

Project 8: Strategy Evaluation

Wang Ming Shen
mwang709@gatech.edu

1 INDICATORS

For this project, with 3 indicators implemented from Project 6, they will use them to generate trade signals using the manual strategy and strategy learner. The 3 indicators are - Simple Moving Average (SMA), Relative Strength Index (RSI) and momentum.

This project will use JPM stock prices from 1st January 2008 to 31th December 2009 as a case study as the in-sample time periods and 1st January 2010 to 31th December 2011 as the out-of-sample time periods. Each indicators has their parameters and the decision for each parameter will be discussed in the following sections

1.1 Simple Moving Average (SMA)

SMA is a very widely used technical indicator that smooths out the price data. It calculates the average closing prices for a range of days. The range of days is represented as a window size. The mathematical representation for SMA is:

$$SMA = \frac{C_1 + C_2 + \dots + C_n}{n}, \text{ where } C_i \text{ is the } i^{th} \text{ day and } n \text{ is the window size.}$$

1.3 Relative Strength Index (RSI)

Relative Strength Index is another popular indicator that measures the strength of the change of stock price. It is ranged between 0 to 100 where 0 is the oversold condition and 100 is the oversold condition. Below is the formula depicting RSI:

$$RSI = 100 - \frac{100}{1 + RS}, \text{ where } RS \text{ is the relative strength} = \text{average gain} / \text{average loss over a window size.}$$

1.4 Momentum

Momentum is another indicator that measures the rate of change of the stock prices over a window size. Momentum oscillator is usually a positive or negative value. Below is the formula for momentum:

$$\text{Momentum} = \frac{\text{Stock price of today}}{\text{Stock price n days before}} - 1, \text{ where n is the window size.}$$

2 Manual Strategy

To construct the manual strategy, I combined 3 indicators - SMA, RSI and Momentum - to generate buying and selling signals. The case study used is the stock price for "JPM" across the time period of 1st January 2008 to 31st December 2009 for the in-sample and 1st January 2010 to 31st December 2011 for the out-of-sample time periods. The following sections will explain how the entry and exit of the trade was decided and how manual strategy.

2.1 Logic

The main reason as to why the 3 indicators were chosen were mainly due to:

1. SMA - Averaging the price tells the upwards or downwards movement of the stock. This indicator emphasizes the trend of the stock.
2. Momentum - This indicator measures how fast the price is changing, if the price goes up quickly, it may indicate a good point of entry. This indicator emphasizes the speed of the stock.
3. RSI - This indicator values the stock price, if it is overbought or oversold, emphasizing on the strength of the stock.

Each indicator works on a different purpose and 1 indicator alone might be a result of a false signal, by combining the 3 indicators, it becomes more trustworthy. Only when 3 indicators indicate a positive entry point, then the buy signal will appear, vice versa for the sell signal. The following part will explain the logic of buying and selling conditions.

1. SMA - signal is (price of stock - SMA value across a window of 20 trading days) converted into +1 (bullish), -1 (bearish), 0 (neutral). BUY signal will be when SMA signal is +1, SELL signal is when SMA signal is -1.
2. Momentum - signal is measured by the relative change of price across a window of 20 days ago. Positive momentum means a bullish situation and it is a BUY signal. Negative momentum means a bearish situation and it is a SELL signal.
3. RSI - RSI signal is scaled down to 0 and 1. BUY or bullish signal is when RSI is oversold and signal is below 0.3. SELL or bearish signal is when RSI is overbought and signal is above 0.7.

For LONG condition, all signals above must be having BUY signal, and for SHORT condition, all signals above must be having SELL signal. Else no trades will be made. The question assumes that we can only trade +/- 1000 shares, preventing any unnecessary trades. For example, if the LONG condition was fulfilled during the first trading day (all 3 indicators indicate BUY signal), 1000 shares of trades will be made. During the second trading day, the LONG condition was still fulfilled, we will not trade for this trading day to prevent over trading or rebuying of the shares. Overall, only trading when all 3 signals indicate BUY will ensure a clear and LONG condition and not trading just simply due to a strong signal from 1 indication, which might just be a signal of noise.

