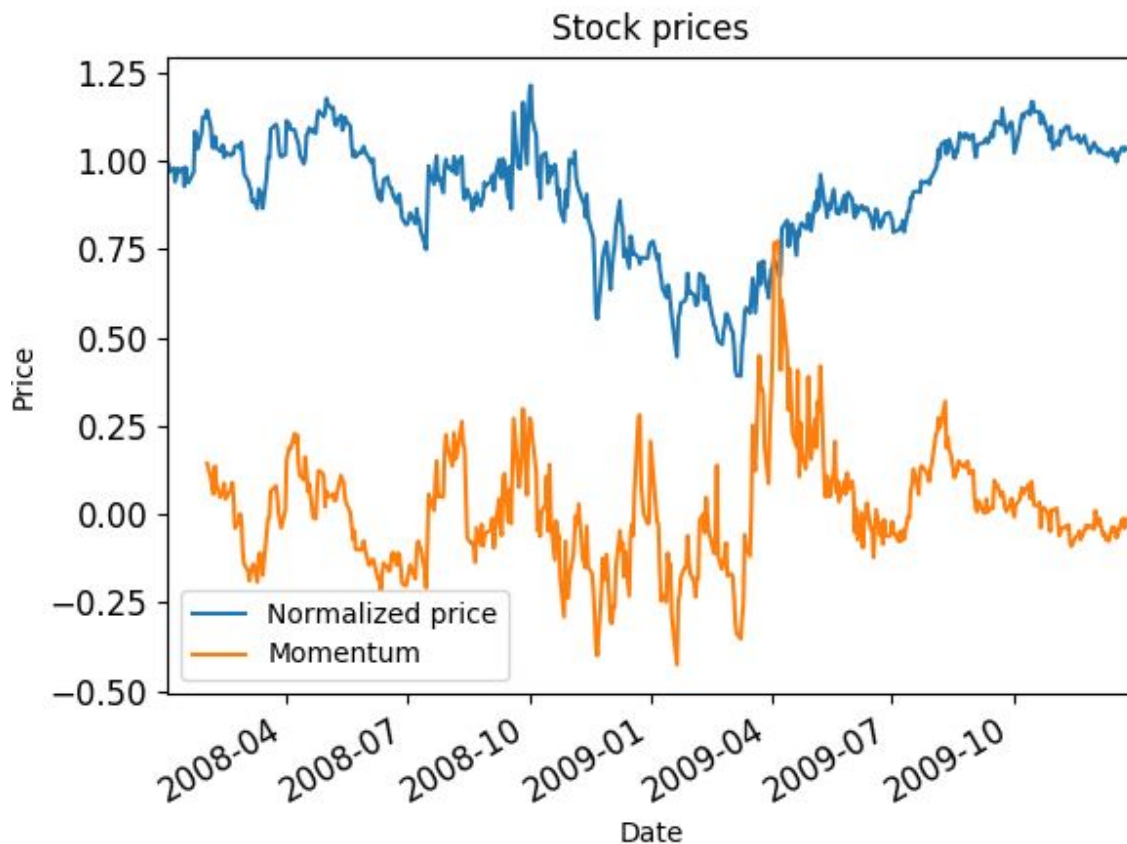


Assignment: Manual Strategy

Part 1: Technical Indicators

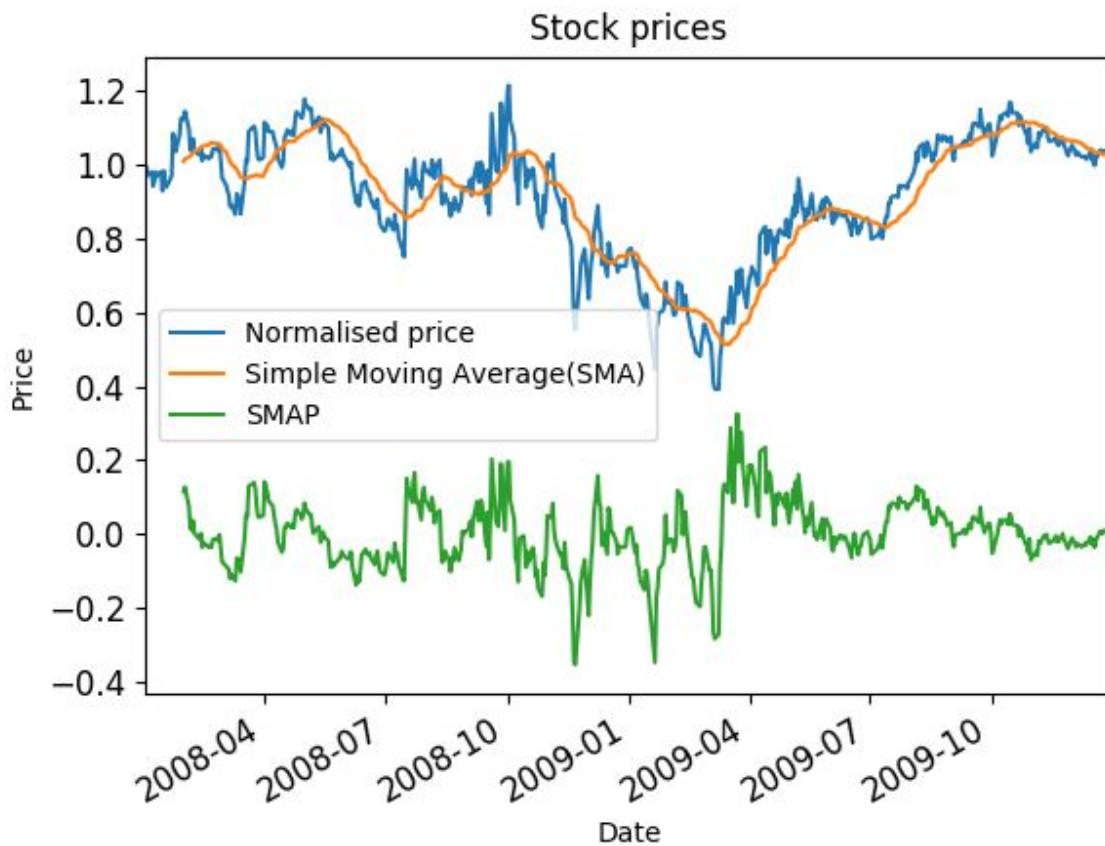
Momentum: The ratio of equity price between a fixed time interval. It can be calculated as P_t/P_{t-n} , where P_t is the price of the equity at time t , P_{t-n} is the price of the equity at n days before time t .



The chart above illustrates the normalized prices and the Momentum with a time interval of 21 days for the stock 'JPM' between Jan-01-2008 to Dec-31-2009.

SMAP: The percentage of the equity price outperform (underperform) the Simple Moving Average (SMA). It can be calculated as $(P_t/SMA) - 1$, where P_t is the price of the equity at time t , SMA is the simple moving average price of the equity at time t . SMA is the moving average of the equity price in previous n days. It can be calculated as $(\sum_{i=t-n}^t P_i)/n$,

