Project 6: Manual Strategy

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Part 1. Indicators

The indicators chosen are Price/SMA; Bollinger Bands and Momentum. For visualization in this report, the data is normalized to 1.0 at the start of the date range.

1. Price/SMA

The first indicator I choses is Price/SMA. It consists of two parts: simple moving average (SMA) and the adjusted stock closing price. SMA is the moving average calculated by adding recent closing prices together and then dividing that by the corresponding time range. The formula is ("Momentum and relative strength index ", 2019):

$$\text{SMA} = \frac{A_1 + A_2 + ... + A_n}{n}$$

where:

A_n = the price of an asset at period n

n = the number of total periods

To compare different stocks altogether, the impact of price differences should be eliminated as various stocks can have diverse prices. Hence, using Price/SMA would be a good choice. If in a stable market, SMA, the average of stock price in recent days, should be similar to price at that time, which makes Price/SMA close to 1. Here I used a 5-day range, which means I looked back 5 days to calculate the SMA of each day (Figure 1). If this ratio is too far from 1, then the market is vibrating. For example, if the ratio is a lot bigger than 1, then the price of that stock is a lot bigger than simple moving average, indicating that we should sell it. On the contrary, a ratio much smaller than 1 implies the current price is rather low comparing to the recent prices and gives a buying signal.
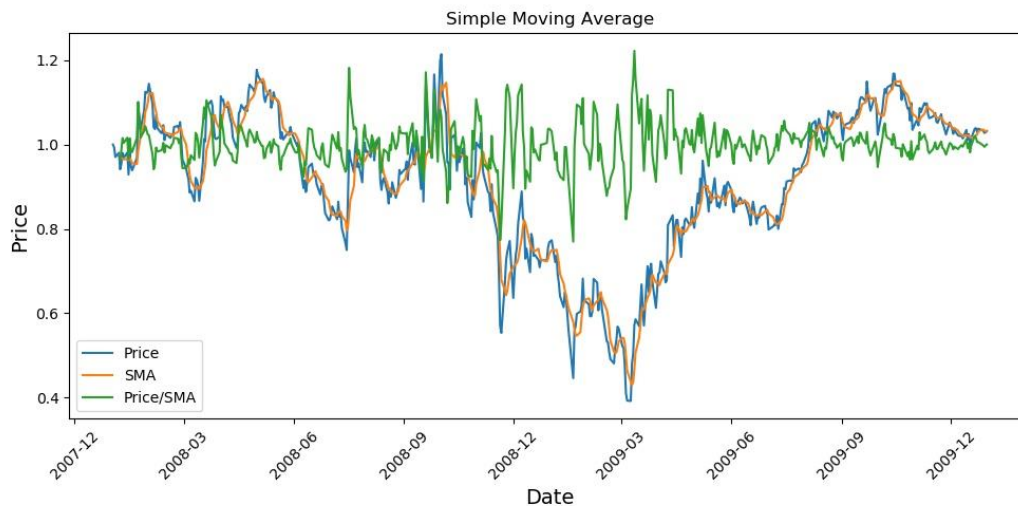
Figure 1. The normalized price of JPM, its SMA and Price/SMA using the 5-day window from January 1, 2008 to December 31 2009.

2. Bollinger Bands

To make the most of SMA, Bollinger Bands are introduced to determine how much of an excursion from SMA should be used to buy/sell. Bollinger Bands add one band above and one band below 2 standard deviations of SMA. The standard deviations of SMA are used because there may be different levels of volatility for different stocks. We could use following formula to calculate the Bollinger Band ("Machine Learning for Trading | Udacity", 2019):