2.2 Result

We will now compare the portfolio from the manual strategy and benchmark strategy. The benchmark portfolio assumes a starting cash of \$100000, investing 1000 shares from JPM stock and holding that position to the end. The table below is the in-sample time period results comparison between manual strategy and benchmark strategy.

IN-SAMPLE	Manual Strategy	Benchmark Strategy
Cumulative Return	0.083212	0.012213
Average Daily Return	0.000271	0.000165
Std Dev of Daily Return	0.014988	0.016860

From the chart above and Figure 1, the cumulative returns for Manual Strategy (0.083212) is significantly higher than the Benchmark Strategy (0.012213). This implies that Manual Strategy is much more profitable than the Benchmark Strategy. The average daily returns of Manual Strategy (0.000271) is also higher than the Benchmark Strategy (0.000165), which indicates Manual Strategy is earning more consistently daily compared to the Benchmark Strategy. The standard deviation of daily return of the Manual Strategy (0.014988) is lower than the Benchmark Strategy (0.016860), which indicates that Manual Strategy does not fluctuate as much and is more stable compared to the Benchmark Strategy. Based on this chart alone, Manual Strategy is better than Benchmark Strategy considering it can make more profits and is more stable.

OUT-OF-SAMPLE	Manual Strategy	Benchmark Strategy
Cumulative Return	0.122733	-0.082750
Average Daily Return	0.000262	-0.000136
Std Dev of Daily Return	0.007945	0.008412

From the chart above and Figure 2 for out-of-sample time periods, the cumulative returns and average daily return for Manual Strategy are as high as the Benchmark Strategy while the standard deviation of daily return of the Manual Strategy is lower than the Benchmark Strategy, this further proves the portfolio for Manual Strategy is more profitable than Benchmark Strategy.

Figure 1 and Figure 2 below plots the in-sample (1st January 2008 to 31st December 2009) and out-of-sample (1st January 2010 to 31st December 2011) time periods for JPM stock for Manual Strategy vs Benchmark Strategy.