P_i is the equity price at time t , n is the time interval in days

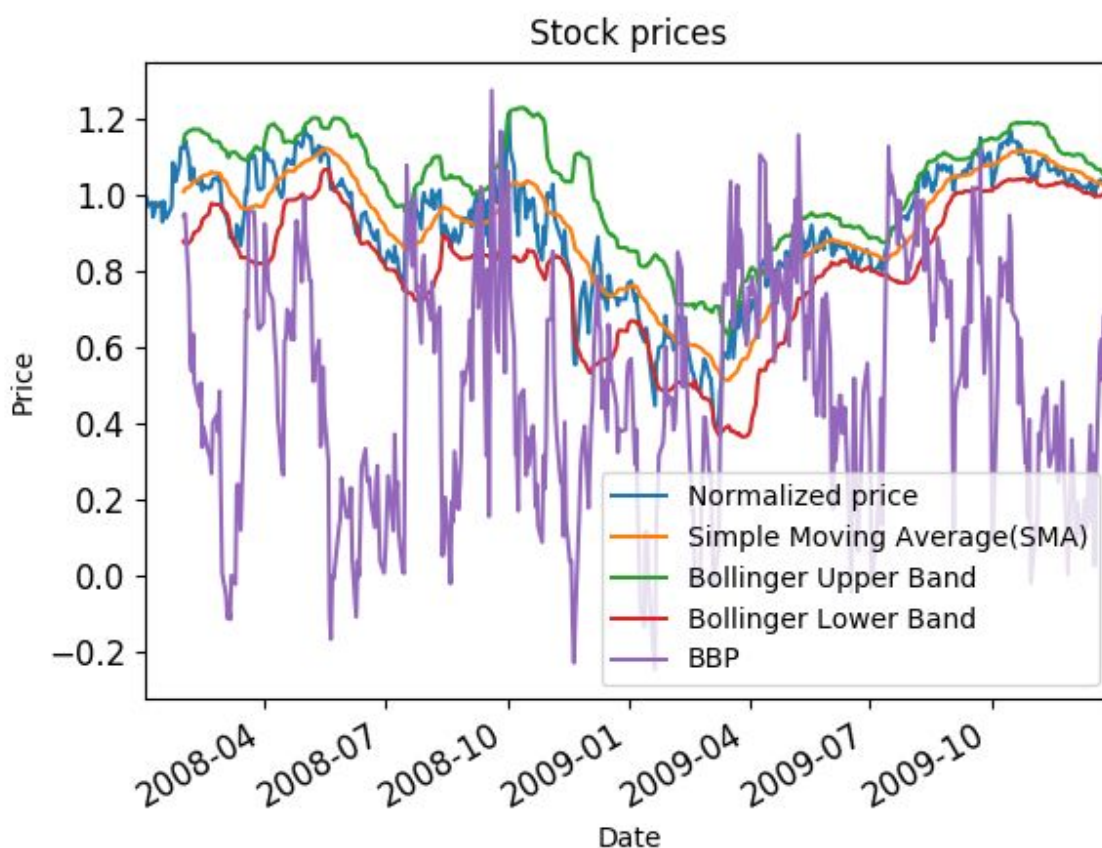


The chart above illustrate the normalized prices, the Simple Moving Average and the SMAP with time interval of 21 days for the stock 'JPM' between Jan-01-2008 to Dec-31-2009.

BBP: The ratio of the equity performance over the Bollinger Band. It can be calculated as

$\frac{P_t - \text{Lower Band}}{\text{Upper Band} - \text{Lower Band}}$. Moving standard deviation σ is calculated as

$(\sum_{i=t-n}^t (P_i - SMA)^2)/n$, *Lower Band* is calculated as $SMA + 2\sigma$, *Upper Band* is calculated as $SMA - 2\sigma$.



The chart above illustrate the normalized prices, the Simple Moving Average, the Bollinger Upper Band, Bollinger Lower Band and the BBP with time interval of 21 days for the stock 'JPM' between Jan-01-2008 to Dec-31-2009.

Part 2: Best Possible Strategy

The idea behind the best possible strategy is that the strategy should capture all of the price changes. The price history data consist of groups of consecutive increasing and decreasing intervals.

In each consecutive increasing interval, buy shares at the beginning of the interval so your position become long 1000 shares in the interval and sell shares at the end of the interval so your position become short 1000 shares.

In each consecutive decreasing interval, sell shares at the beginning of the interval so your position become short 1000 shares in the interval and buy shares at the end of the interval so your position become long 1000 shares.

This methodology captures all of the price changes and make profit from it.

Experiment: Develop the best possible strategy for the 'JPM' stock during the period from 2008-Jan-01 to 2009-Dec-31 with initial cash of 100,000. Compare the portfolio value of the trading strategy and the value of holding 1000 shares of the stock 'JPM'.

