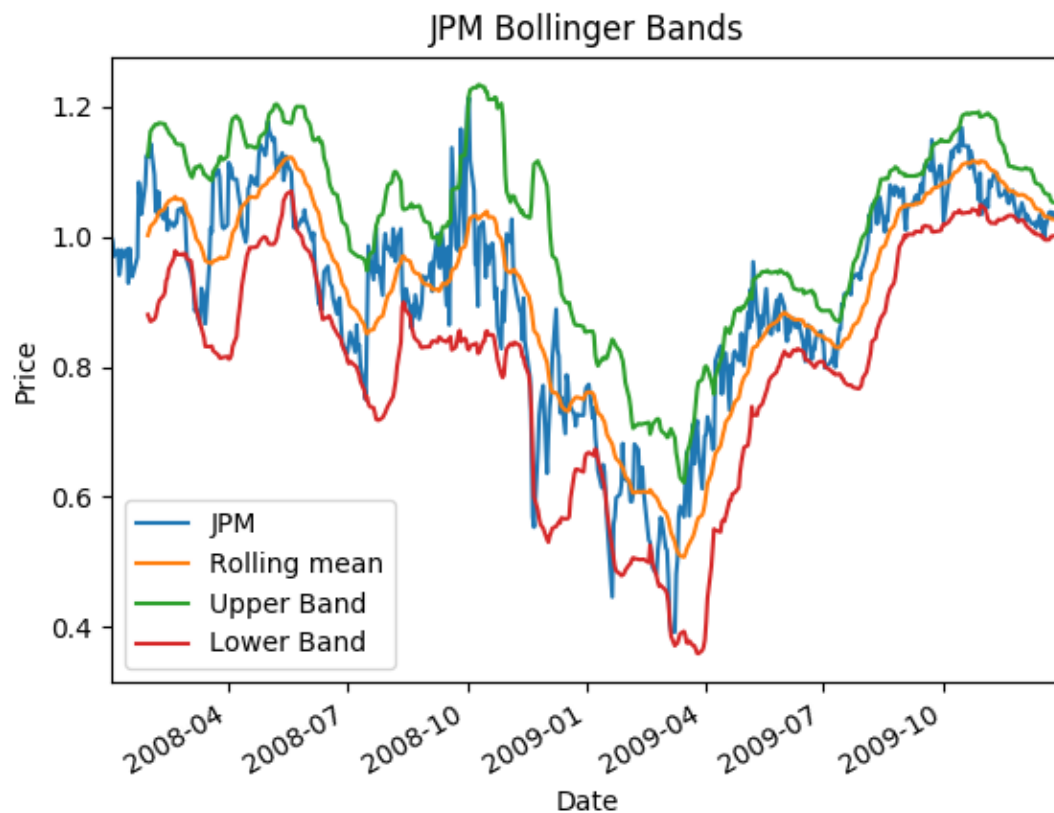
SMA (Simple moving Average)

The simple moving average is a rolling mean over a given time period (we'll use 20 day rolling mean). Thus, over the 20 day time period, we average all the values and we get one mean. We then move the window forward and take another mean. We repeat this every day.

To develop this indicator we will plot three things:
1. Price
2. SMA (Simple Moving Average)
3. Price/SMA