$$BB[t] = \frac{price[t] - SMA[t]}{2 \cdot std[t]}$$

Generally, this value ranges from +1 to -1. But when there are excursions above or below, then it means the actual price crosses upper or lower band. Figure 2 represents the upper and lower Bollinger bands for SMA and other values. Graphically, if the price is high as it goes from outside the upper band and cross down inside it, it issues the sell signal. Meanwhile, if a lower price is low enough and it moves through the bottom band and goes back inside the band, it becomes a buying signal.
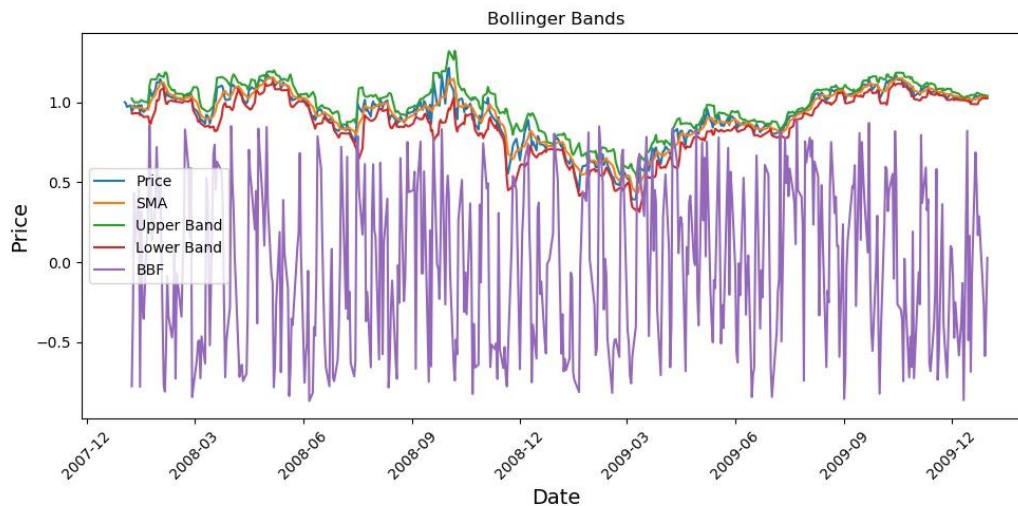
Figure 2. The upper and lower Bollinger bands as well as the value of Bollinger Band feature for SMA using the 5-day window from January 1, 2008 to December 31 2009.

3. Momentum

The momentum of stock market could be calculated by taking price differences for a fixed time interval continually. The formula for momentum is ("Summer 2019 Project 6: Manual Strategy ", 2019):

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momentum[t] = (price[t]/price[t-N]) - 1
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As I constructed a 3-day momentum line, the latest closing price was divided by closing price 5 days ago first and then momentum equals this value minus 1. In Figure 3, the positive or negative value is plotted around the zero line while the price of JPM is also plotted.

The momentum, as a trend-following indicator, measures the change of price and it usually ranges from +0.5 to -0.5. When the absolute value of momentum is significantly large, then the price is changing rapidly. As an indicator, an uptrend that goes across zero may be used as a signal to buy, or a crossing down through zero can be seen as a signal to sell. Combined with other indicators such SMA,

momentum could be used in a more refined way. How high/low the momentum reaches shows the steepness the SMA is rising/falling.
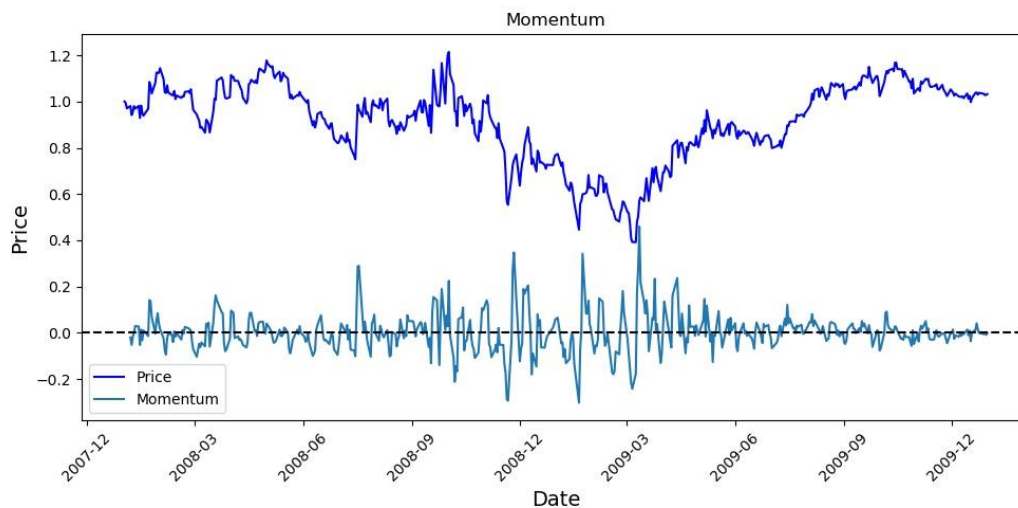