Run the script: BestPossibleStrategy.py

```
if __name__ == '__main__':  
  
    testStrategy(symbol='JPM',sd=dt.datetime(2008,1,1), ed=dt.datetime(2009,12,31), sv=100000)
```

Output:

Strategy:

	Date	Symbol	Order	Shares
0	2008-01-02	JPM	BUY	1000
1	2008-01-04	JPM	BUY	2000
2	2008-01-07	JPM	SELL	2000
3	2008-01-08	JPM	BUY	2000
4	2008-01-10	JPM	SELL	2000
5	2008-01-11	JPM	BUY	2000
6	2008-01-14	JPM	SELL	2000
7	2008-01-15	JPM	BUY	2000
8	2008-01-16	JPM	SELL	2000
9	2008-01-18	JPM	BUY	2000
10	2008-01-23	JPM	SELL	2000
11	2008-01-25	JPM	BUY	2000
12	2008-01-29	JPM	SELL	2000
..
267	2009-11-27	JPM	BUY	2000
268	2009-11-30	JPM	SELL	2000
269	2009-12-03	JPM	BUY	2000
270	2009-12-04	JPM	SELL	2000
271	2009-12-09	JPM	BUY	2000
272	2009-12-10	JPM	SELL	2000
273	2009-12-11	JPM	BUY	2000
274	2009-12-14	JPM	SELL	2000
275	2009-12-15	JPM	BUY	2000
276	2009-12-16	JPM	SELL	2000
277	2009-12-17	JPM	BUY	2000
278	2009-12-22	JPM	SELL	2000
279	2009-12-23	JPM	BUY	2000
280	2009-12-24	JPM	SELL	2000
281	2009-12-29	JPM	BUY	2000

Performance Criteria:

Cumulative return of the benchmark is
0.0123

Cumulative return of the portfolio is
5.7861

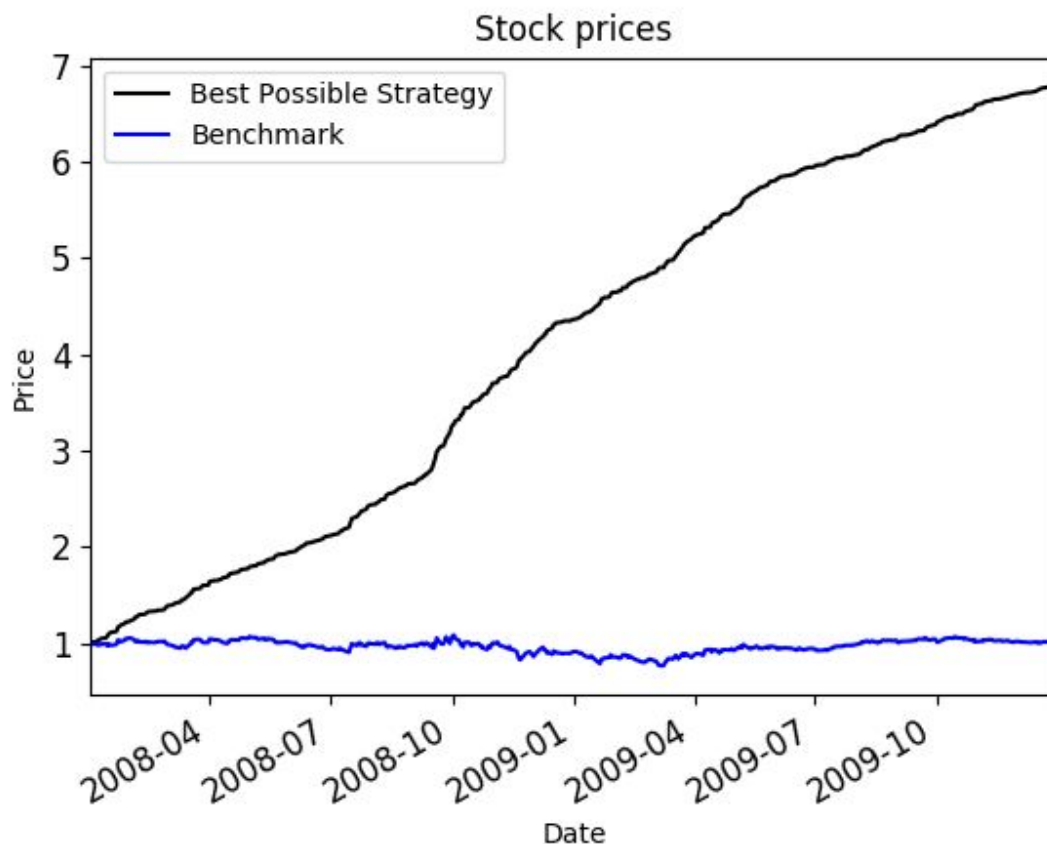
Stdev of the daily return of the benchmark is
0.017004