A plot of the SMA is shown below:
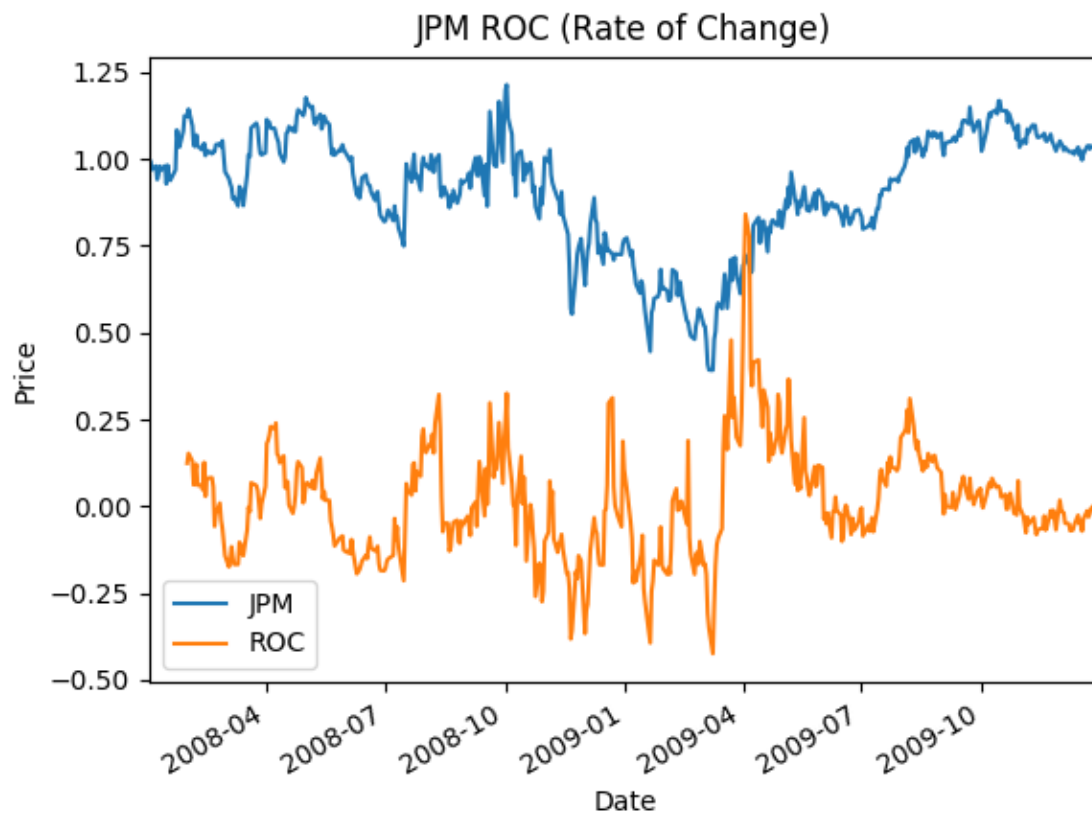
JPM SMA (Simple Moving Average)
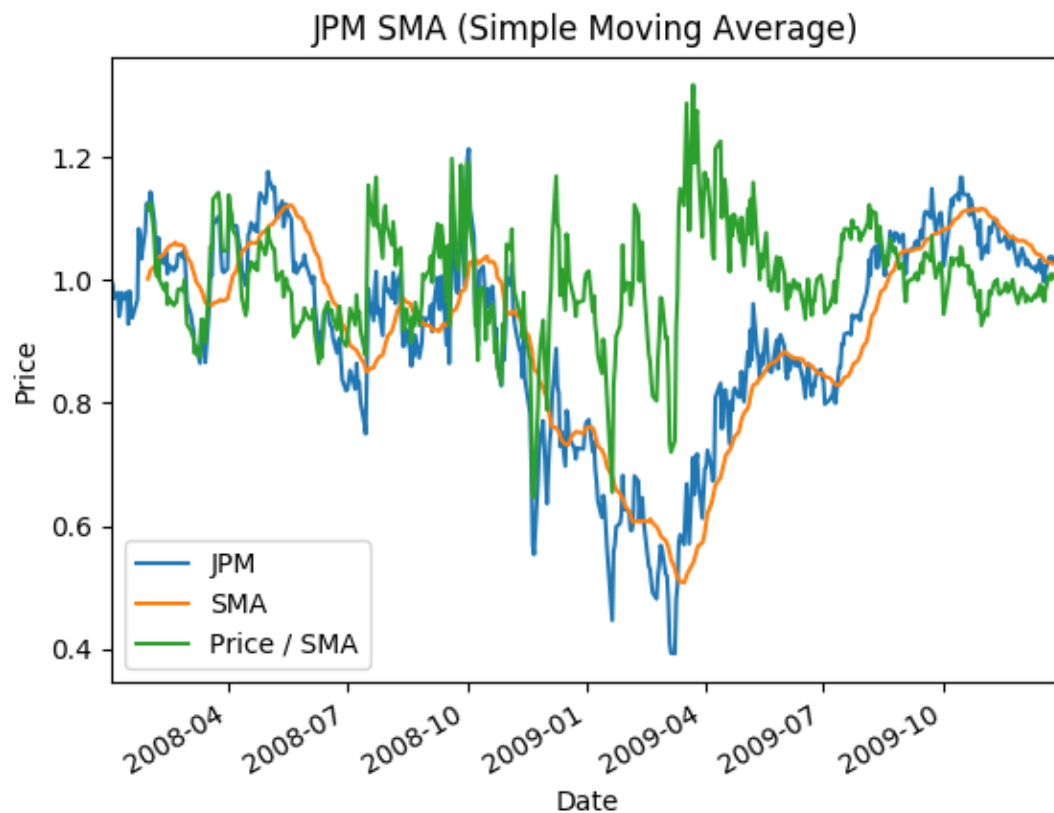
Rate of Change (ROC)

The Rate of Change measures the percentage change between the most recent price and the price some time period ago (we'll use 20 days in this case). If ROC is going up, that means bullish, if the ROC is going down, that means bearish.