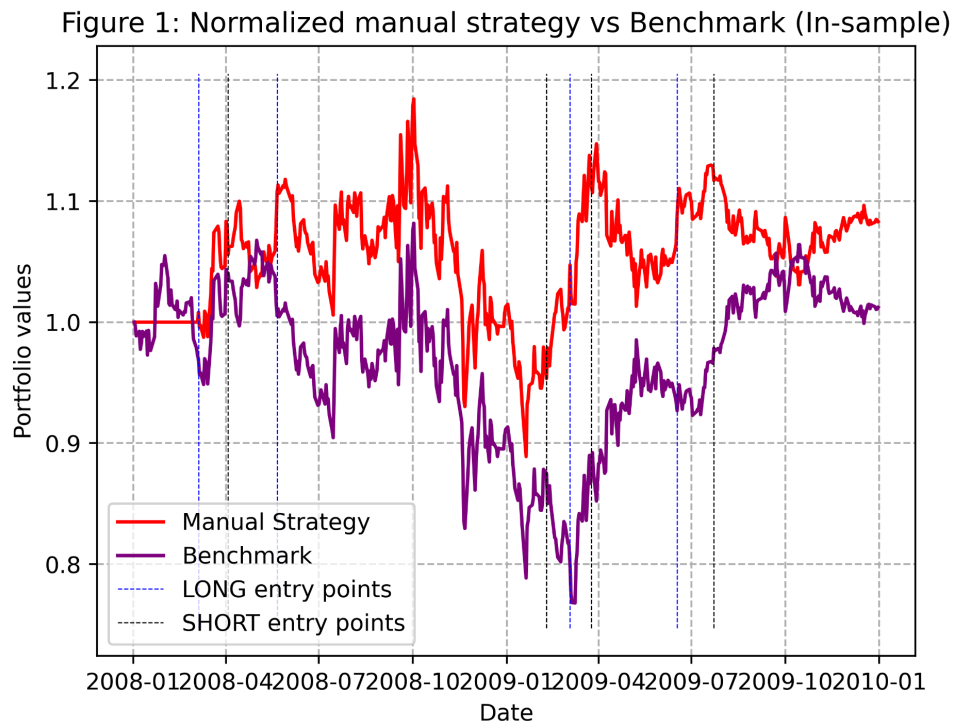


Figure 1

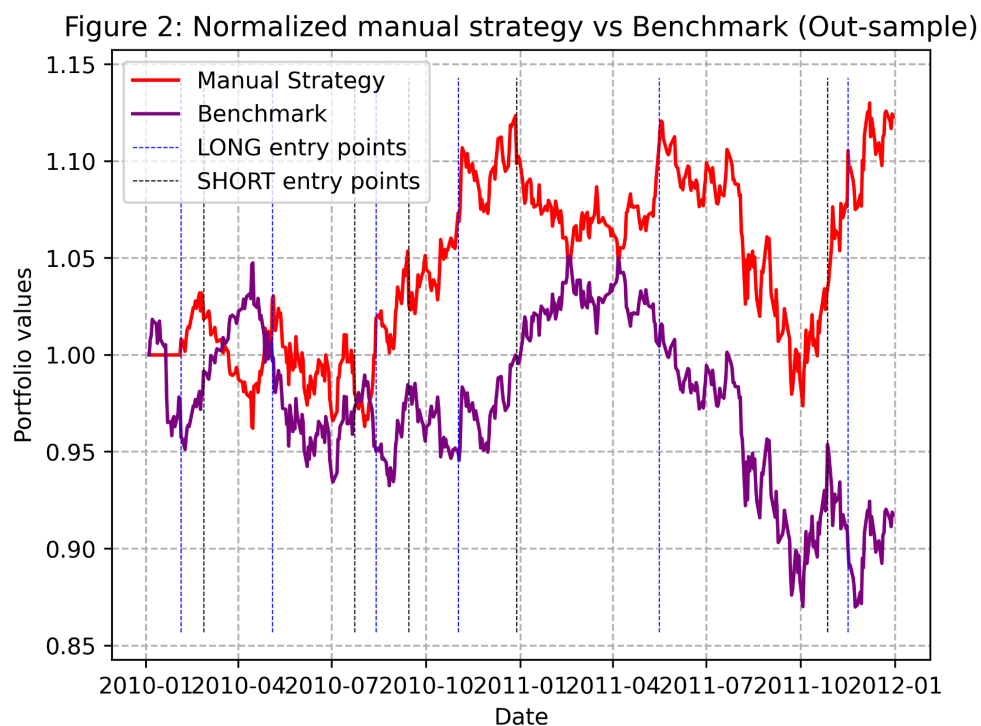


Figure 2

2.3 Evaluate

The reason as to why combining the 3 indication (Munual Strategy) works:

- Combined trend (SMA, RSI) and strength (Momentum) perspective, taking them into consideration while making trade choices. Gave us more confidence in the signal to LONG or SHORT.
- Reduce noises (1 signal may indicate BUY but other 2 signals do not do so, this can be a false signal or noise), avoid bad trades.

However, there are also some factors to consider. Let's say the stock price has already started rising but we have to ultimately wait till all 3 indicators show a BUY signal, this prevents early detection of the bullish stock price.

3 Strategy Learner

Similar to the manual strategy, I combined 3 indicators - SMA, RSI and Momentum - to generate buying and selling signals, using Bag Learner (RTLearner) as base.

3.1 Logic

By combining the 3 indicator values and sending them into Bag Learner as features to train with RTLearner. Instead of deciding a BUY or SELL signal by combining the signals from each indicator, and deciding to LONG or SHORT when all signals are the same (Manual Strategy), Strategy Learner will accept the values from all the indicators as features, and target variables (+1 / 0 / -1) as labels. The labels provided by the Strategy Learner are classified as follows. It shows the frame of my Strategy Learner.

- BUY (+1) when we expect a 7% return in the next 54 days window.
- SELL (-1) when we expect a -7% return in the next 54 days window.
- HOLD, otherwise.

The learner uses Bag Learner, built using RTLearner. The case study used is the stock price for “JPM” across the time period of 1st January 2008 to 31th December 2009 for the in-sample and 1st January 2010 to 31th December 2011 for the out-of-sample time periods. The details on building the Strategy Learner are as follows.

