PROJECT8 - Strategy Evaluation

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1 INDICATOR OVERVIEW

I have used the following three technical indicators: Bollinger Bands, Moving Average Convergence Divergence, Aroon Indicator.

1.1 Bollinger Bands

I used the following value:

BBP = (Stock Value – SMA(20)) / 2 STD

where SMA(20) is 20 days simple moving average and STD is standard deviation for 20 days. If stock value is above 1, it is overvalued and if the stock value is below -1, it is undervalued.

For the manual strategy, anytime BBP is above 1, I take it as a SELL signal.

For the strategy learner, BBP is added as a feature value for each day.

1.2 Moving Average Convergence Divergence

MACD is calculated as EMA(12)-EMA(26) where EMA is exponential moving average. EMA is calculated as

$$EMA(Today) = Value(Today) * factor + EMA(Yesterday) * (1 - factor)$$

where factor is 2/(1+Days). EMA(12) is EMA for 12 days, for example. EMA is like SMA but puts more emphasis on the later days rather than the earlier ones.

The signal for MACD is its own EMA for 9 days span.

For this particular project, I divide MACD to its signal. I use this single valued ratio for Manual Strategy and Strategy learner.

For the manual strategy, if the ratio is below 1 now, but it was above 1 in the preceding date, this is a SELL signal.

For the strategy leaner, this ratio is added as a feature value for each day.

1.3 Aroon Indicator

Aroon indicator is calculated as

Aroon Up = 100 * (25 – number of days since the highest value found in the 25 trailing values) / 25

Aroon Down = 100 * (25 – number of days since the lowest value found in the 25 trailing values) / 25

Aroon Oscillator = Aroon Up – Aroon Down

For the manual strategy, if Aroon Oscillator is below 0, but it was above 0 in the preceding date, then this is a SELL signal.

For the strategy learner, the Aroon Oscillator is added as a feature value for each day.

2 MANUAL INDICATOR

I created three sell signals:

- Anytime BBP is above 1, this is a SELL signal. If BBP is above 1, most likely the value will decline.
- For MACD, if the aforementioned ratio is below 1 now, but it was above 1 in the preceding date, this is a SELL signal. When MACD and its signal cross, and MACD is below it signal, this is a sell signal. Therefore, I divide these two values. When the value goes below 1, it is a sell signal.
- if Aroon Oscillator is below 0, but it was above 0 in the preceding date, then this is a SELL signal. If Aroon Oscillator goes to negative, this is a sell sign because downwards pressure is dominating the upwards pressure. When Aroon Down goes below Aroon Up, this is a sell sign.

These three indicator values are used with the described if-else conditions above. If the condition is met, this is a SELL signal as described above. If 1 or more SELL signals are satisfied, then I sell it. Otherwise, I buy it. The first day is a buy. The last day is a sell. For the manual strategy, I either bought 2000 or sold 2000 except for the start and the end dates.

Figure 1 shows the benchmark vs manual strategy comparison for in-sample data. Manual strategy performs better over time.

