P8 Strategy Evaluation Report

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1 INTRODUCTION

This report deployed creation and evaluation of advanced trading strategies, leveraging a set of technical indicators. The core of this report involved two main components: a Manual Strategy and a Strategy Learner, each utilizing three selected indicators for consistency and analytical comparability.

2 INDICATOR OVERVIEW

2.1 Bollinger Bands (BB)

Bollinger Bands are statistical constructs characterizing the prices and inherent volatility of a financial instrument over time. The bands comprise a middle trajectory representing an N-period simple moving average (SMA), an upper trajectory at K times (typically 2) an N-period (typically 14 days) standard deviation above the middle band, and a lower trajectory at K times an N-period standard deviation below the middle band.
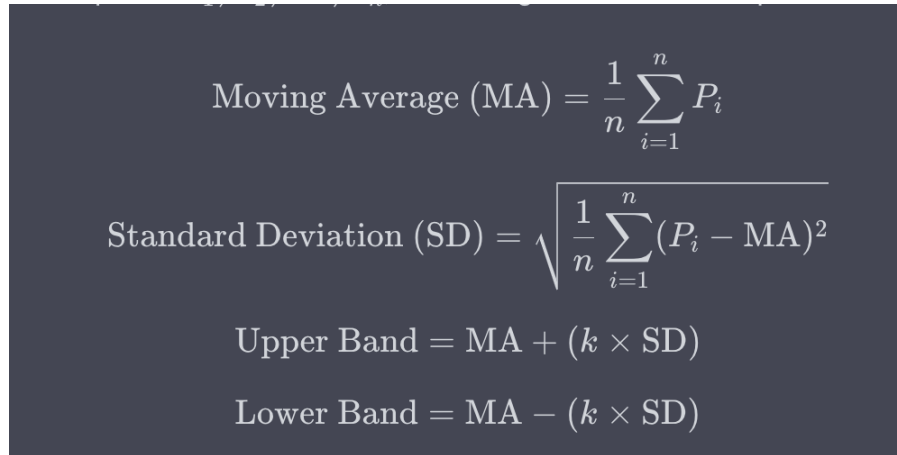
$$\text{Moving Average (MA)} = \frac{1}{n}\sum_{i=1}^{n}P_i$$

$$\text{Standard Deviation (SD)} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(P_i - \text{MA})^2}$$

$$\text{Upper Band} = \text{MA} + (k \times \text{SD})$$

$$\text{Lower Band} = \text{MA} - (k \times \text{SD})$$

Figure 1—BB formula

Key parameters:
K: width of the band
N: look-back window
Buy Signal:

When the price touches or goes below the lower band and then starts to rebound.
Sell Signal:
When the price touches or rises above the upper band and then starts to pull back. When the price crosses below the middle band (moving average) from above.

2.2 Exponential Moving Average (EMA)

The Exponential Moving Average (EMA) is a type of moving average that gives more weight to recent prices, making it more responsive to new information compared to a simple moving average (SMA). The formula for EMA involves taking the difference between the current price and the previous day's EMA, and multiplying it by a smoothing factor, which is then added to the previous EMA. Key parameters:

$$\text{EMA}_t = \alpha \times P_t + (1 - \alpha) \times \text{EMA}_{t-1}$$

Figure 2—EMA Formula

N: look-back window
Buy Signal:
When the price to EMA is increasing above 1.
Sell Signal:
When the price to EMA is dropping below 1.