Figure 3. The momentum and price of JPM using the 3-day window from January 1, 2008 to December 31 2009.

Part 2. Best possible strategy

Since I could foresee and know future prices, the best possible strategy is to buy and sell as much as possible according to stock trend and maximize profits. The exact design is as follows:

1) For every day in the in-sample range except the last day, if the stock price of the next day is higher than that day, I order a Buy and go long.

2) On the contrary, if the price of the next day (tomorrow) is going to decrease and become lower than the day before (today), I would order a Sell and go short today.

3) Certainly, the holdings are allowed in only 3 positions: 1000, 0, -1000 shares. No further operation would be processed if it exceeds this limit.

According to calculation of several parameters, this strategy outperforms the benchmark. Below is the theoretically best strategy compared with benchmark

map in 2008-2009. We could see that the portfolio value of this optimal strategy is nearly 7 times of the benchmark.
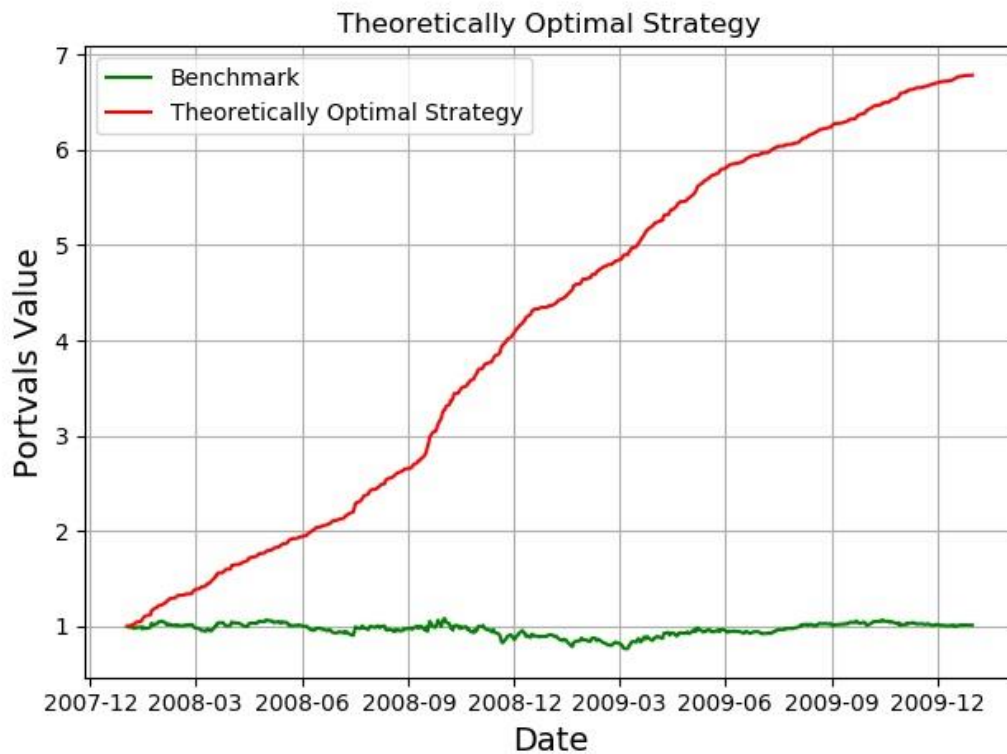

Figure 4. The Portfolio Value of Best possible strategy (Theoretically Optimal Strategy) vs Benchmark from January 1, 2008 to December 31 2009.

Besides, several parameters are calculated as well and shown in Table 1.