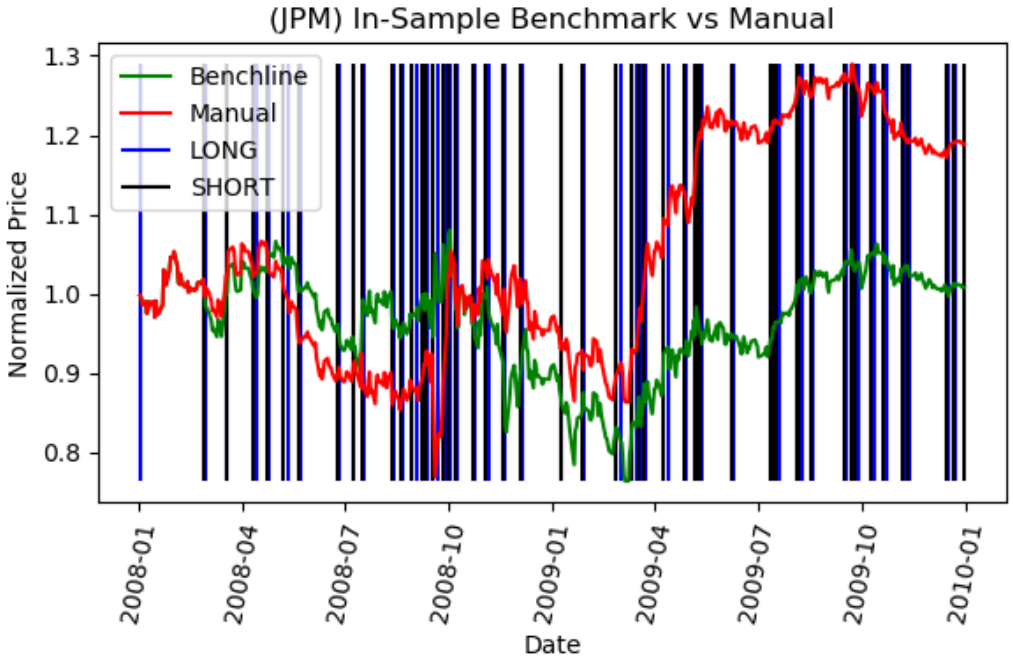

Figure 1 — Benchmark vs Manual Strategy comparison for In-Sample Data.

Figure 2 shows the benchmark vs manual strategy comparison for out-sample data. Manual strategy performs worse over time. This is because of the impact. Figure 3 shows out-sample with impact 0.0005 and manual performs better than benchmark.

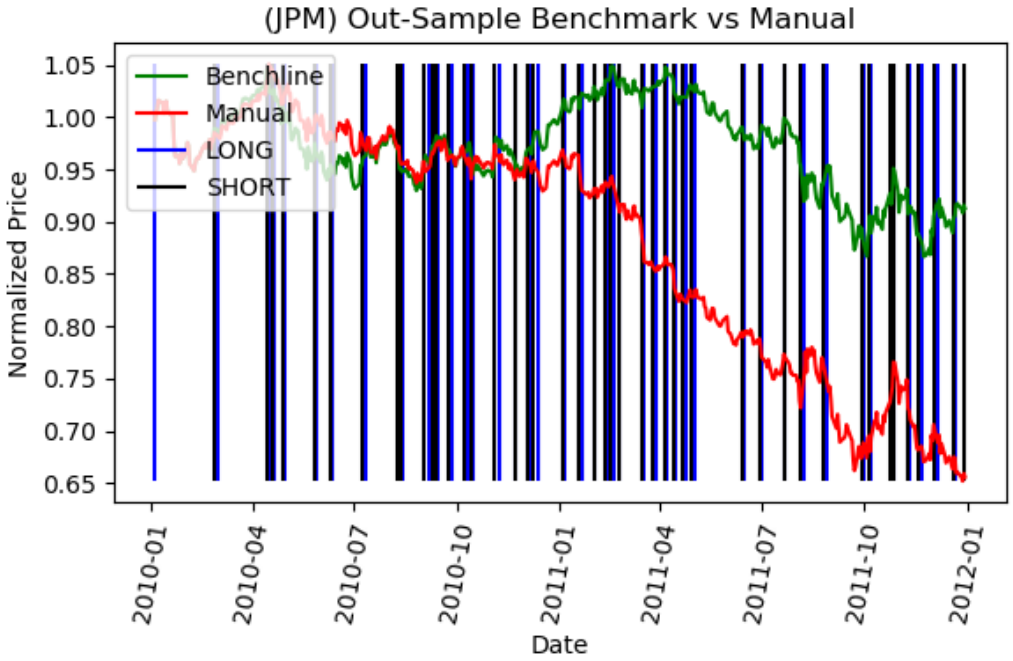

Figure 2 — Benchmark vs Manual Strategy comparison for Out-Sample Data for impact 0.005.

