Trading Strategy Learner comparison with traditional manual strategy

3 indicators are used in this research in both Manual Strategy and Strategy Learner. Please note all below uses stock JPM and in-sample period is 2008-01-01 to 2009-12-31 while out-of-sample period is 2010-01-01 to 2011-12-31.

I. Indicators Overview

1. **Price / 14-day Simple Moving Average**
   This indicator divides price by 14-day equally weighted simple moving average price. Since daily prices is filled with noises, it's better to use simple moving average to identify the trend of stock prices since simple moving average smooths out a lot of daily volatilities. This may work because the stock price has the tendency to revert to the mean, so when this indicator has a high value, prices tend to go down and we need to sell the stock and vice versa.
2. **Bollinger Bands %**
   Based on the 14-day simple moving average, we create the Bollinger Band where upper and lower band is 2 standard deviations away from average.
   Middle Band = 14-day simple moving average (SMA)
   Upper Band = 14-day SMA + (14-day standard deviation of price x 2)
   Lower Band = 14-day SMA - (14-day standard deviation of price x 2)
   Bollinger Bands% = (price – bottom band) / (upper band – lower band)
3. **Stochastic Oscillator %D**
   This is a momentum indicator, it attempts to predict price turning points by comparing the closing price and the price range. This indicator may work because prices tend to close near the high when there is an upward trend, and tend to close near the low when there is a downward trend.
   Lowest Low = lowest low for 14 days
   Highest High = highest high for 14 days
   %K = (Current Close - Lowest Low) / (Highest High - Lowest Low) * 100
   %D = 3-day Simple moving average of %K
   (The high and low data here is adjusted as well.)

II. Manual Strategy

I implemented the manual strategy to buy or sell based on below signals:
Buy Signal: (all 3 conditions must be met)

1. Price / 14-day Simple Moving Average <0.95
2. Bollinger Bands % < 0
3. Stochastic Oscillator %D <30

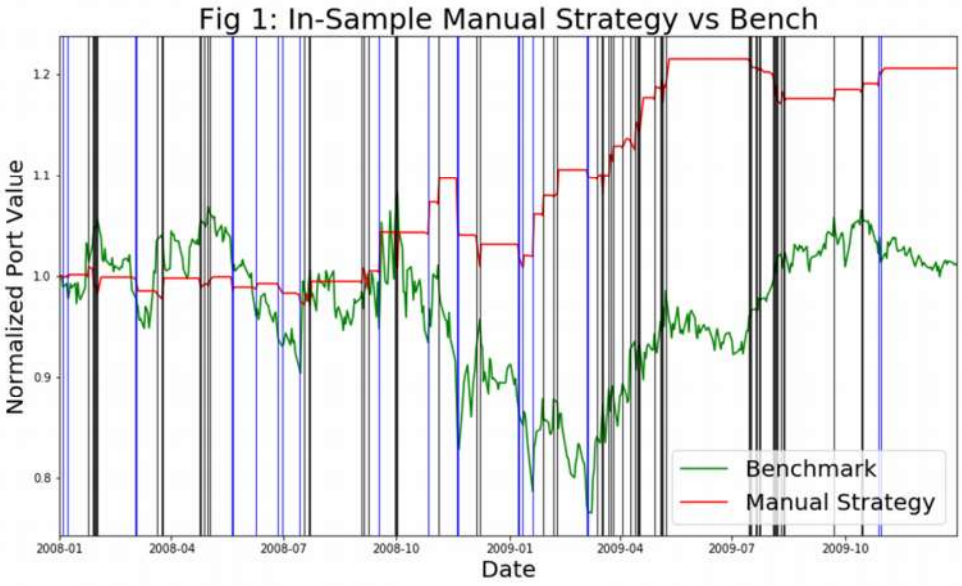
Sell Signal: (all 3 conditions must be met)