To develop this indicator we plot two things:
1. Price
2. ROC using 20 day period

We can view the ROC curve for JPM below. Furthermore, as noted before, as ROC is going up we note that it's bullish, when it's going down we know it's bearish. In particular when it's above 0 we know we're generally trending upwards, when it's below, we know we're generally downwards.

Exponential Weighted Moving Average (EWMA)

The exponential weighted moving average is similar to the simple moving average. However, while the SMA reduces noise in the measure, it comes at a price, which is that it is a lagging indicator. To account for this, we can use the Exponential Weighted Moving Average which weights data point farther away less.

To develop this indicator, we plot two things:
1. Price
2. The Exponential Weighted moving Average

The Exponential Weighted Moving Average tells us similar things as the simple rolling mean, but just is a more "real time" metric.

JPM EWMA (Exponential Weighted Moving Average)
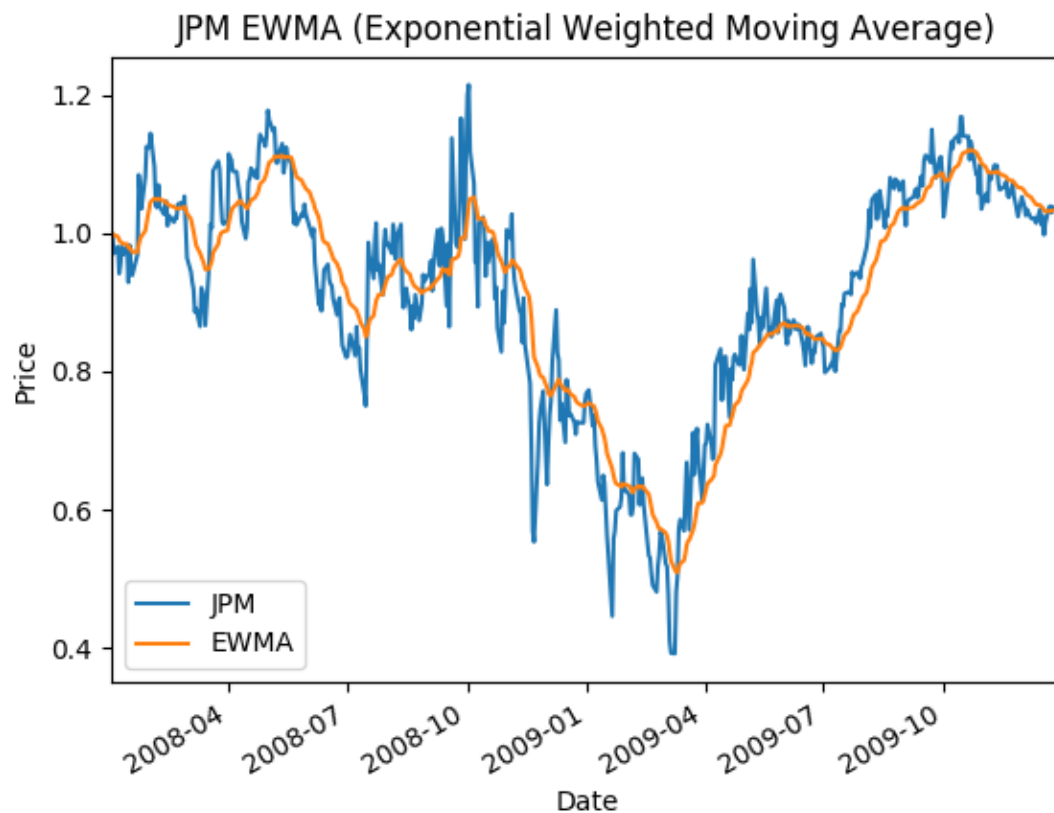
Part 2: Best Possible Strategy