Stdev of the daily return of the portfolio is
0.004548

Mean of the daily return of the benchmark is
0.000168

Mean of the daily return of the portfolio is
0.003817

Performance Chart:



The chart above reports the Benchmark value normalized to 1.0 with Blue line and the best possible portfolio value normalized to 1.0 with black line.

Part 3: Manual Rule-Based Trader

The idea behind the manual strategy is a combination of three indicators described above: Momentum, SMAP, BBP.

The reasoning behind the Manual Rule is that:

If the momentum is less than zero, or SMAP is less than -0.05 and the BBP is less than 0, it means the stock is reaching outside the Bollinger lower band and it is very likely to bounce back and there is a chance to make profit by longing the stock;

If the momentum is great than zero, or SMAP is larger than 0.05 and the BBP is larger than 1, it means the stock is reaching outside the Bollinger upper band and it is very likely to bounce back and there is a chance to make profit by shorting the stock.

The Manual Rule is implemented as follows:

If Momentum < 0 or SMAP < -0.05 and BBP < 0 Then:
 Buy stocks till the position is long 1000
Else If Momentum > 0 and SMAP > 0.05 and BBP > 1 Then:
 Sell stocks till the position is short 1000
Else
 Do nothing

Experiment: Develop the strategy with the manual rule for the 'JPM' stock during the period from 2008-Jan-01 to 2009-Dec-31 with initial cash of 100,000. Compare the portfolio value of the trading strategy and the value of holding 1000 shares of the stock 'JPM'.

Run the script: ManualStrategy.py (first output only)

```
if __name__ == '__main__':  
    testStrategy(symbol='JPM', sd=dt.datetime(2008, 1, 1), ed=dt.datetime(2009, 12, 31), sv=100000)  
    testStrategy(symbol='JPM', sd=dt.datetime(2010, 1, 1), ed=dt.datetime(2011, 12, 31), sv=100000)
```

Output:

Strategy:

	Date	Symbol	Order	Shares
0	2008-02-22	JPM	BUY	1000
1	2008-07-17	JPM	SELL	2000
2	2008-08-15	JPM	BUY	2000
3	2008-09-11	JPM	SELL	2000
4	2008-09-15	JPM	BUY	2000
5	2008-09-19	JPM	SELL	2000
6	2008-10-07	JPM	BUY	2000
7	2009-03-18	JPM	SELL	2000
8	2009-06-03	JPM	BUY	2000
9	2009-07-15	JPM	SELL	2000
10	2009-10-01	JPM	BUY	2000

Performance Criteria:

Cumulative return of the benchmark is
-0.005803

Cumulative return of the portfolio is
0.003507

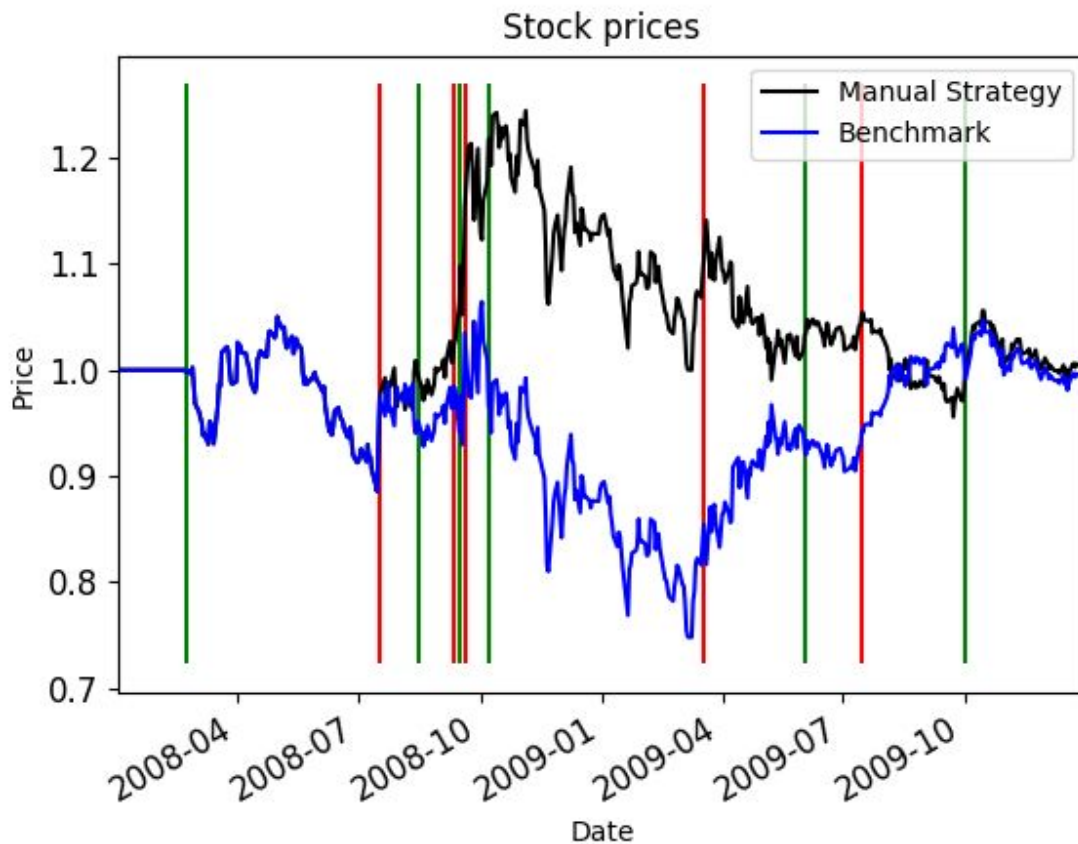
Stdev of the daily return of the benchmark is
0.016988

Stdev of the daily return of the portfolio is
0.014568

Mean of the daily return of the benchmark is
0.000132

Mean of the daily return of the portfolio is
0.000112

Performance Chart:



The chart above reports the Benchmark value normalized to 1.0 with Blue line and the best possible portfolio value normalized to 1.0 with black line. The green vertical line indicates the enter point and the red vertical line indicates the exit point.

Conclusion: Because the cumulative return of the portfolio is 0.003507 compared to the cumulative return of the benchmark of -0.005803. The manual rule strategy outperformed the benchmark over the in sample period.

Part 4: Comparative Analysis

Experiment: Develop the strategy with the manual rule for the 'JPM' stock during the period from 2010-Jan-01 to 2011-Dec-31 with initial cash of 100,000. Compare the portfolio value of the trading strategy and the value of holding 1000 shares of the stock 'JPM'.

Run the script: ManualStrategy.py (second output only)


```

if __name__ == '__main__':
    testStrategy(symbol='JPM', sd=dt.datetime(2008, 1, 1), ed=dt.datetime(2009, 12, 31), sv=100000)
    testStrategy(symbol='JPM', sd=dt.datetime(2010, 1, 1), ed=dt.datetime(2011, 12, 31), sv=100000)

```

Output:

Strategy:

	Date	Symbol	Order	Shares
0	2010-02-17	JPM	BUY	1000
1	2010-02-26	JPM	SELL	2000
2	2010-04-26	JPM	BUY	2000
3	2010-07-13	JPM	SELL	2000
4	2010-07-21	JPM	BUY	2000
5	2010-09-09	JPM	SELL	2000
6	2010-10-08	JPM	BUY	2000
7	2010-11-05	JPM	SELL	2000
8	2010-11-26	JPM	BUY	2000
9	2010-12-10	JPM	SELL	2000
10	2011-02-04	JPM	BUY	2000
11	2011-02-16	JPM	SELL	2000
12	2011-03-07	JPM	BUY	2000
13	2011-10-24	JPM	SELL	2000
14	2011-11-10	JPM	BUY	2000