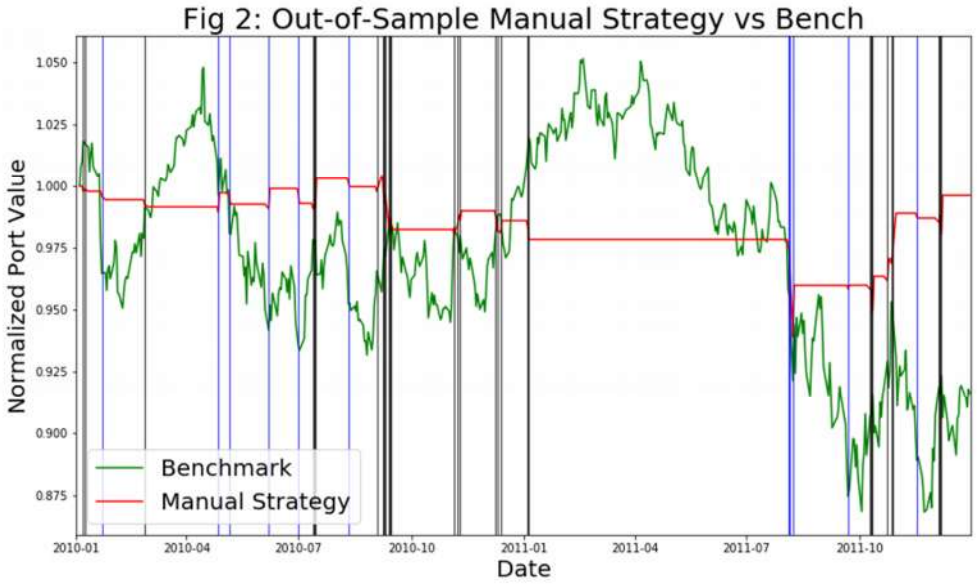
1. Price / 14-day Simple Moving Average >1.05
2. Bollinger Bands % >0.8
3. Stochastic Oscillator %D >70

This should work because:

1. The stock price has the tendency to revert to the mean, so when this indicator has a high value, prices tend to go down and we need to sell the stock and vice versa. For example, for buy signal, when Price / 14-day Simple Moving Average <0.95 and Bollinger Bands % < 0 should work, the price significantly diverges from the mean, so there should be price reversion in the future.
2. Due to price momentum, prices tend to close near the high when there is an upward trend, and tend to close near the low when there is a downward trend. For example, in buy signal, Stochastic Oscillator %D <30 means that there is potential for price to reach the highest high in the most recent 14 days.

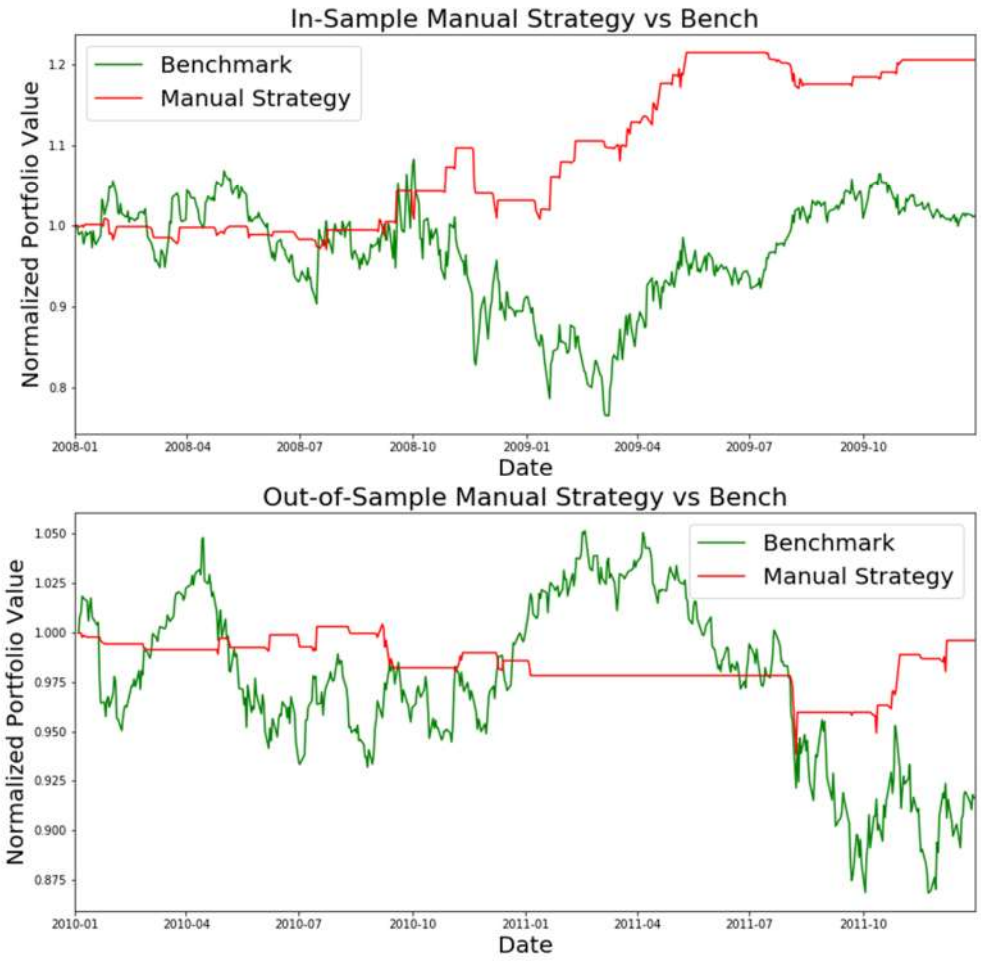
The below figure shows the in-sample and out-of-sample manual strategy based on the above indicators and parameters and benchmark performances. Blue vertical lines indicates LONG entry points while black indicates SHORT entry points.