In this section, we develop a best possible strategy:

1. Describe how we created it
2. Assumptions we made to make it work
3. Provide a chart that illustrates its performance versus the benchmark
   a. Benchmark: The performance of a portfolio starting with $100,000 cash, investing 1000 shares in JPM and holding that position

To create the best possible strategy, we assume that we can see "into the future" and see the price data through the time period specific. On any given day we look in the next date:

1. If the price would have gone up, we should be at a +1000 position (since given the constraints we can't be more than +1000 position). This means, if allowed, we should buy as many shares as possible to reach +1000 position since we know the price will go up so we want to be long.
2. If the price would have gone down, we should be at a -1000 position (since given the constraints we can't be more than +1000 position). This means, if allowed, we should sell as many shares as possible to reach a -1000 position since we know the price will go down so we want to be short.

In text, the performance of the best possible strategy against benchmark is reported below:
```
('The cumulative returns for the best portfolio is: ',
5.7861000000000002)
('The stdev of daily returns for the best portfolio is: ',
0.0045478231979080028)
('The mean of daily returns for the best portfolio is: ',
0.0038167861508578197)
('The cumulative returns for the benchmark portfolio is: ',
0.012299999999999978)
('The stdev of daily returns for the benchmark portfolio is: ',
0.017004366271213767)
('The mean of daily returns for the benchmark portfolio is: ',
0.00016808697819094035)
```

In addition, we also add the following plot to visually see this over time.
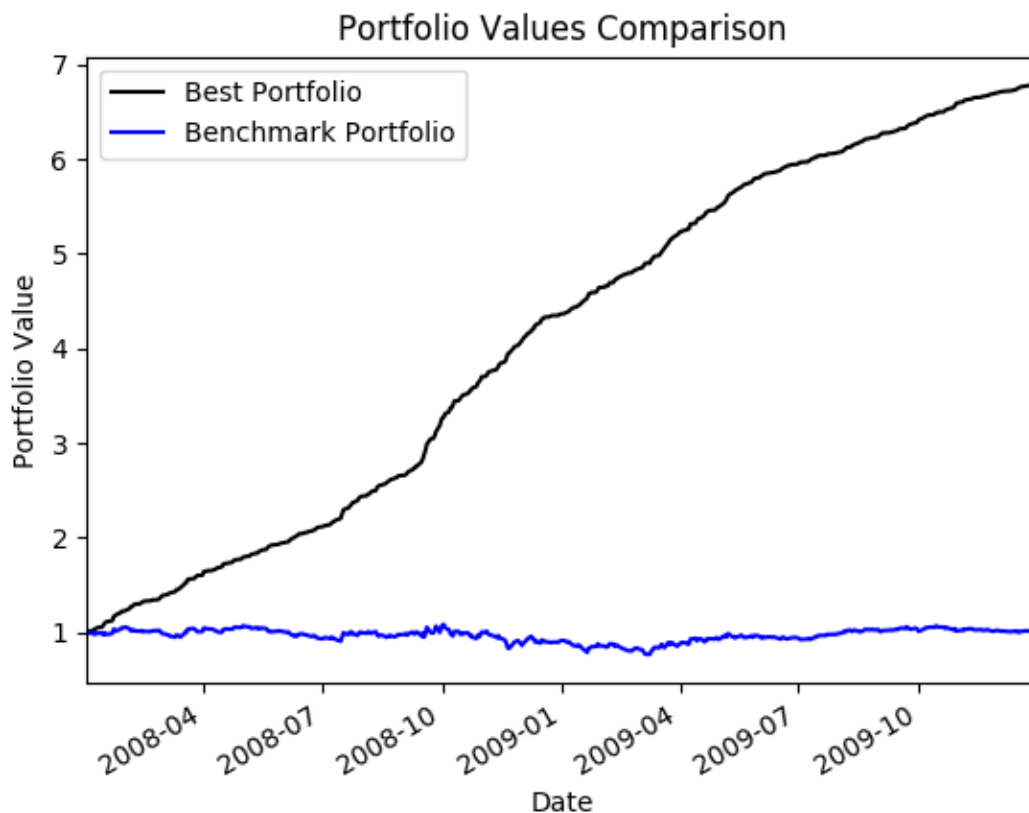
Part 3: Manual Rule-Based Trader

For our manual strategy we will use the Bollinger Bands technical indicator to guide our Sell or Buy decisions. In particular:

1. Start by buying 1000 shares of JPM on the first day.
2. When the price hits the lower band, we buy.
3. When the price hits the higher band, we sell.