Table 1. Cumulative return; standard deviation and mean of daily returns of the benchmark and best optimal portfolio from January 1, 2008 to December 31 2009.

Strategy	Cumulative Return	Stdev of daily returns	Mean of daily returns
Best possible Strategy	5.783	0.004	0.004
Benchmark	0.012	0.013	0.013

Part 3. Manual Strategy

According to what is mentioned in Part 1 and several runs of fine tuning of parameters, the manual strategy used a 10-day window for the three indicators: price/SMA, Bollinger bands feature value (BBF) and Momentum and these indicators are combined in the following way to create the overall signal:

1) For LONG entry point, if price/SMA is smaller 0.95 and Momentum is larger than -0.3, this would assure the trend is not going to fall quickly even though the market is very likely to be vibrating. Meanwhile, I would check if BBF is smaller than -0.9, it indicates the price has reached a relevant low point. Once these requirements are all met, I order a Buy and go long using as much money as I have;

2) For SHORT entry point, the manipulation is as follows: If price/SMA > 1.05, BBF > 0.9, and Momentum < 0.3, I order a Sell and go short using as many stocks as I have. This would assure the entry point is at a rather high price even though the market is vibrating, so as to gain more profits.

3) If the above conditions are not met, then I would not operate the portfolio.

4) Certainly, the holdings are allowed in only 3 positions: 1000, 0, -1000 shares. No further operation would be processed if it exceeds this limit.

The chart comparing this rule-based strategy and the benchmark has been plotted in Figure 5, as well as the entry points. Besides, several parameters are calculated as well and shown in Table 2. I believe this is an effective strategy. In the first 4 months, the portfolio value of this strategy is similar to benchmark, but in most times, it is larger than the benchmark. Besides, the cumulative return of manual strategy is 0.0518, which is far larger (6 times) than the cumulative return of benchmark 0.0082.
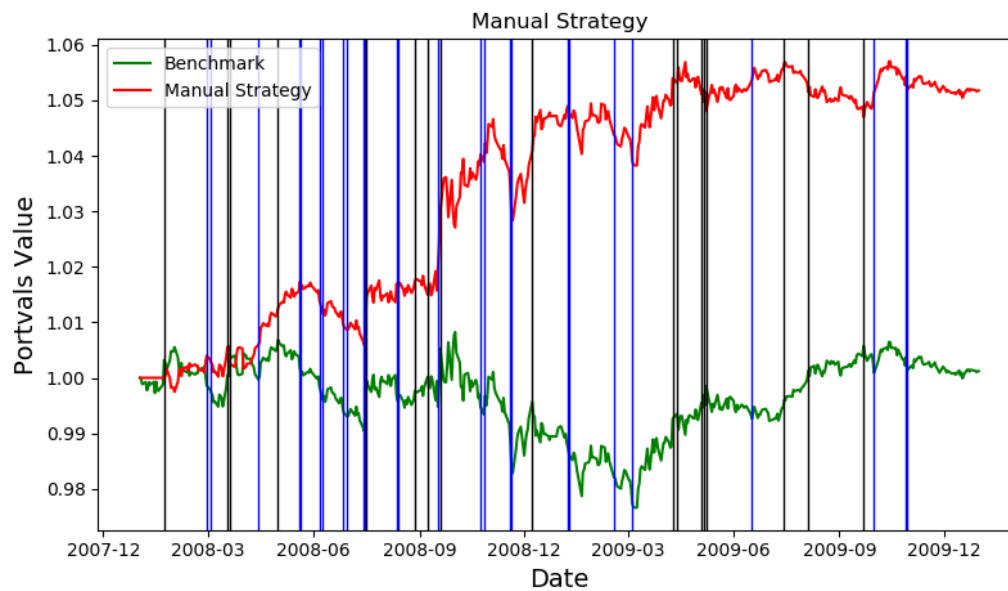
Figure 5. The Portfolio Value of Manual Strategy vs Benchmark from January 1, 2008 to December 31 2009.

Table 2. Cumulative return; standard deviation and mean of daily returns of the benchmark and manual strategy from January 1, 2008 to December 31 2009.