- Leaf size is set to 5 and bag size is set to 20. Experimenting with different configurations and by observing portfolio statistics like cumulative returns and average daily returns, leaf size less than 5 leads to overfitting and over 5 leads to underfitting. While bag size lower than leads to unstable results.
- Train it under `add_evidence()` function call, by fetching the prices for “JPM”, creating features that will be sent for Bag Learning. The feature includes the results from indicators (SMA, RSI, Momentum). Generate labels as explained above. The features and label will be sent for Bag Learner.
- Prediction phase from `testPolicy()` function call, by fetching the prices for “JPM”, creating features that will be sent for Bag Learning. The feature includes the results from indicators (SMA, RSI, Momentum). Predictions

are made by calling the learner.query() which returns signals of +1 (BUY signal), 0 (hold) and -1 (SELL signal).

- Creating a portfolio according to the predictions taking assumptions that we can only trade +/- 1000 shares, preventing any unnecessary trades. For example, if the LONG condition was fulfilled during the first trading day (all 3 indicators indicate BUY signal), 1000 shares of trades will be made. During the second trading day, the LONG condition was still fulfilled, we will not trade for this trading day to prevent over trading or rebuying of the shares. Overall, only trading when all 3 signals indicate BUY will ensure a clear and LONG condition and not trading just simply due to a strong signal from 1 indication, which might just be a signal of noise.

Note that all the indicators had NULL values dropped. RTLearner is able to handle my values that are not scaled as these indicator values are already comparable. RSI is in a range of 0 to 100, Momentum is the percentage change (0 to 100) and SMA is normalized and all indicator results are bounded, with an discrete output of +1 / 0 / -1, explained above.

4 Experiment 1

The goal of this experiment is to compare the results for manual strategy and strategy learner. The configurations for the comparison are based on stock price for “JPM” across the time period of 1st January 2008 to 31th December 2009 for the in-sample and 1st January 2010 to 31th December 2011 for the out-of-sample time periods. Starting the portfolio at \$100000, commission of \$9.95 per trade, market impact of 0.5%, trade size of +/- 1000 shares, compared with a benchmark strategy starting value of \$100000, where 1000 shares were purchased on the first trading day the hold throughout the rest of the time periods.

IN-SAMPLE	Manual Strategy	Benchmark Strategy	Strategy Learner
Cumulative Return	0.083212	0.012213	0.429146
Average Daily Return	0.000271	0.000165	0.000800
Std Dev of Daily Return	0.014988	0.016860	0.0135343