To better show the performance of in-sample and out-of-sample periords, please see the below charts withougt Long/Short vertical lines. In sample performance is much better than out of sample performances and will be explained later using the actual numbers inside the summary table.

Fig 3: In-Sample vs Out-of-Sample



This following table presents statisctis for manual strategy and benchmark in both in-sample and out-of-sample periods. (Below char assumes risk-free rate is 0.)

	In-sample	Out-of-sample
Port cumulative return	0.20525100000000007	-0.003721499999999822
Bench cumulative return	0.01232493334014717	-0.08357911003280027
Port std of daily return	0.006216542613783298	0.002696795079928812
Bench std of daily return	0.017041247068174344	0.008500158322332455
Port mean daily return	0.0003896499801029008	-3.768582121557138**e-06**
Bench mean daily return	0.00016875916214640016	-0.00013742923038916318
Port Annual Sharpe ratio	0.9950067197427032	-0.022183512191577215
Bench Annual Sharpe ratio	0.15720496488905156	-0.2566565605198889

During the in-sample period, manual strategy performs significantly better than benchmark. Cumulative return (20.53%) is around 20 times of the benchmark cumulative return (1.23%). Also volatility is lower, with 0.62% versus benchmark volatility is 1.70%, this indicates a lower

risk investing in the manual strategy because daily portfolio values fluctuates less than benchmark. Mean return of manual strategy is 0.04% while for benchmark it's 0.02%. With higher daily return and lower risk, it indicates a higher Sharpe ratio for manual strategy, and it's a better strategy than holding the benchmark.

During the out-of-sample period, it's much harder to tell which one performs better, but based on statistics manual strategy is still better if you have to invest in one. Cumulative return are both below 0, but manual strategy (-0.37%) loses less than benchamark (8.36%). For manual strategy, daily volatility is lower, and mean daily return is higher, indicating a higher Sharpe ratio. However, negative Sharpe ratios don't convey useful messages like positive Sharpe ratio, because it means it's better to invest in risk-free rate.

We can tell from above figures, manual strategy does much better in-sample compared to out-of sample since it trains itself using in-sample data, since cumulative return and daily return is higher, and volatility is lower. This is expected behavior because in-sample's data is used in training, but in real life investing based on the strategy will be out of sample and will yield totally different results than the in-sample period.

III. Strategy Learner

The strategy learner use a BagLearner for Random Tree Learner, with leaf size 20, bag size 20 and no boosts.