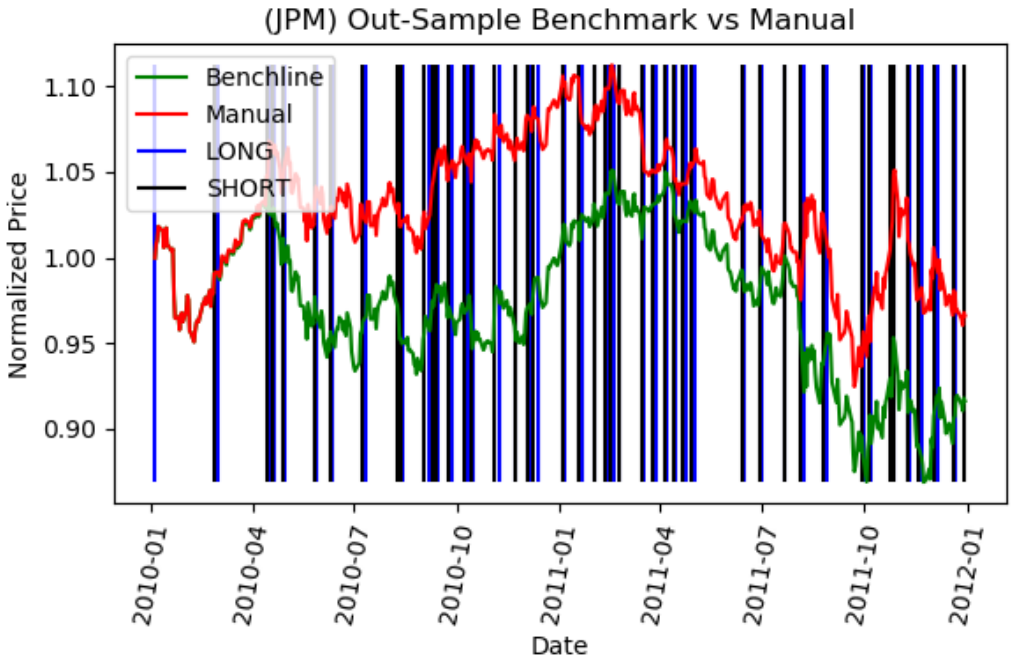

Figure 3 — Benchmark vs Manual Strategy comparison for Out-Sample Data for impact 0.005

Table 1 — Statistical Summary for In-Sample, Out-Sample Benchmark and Manual Strategy Portfolios

	Cumulative Return	Average Daily Return	Standard Deviation	Sharpe Ratio
In-Sample Benchmark	0.0102	0.0002	0.0170	0.1534
In-Sample Manual	0.1913	0.0005	0.0163	0.4674
Out-Sample Benchmark	-0.0853	-0.0001	0.0085	-0.2636
Out-Sample Manual	-0.3428	-0.0008	0.0097	-1.2932

Table 1 shows the cumulative return, average daily return, standard deviation of daily return and sharpe ratio for In-Sample, Out-Sample Benchmark and Manual Strategy cases. The differences between in-sample and out-sample are mainly due to the general decline in stock value during out-sample period. For in-sample data, Manual strategy gives better return because technical indicators make good decisions overall. Unfortunately, manual performed worse than benchmark for out-sample because of the impact value. In Figure 3, I showed that a lower impact value gives better return for manual strategy for out-sample as well. Average daily return (ADR) is higher for manual strategy for in-sample. However, out-sample ADR manual is worse than benchmark. Standard deviations are very similar for manual and benchmark strategies because overall they show the same trend. Manual strategy was not constructed to maximize the sharpe ratio, but the cumulative return. For in-sample, sharpe ratio is better for manual strategy than benchmark because manual strategy has higher average daily return. However, sharpe ratio of out-sample is worse for manual than benchmark.

3 STRATEGY LEARNER

This section has two functions: add_evidence and TestPolicy

3.1 Add Evidence (Training)

I used a bag learner of random trees with minimum leaf size as 5. I used 20 bags.

I prepared the training input values as follows: The aforementioned three indicators (MACD, BBP, Aroon Indicator) are fed into each date for the in-sample as training x value. Training y values are calculated as follows. The stock prices are divided with the stock prices of 6 days ago. If this value is above Ybuy, then it is a buy (1). If this value is below Ysell, then is a sell (-1). Otherwise, the training value is 0.