I believe this is an effective strategy because when the price hits the lower band, it potentially means the stock price is too low and will rebound, so we want to enter a long position. Similarly, when the price hits the upper band, it potentially means the stock price is too high and will correct downwards, so we want to enter a short position.

Below, we compare the Manual Portfolio vs the Benchmark Portfolio. In addition, the red lines mark Short positions whereas the green lines represent long positions. Note that we start the manual portfolio by purchasing 1000 shares of JPM.
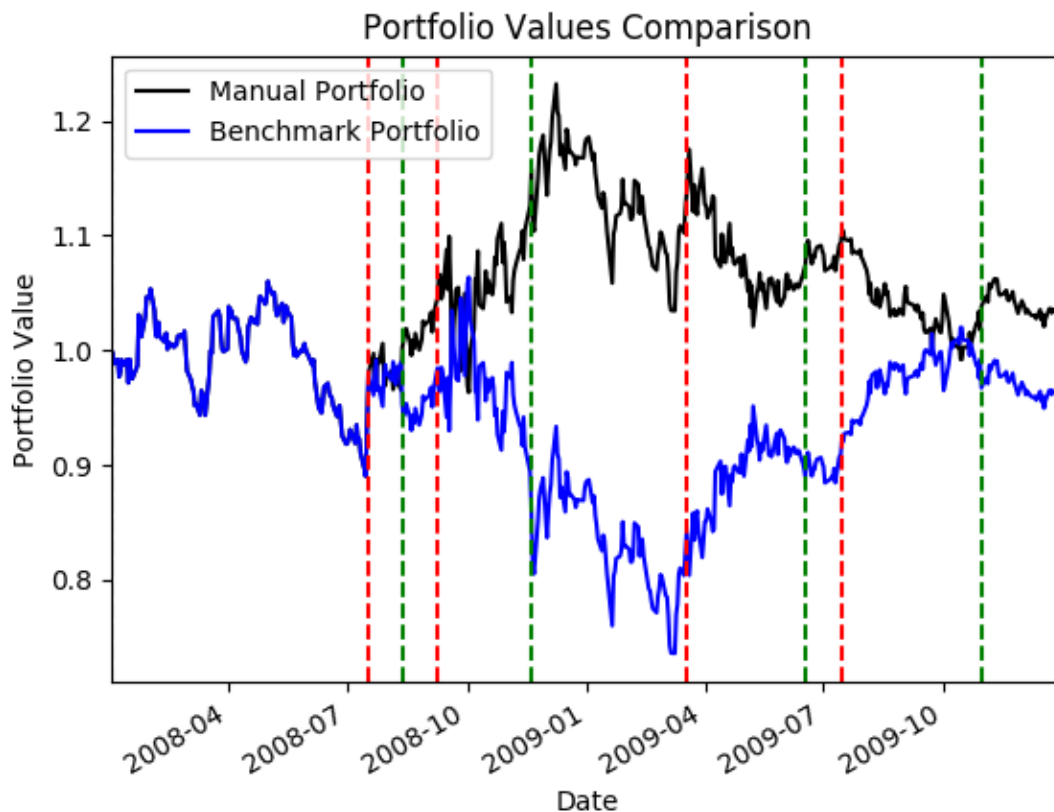
In addition, a text description of the portfolio values are:
('Cumulative Returns; Manual Portfolio: ', 0.03315)
('stdev of daily returns; Manual Portfolio: ', 0.01523)
('mean of daily returns; Manual portfolio is: ', 0.00018)
('Cumulative Returns; Benchmark Portfolio is: ', −0.03792)
('stdev of daily returns; Benchmark Portfolio is: ', 0.01747)
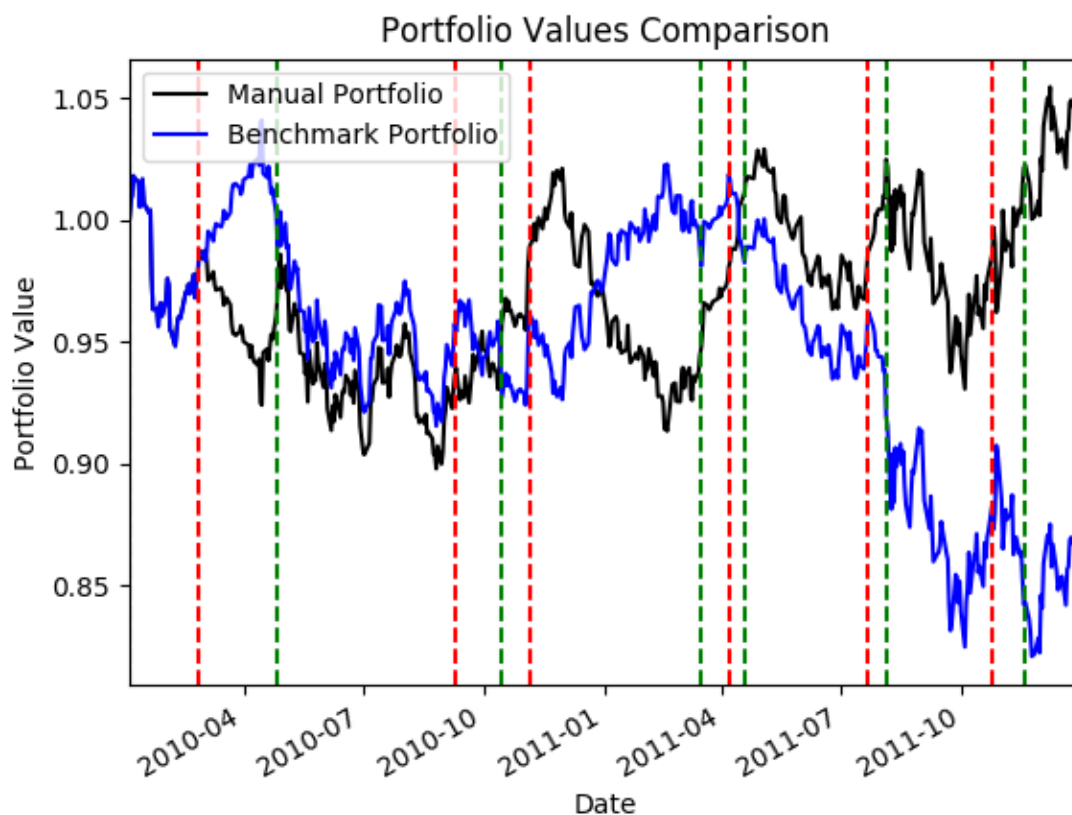('mean of daily returns; Benchmark Portfolio is: ', 8.0e−05)
So you can see that the cumulative returns for the manual portfolio is 3.3 percent compared to -3.7 percent in the benchmark portfolio.