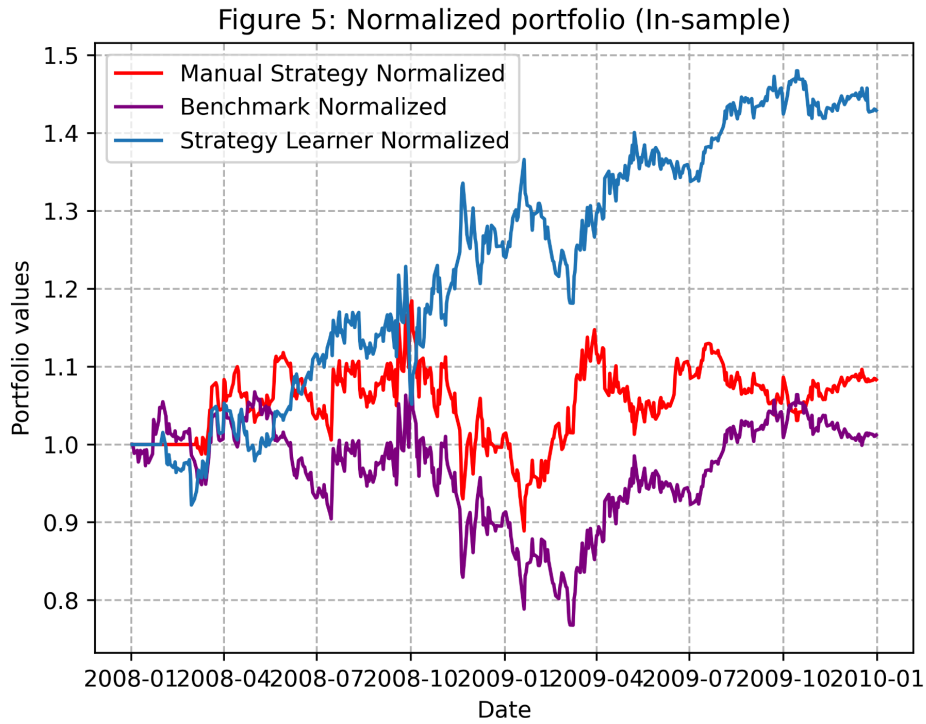


Figure 5

From the chart above and Figure 5, the cumulative returns for Strategy Learner (0.429146) is significantly higher than the Manual Strategy (0.083212) and Benchmark Strategy (0.012213). This implies that Strategy Learner is much more profitable than the Manual Strategy and Benchmark Strategy. The average daily returns of Strategy Learner (0.000800) is also higher than the Manual Strategy (0.000271) and Benchmark Strategy (0.000165), which indicates Strategy Learner is earning more consistently daily compared to the Manual Strategy and Benchmark Strategy. The standard deviation of daily return of the Strategy Learner (0.0135343) is lower than the Manual Strategy (0.014988) and Benchmark Strategy (0.016860), which indicates that Strategy Learner does not fluctuate as much and is more stable compared to the Manual Strategy and Benchmark Strategy. Based on this chart alone, Strategy Learner is better than Benchmark Strategy and Manual Strategy considering it can make more profits and is more stable.

OUT-OF-SAMPLE	Manual Strategy	Benchmark Strategy	Strategy Learner
Cumulative Return	0.122733	-0.082750	0.2145
Average Daily Return	0.000262	-0.000136	0.000413
Std Dev of Daily Return	0.007945	0.008412	0.007319

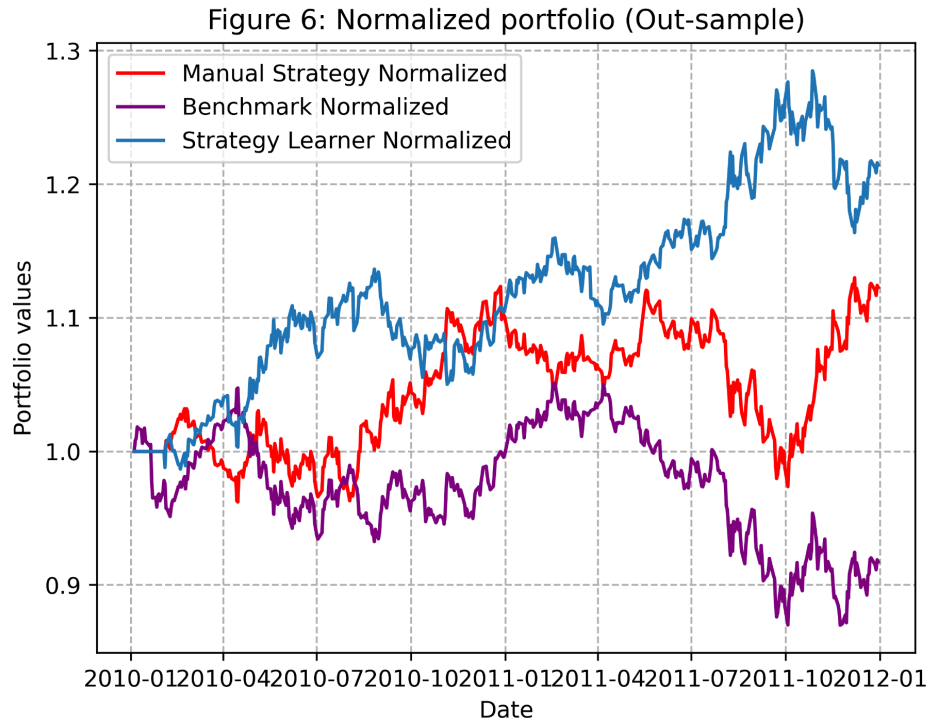


Figure 6

From the chart above and Figure 6 for out-of-sample time periods, the cumulative returns and average daily returns for Strategy Learner is significantly higher than the Manual Strategy and Benchmark Strategy. The standard deviation of daily return of the Strategy Learner is lower than the Manual Strategy and Benchmark Strategy. Based on this chart alone, Strategy Learner is better than Benchmark Strategy and Manual Strategy considering it can make more profits and is more stable.