Performance Criteria:

Cumulative return of the benchmark is
-0.058609

Cumulative return of the portfolio is
-0.005804

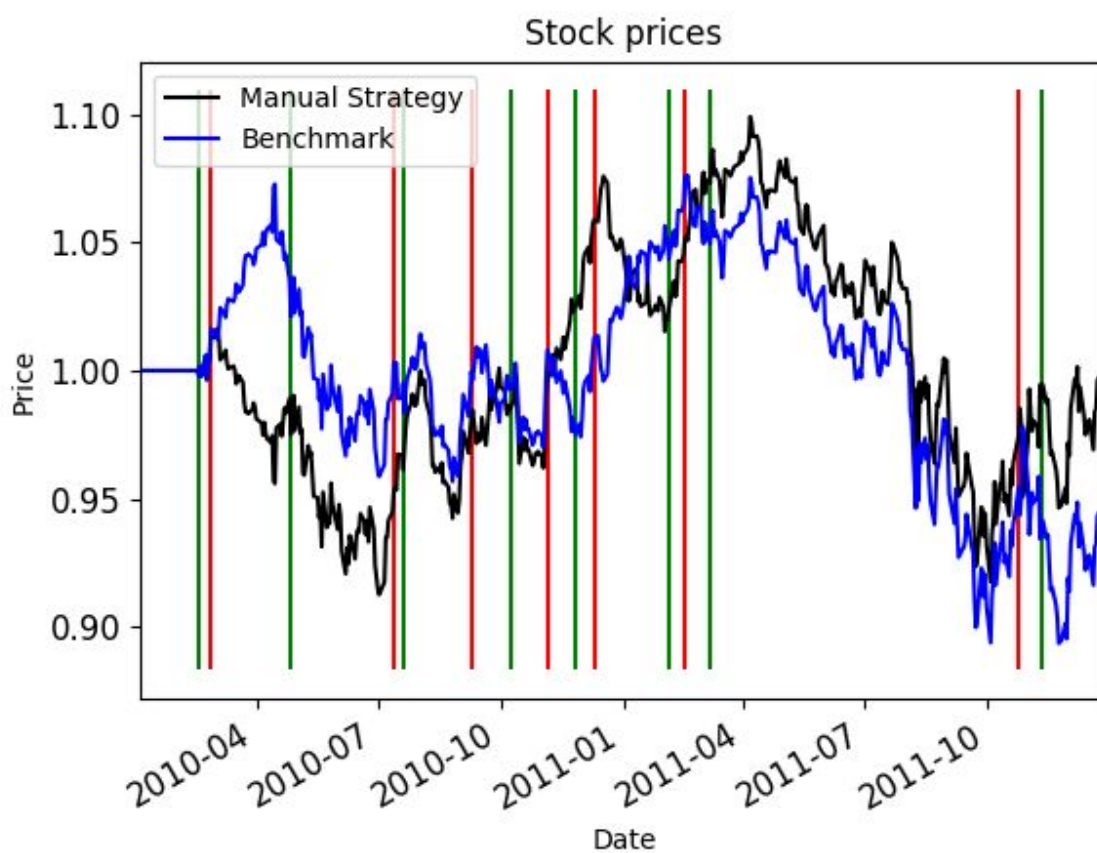
Stdev of the daily return of the benchmark is
0.008007