Part 4: Comparative Analysis

We now evaluate the performance of the strategy in the out of sample period. Again, we will use the Bollinger Bands technical indicator to guide our Sell or Buy decisions. In particular:

1. Start by buying 1000 shares of JPM on the first day.
2. When the price hits the lower band, we buy.
3. When the price hits the higher band, we sell.

Below, we present the chart in the out of sample period. Again, the red lines indicate sell positions, the green line represents buy positions.

The portfolio performance is:
('Cumulative Returns; Manual Portfolio: ', 0.04581)
('stdev of daily returns; Manual Portfolio: ', 0.008240)
('mean of daily returns; Manual portfolio is: ', 0.00012)
('Cumulative Returns; Benchmark Portfolio is: ', -0.13364)
('stdev of daily returns; Benchmark Portfolio is: ', 0.00878)
('mean of daily returns; Benchmark Portfolio is: ', -0.00025)

Thus, we can see that the portfolio performance of the manual portfolio in the out of sample period is 4.5% compared to -13.3 percent of the benchmark portfolio.

We can also create a table to show the results

Time Frame	Strategy Type	Cumulative Returns
In Sample Period	Benchmark	-3.7%
In Sample Period	Manual Strategy	3.3%
Out of Sample Period	Benchmark	-13.3%
Out of Sample Period	Manual Strategy	4.5%

Definitely one big factor in all of this is that the dates are around the Great Recession. That is why a simple buy and hold strategy of just JPM we see yields very negative returns in both the in-sample and out-of-sample period and our manual strategy is much better than the simple benchmark.

Our Manual Strategy works best when there is high variance so that we can take advantage of buy and sell. In this period because there was high variance, our strategy worked OK (not perfect) but better than benchmark.