Steps:

1. X represents indicators, Y represent whether to long a stock(1), short a stock(-1), or holding cash(0) based on 5-day return.
   If 5-day return is larger than 0.02 + market impact, go long, because you if you long the stock you will earn 0.02 return even with market impact.
   If 5-day return is less than -0.02 - market impact, go short.
   Otherwise, hold cash (without going long or short).
2. Calculate the values of 3 indicators in period 2008-01-01 – 2009-12-31, use them as X train set. These X values are calculated each day from current day's (and earlier) data.
3. Calculate Y based on step1 for each day
4. Put training X and training Y into BagLearner to train

Because it's leveraging Random Tree Learner, there is no need to discretize the data. Random tree is going to select a value randomly as the node of the tree to split the available dataset.

IV. Experiment 1

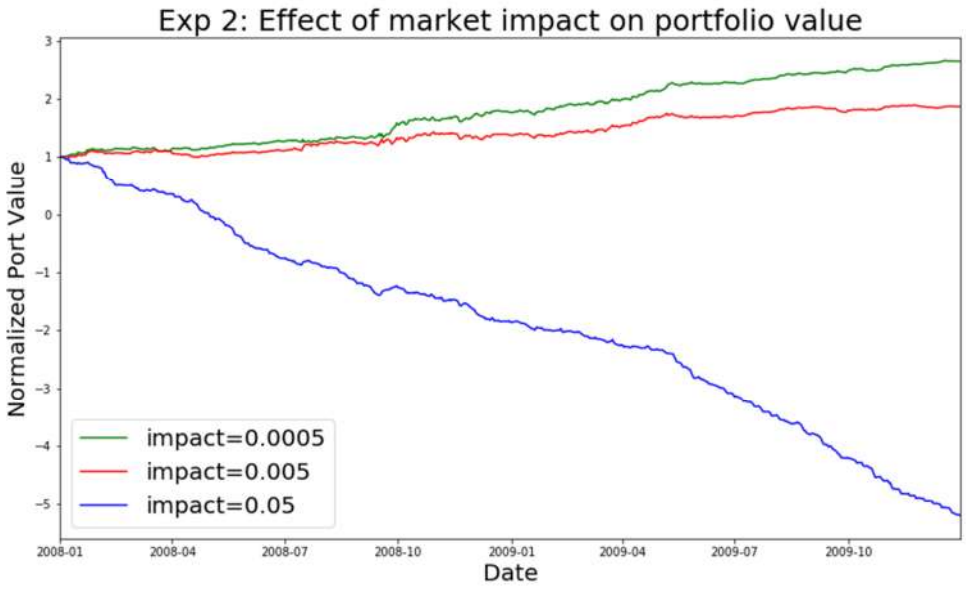
This experiment shows in-sample comparison of strategy learner and manual strategy. According to the plot, the best strategy is Strategy learner, then manual strategy, then benchmark.

	Manual Strategy	Strategy Learner	Benchmark
Cumulative Return	0.20525	1.06494	0.01232
Daily Return std	0.00621	0.01151	0.01704
Daily Return mean	0.00039	0.00151	0.00017
Sharpe ratio	0.99501	2.07540	0.15720

According to above chart and table, strategy learner is the outperforming the rest for in-sample period. Its cumulative return is much higher, 106.50%, then others, also there is a higher mean daily return. Although volatility is higher than manual strategy, it has a Sharpe ratio of more than 2. This indicates that Strategy Learner performs the best among the three.

V. Experiment 2

This experiment shows how market impact could affect in-sample trading behavior and results. Hypothesis: The larger the market impact, and the less cumulative return, the lower the Sharpe ratio.



	Impact = 0.0005	Impact = 0.005	Impact =0.05
Cumulative Return	1.64414	0.86563	-6.19917
Daily Return std	0.01027	0.01159	0.37710
Daily Return mean	0.00198	0.00130	0.01857
Sharpe ratio	3.06675	1.78705	0.78165

From the above chart, we can see using strategy learner, how portfolio value evolves if there is different market impact. When market impact is 0.0005, it yields the highest cumulative return, lowest volatility and highest Sharpe ratio.