Ybuy = 0.001 + impact + commission * 0.001

Ysell = -0.001 - impact - commission * 0.001

Once the training is done, the user can test the policy with the in-sample or out-sample data in TestPolicy function.

I did not discretize or adjust the data from the manual strategy because I set up the data accordingly. However, I made changes compared to project 6. For example, for MACD, I return the division of MACD to Signal. This ratio is enough to determine a move. BBP was already calculated and had to be returned. Aroon indicator was not changed and only was returned.

3.2 Test Policy (Testing)

In-sample or out-sample data can be entered to query the output (-1, 0 ,1). Training is not done here. An already trained model estimates the output. Based on the output, I return a trades dataframe that contains the trade value (0, -1000, 1000, 2000, -2000) for each day. All the hyperparameters above were determined with trial-and-error.

4 EXPERIMENT 1

Experiment 1 compares three scenarios.

- Benchmark
- Manual Strategy

- Strategy Learner

Throughout the experiment the following parameters are used.

Ticker: JPM

Start Date: 1/1/2008

End Data: 12/31/2009

Starting value: 100000 (Starting amount of money that you have)

Impact: 0.005 (For every trade, you lost this percentage of your stock value).

commission: 9.95 (Every time there is a trade, this commission is lost)

Total holdings can go to negative. the allowed stock positions are -1000, 0, 1000. Allowed trades are -2000, -1000, 0, 1000, 2000.

4.1 Benchmark

Buy 1000 JPM at the first date, sell at the last date. Compute portfolio value based on this strategy by using the impact and commission above.

4.2 Manual Strategy

Use the manual strategy (explained above) to decide which trades to do. Compute portfolio value for every day. Use impact and commission as above.

4.3 Strategy Learner

Use the strategy learner (explained above) to decide which trades to do. Compute portfolio value for every day. Use impact and commission as above.

4.4 Compute_portvals

Portfolio values can be computed by using compute_portvals function in marketsim project.

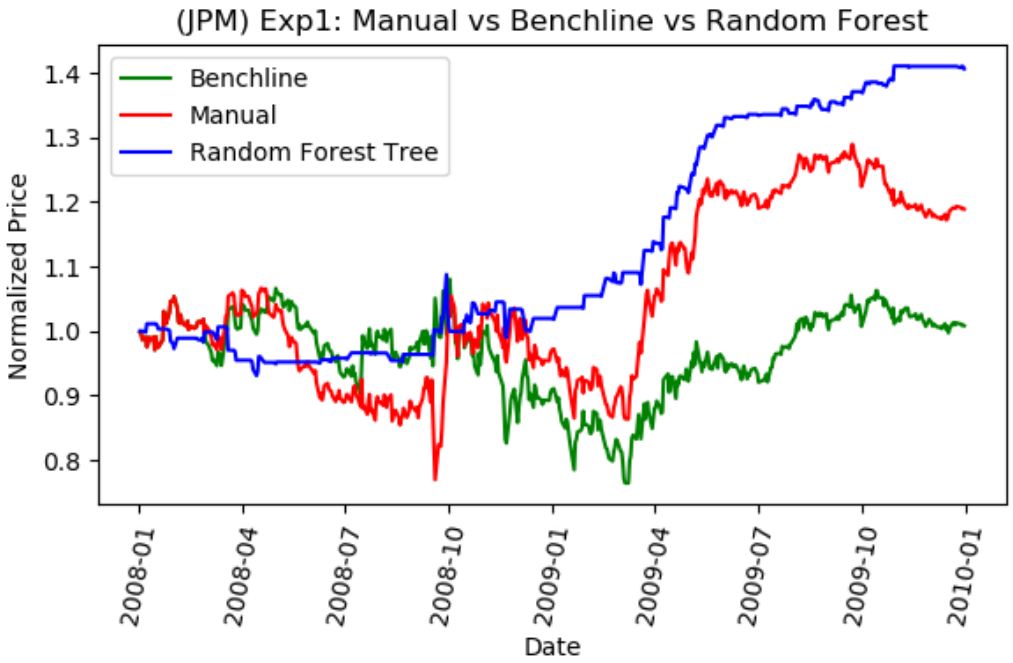

Figure 4 — Benchmark vs Manual Strategy vs Strategy Learner comparison for In-Sample Data.