This experiment demonstrates that both a manual strategy and Strategy Learner model can outperform a basic benchmark in-sample. The StrategyLearner, in particular, shows more promising and profitable results. While not guaranteed to

outperform well every time out-of-sample, the results are still meeting exceeding the benchmark and manual strategy and it is generally a promising model to use for trading.

5 Experiment 2

The goal of this experiment is to compare the results for strategy learners with different market impact. The configurations for the comparison are based on stock price for “JPM” across the time period of 1st January 2008 to 31th December 2009 for the in-sample. Starting the portfolio at \$100000, commission of \$9.95 per trade, market impact in a range of [0.005, 0.01, 0.05], trade size of +/- 1000 shares. With the impact range of [0.005, 0.01, 0.05], we will observe the changes to the cumulative return and standard deviation of daily return for the different learners, running 3 cycles each, and averaged out.

	Impact = 0.005	Impact = 0.01	Impact = 0.05
Cumulative Return over 3 cycles	0.448963	0.289712	-0.001623
Std Dev of Daily Return over 3 cycles	0.014178	0.013515	0.020282

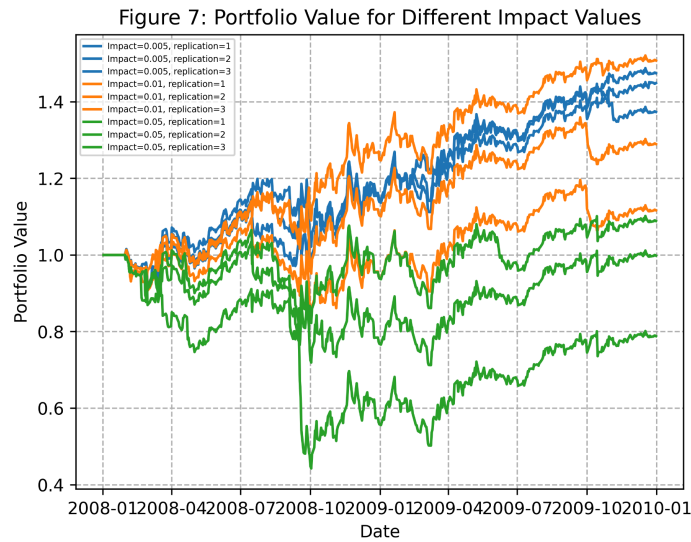


Figure 7

From the chart above and Figure 7, the portfolio value charts across different impact values shows a clear pattern:

- At impact = 0.005, the learner is trading more aggressively, cumulative returns are higher than other impact levels and standard deviation is relatively low.
- At impact = 0.01, cumulative returns drop, and the standard deviation is lower.
- At impact = 0.05, trading behavior becomes conservative. cumulative returns drop even lower, and the standard deviation is higher.

Overall , when impact increases, returns decrease and standard deviation increases. This is because when impact increases, traders pay more to buy the shares and get less to sell, so a good trade will make you lose more money compared to the case where impact is lower. Below is a very simple example to illustrate impacts of buying at \$100 and wanting to sell it at \$102.

Impact = 0.5%

- BUY price = $\$100 * (1 + 0.5\%) = \100.5
- SELL profits = $\$102 - \$100.5 = \$1.5$

Impact = 5%

- BUY price = $\$100 * (1 + 5\%) = \105
- SELL profits = $\$102 - \$105 = -\$3$ (Lose money!)

Thus, it is logical that at a higher impact, traders will not easily take risks and they become conservative, making careful trades. This leads to lower trades being made, lower trades reduced in opportunity for profits. That is the reason why smaller impacts will lead to higher returns.

For producibility of results, impacts should be an array of float or integer impact values ,for example, [0.005, 0.01, 0.05]. Symbol represents the stock in this case, in_start_date represents the in-sample starting time period in datetime format, in_end_date represents the in-sample ending time period in datetime format, commission is the commission per trade and sv is the starting value.