Strategy	Cumulative Return	Stdev of daily returns	Mean of daily returns
Manual Strategy	0.0518	0.0015	0.0001
Benchmark	0.0082	0.0016	3.7365e-6

Comparative analysis

The same strategy mentioned above is used in the out of sample period and its performance has been evaluated in Figure 6. From the perspective of trend, the manual strategy outperforms the benchmark, except from December 2010 to July 2011. However, it is not as good as its performance in the in-sample period. As we could see in Table 3, the cumulative return from 2010 to 2011 is 0.0082, which is far smaller than 0.0518 from 2008 to 2009. Nevertheless, the Benchmark cumulative return for 2010-2011 is a negative number, so we could say this strategy is at least better than the benchmark. The reason that this strategy is not

very satisfactory is probably because the financial market in this out-of-sample time range is not prosperous. The standard deviation from 2010-2011 is also half of the 2008-2009 season, which gives our strategy less opportunity to find entry points.
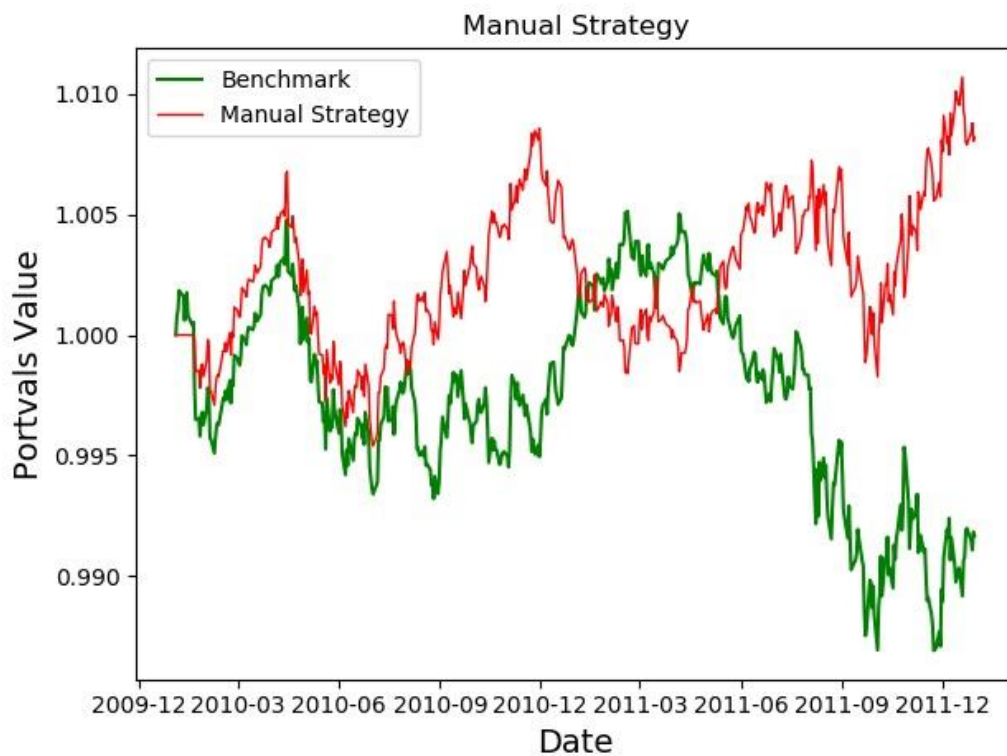

Figure 6. The Portfolio Value of Manual Strategy vs Benchmark from January 1, 2010 to December 31 2011.

Table 3. Cumulative return; standard deviation and mean of daily returns of the benchmark and manual strategy from January 1, 2008 to December 31 2011.

Strategy	Cumulative Return	Stdev of daily returns	Mean of daily returns
Manual Strategy for 2010-2011	0.0082	0.0008	1.6555e-5
Manual Strategy for 2008-2009	0.0518	0.0015	0.0001
Benchmark for 2010-2011	-0.0083	0.0008	-1.6320e-5
Benchmark for 2008-2009	0.0082	0.0016	3.7365e-6

Reference

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