Once we have portfolio values for all the scenarios, we normalize them to 1 and plot as shown in Figure 4. The results are expected. Manual strategy uses some information coming from technical indicators. Therefore, it should perform better than the benchmark. Random Forest Tree can identify which patterns succeed in higher portfolio. Therefore, it performs the best. I think, as far as the in-sample data is concerned, we should expect similar results for other tickers and dates as well. I think out-sample are more difficult to estimate because testing accuracy should be lower than training.

5 EXPERIMENT 2

A strategy learner that has the same parameters as experiment 1 except the commission and impact is used. Commission is 0. Impact varied between 0 and 0.05 for 4 times. Each time strategy learner is trained and tested with the in-sample data. The portfolio value for each impact case is normalized and plotted.

Figure 5 shows the impact if impacts. As the impact goes up, return goes down. This is because impact makes us lose money every time we make trade.

Cumulative and average daily returns are tabulated in Table 2. Lower impact gives higher cumulative return and higher average daily return as expected.

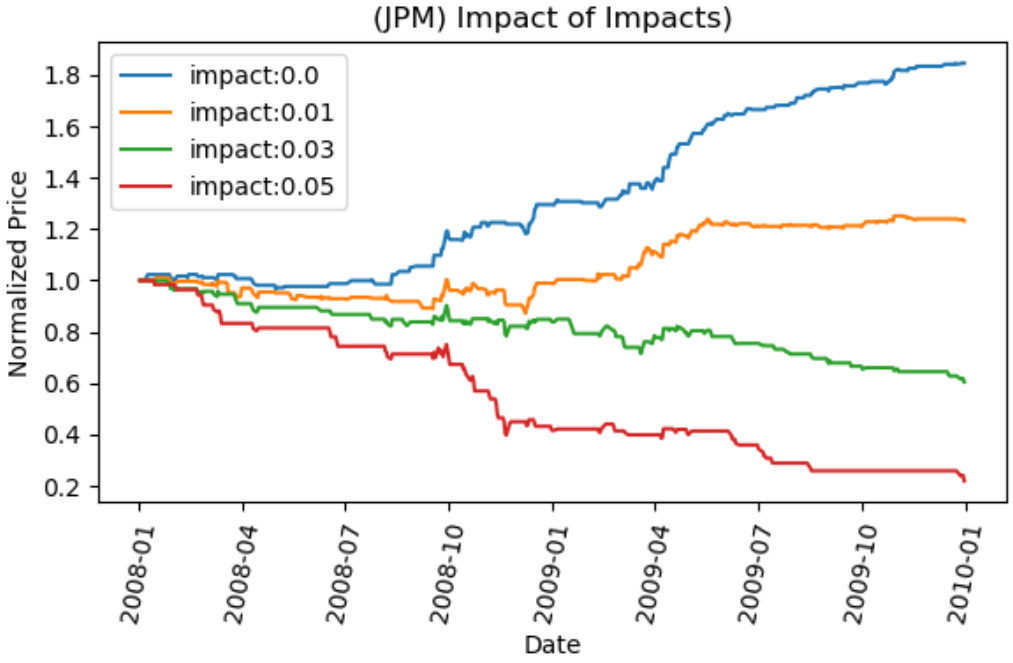

Figure 5 — Benchmark vs Manual Strategy vs Strategy Learner comparison for In-Sample Data.

Table 2 — Statistical Summary for In-Sample for varying impact values.

Impact	Cumulative Return	Average Daily Return
0	0.7144	0.001098
0.01	0.360496	0.000641
0.03	-0.56934	-0.00159
0.05	-0.63261	-0.00191