Stdev of the daily return of the portfolio is
0.007879

Mean of the daily return of the benchmark is
-0.000088

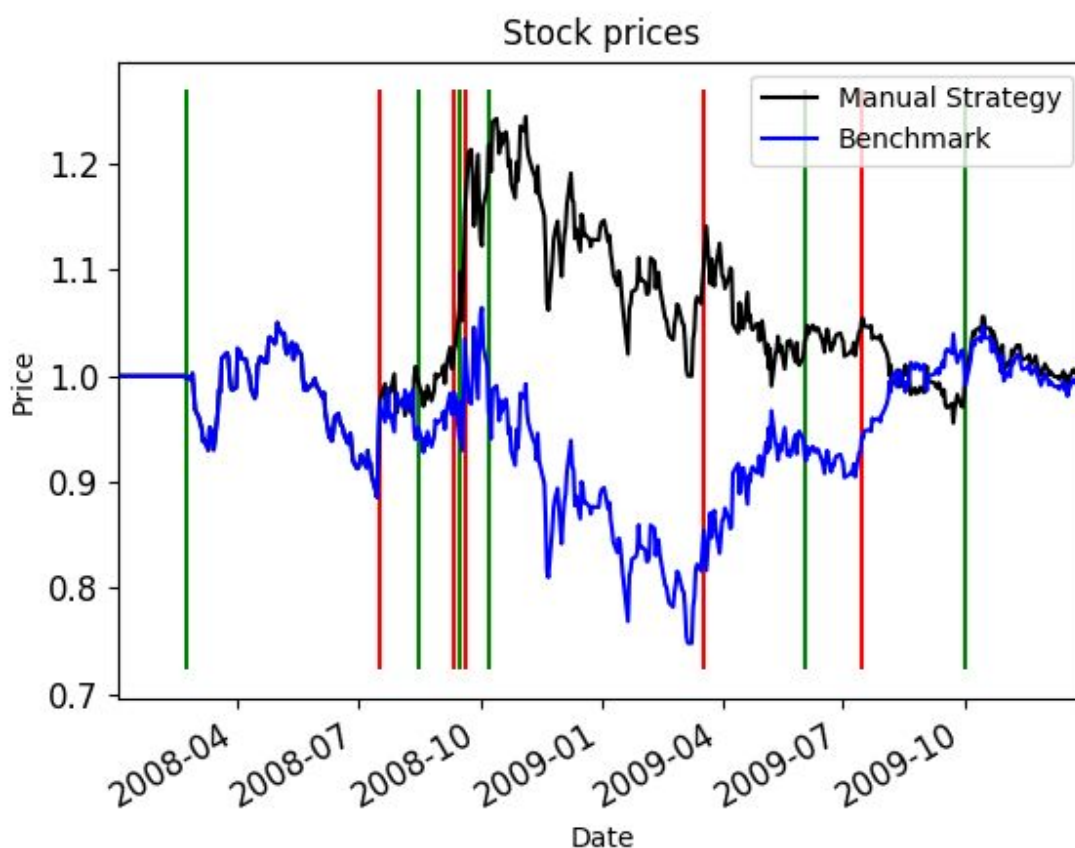
Mean of the daily return of the portfolio is
0.000019

Out Sample Performance Chart:



The chart above reports the Benchmark value normalized to 1.0 with Blue line and the best possible portfolio value normalized to 1.0 with black line. The green vertical line indicates the enter point and the red vertical line indicates the exit point.

In Sample Performance Chart(for reference):



The chart above reports the Benchmark value normalized to 1.0 with Blue line and the best possible portfolio value normalized to 1.0 with black line. The green vertical line indicates the enter point and the red vertical line indicates the exit point.

Conclusion: Because the cumulative return of the portfolio is -0.005804 compared to the cumulative return of the benchmark of -0.058609. The manual rule strategy outperformed the benchmark over the out sample period.

Comparison Table:

	In Sample Portfolio	Out Sample Portfolio	In Sample Benchmark	Out Sample Benchmark
Cumulative Return	0.003507	-0.005804	-0.005803	-0.058609
Average Daily Return	0.000112	0.000019	0.000132	-0.000088
Std of Daily	0.014568	0.007879	0.016988	0.008007

Return				
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Analysis: The manual rule trading strategy outperforms the benchmark in both the in sample period and the out sample period, which means the manual rule trading strategy works.

However, the manual rule trading strategy performs better in the in sample period than the manual rule trading strategy in the out sample period. That is because the manual rule is the result of manually fitting the in sample data to get the best performance, there must be certain overfitting problems inside.