2.3 Relative Strength Index (RSI)

The Relative Strength Index (RSI) is a momentum oscillator that measures the speed and change of price movements. RSI oscillates between 0 and 100 and is typically used to identify overbought or oversold conditions in a traded security.
Key parameters:
ul: Upper limit
ll: Lower limit
Buy Signal:
When the RSI crossed below lower limit, which is a strong signal for oversold.
Sell Signal:
When the RSI crossed above upper limit, which is a strong signal for overbought.

$$\text{RSI} = 100 - \left(\frac{100}{1 + \text{RS}} \right)$$

Where:

$$\text{RS} = \frac{\text{Average Gain over } n \text{ periods}}{\text{Average Loss over } n \text{ periods}}$$

Figure 3—Relative Strength Index (RSI)

3 MANUAL STRATEGY

For the manual strategy, the approach here was to take a majority vote among the indicators: if most indicators suggest buying, we go long; if most suggest selling, we go short; otherwise, we hold. For those dates we do not have enough data (the beginning few days for example), we hold until finishing the data collection. The reason behind this approach was to give equivalent weights to each indicators and did not over/under estimate any signals. Figure 4 and figure 5 showed the in-sample and out-sample performances for the manual strategy. Overall, the manual strategy could beat the benchmark. More detailed statistics are shown in Table 1 and 2. The mean of daily returns and standard deviation of manual strategy all perform better than the benchmark.
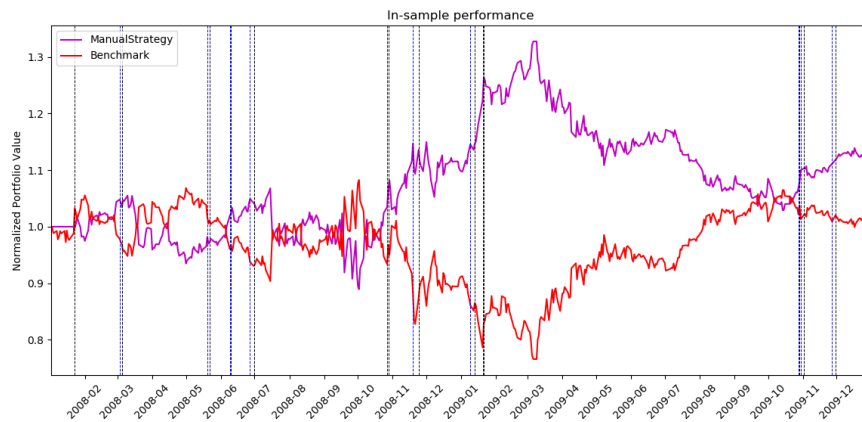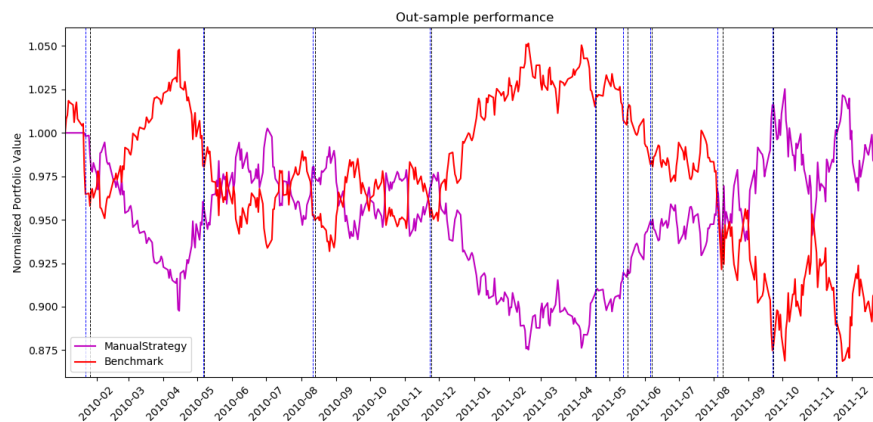

Figure 4—Manual strategy 1

Figure 5—Manual strategy 2

Table 1—In-sample Statistics

Statistics	Benchmark	Manual Strategy
Cumulative Return	0.012325	0.125827
Stdev of Daily Returns	0.017041	0.014872
Mean of Daily Returns	0.000169	0.000346

Table 2—Out-Sample Statistics

Statistics	Benchmark	Manual Strategy
Cumulative Return	-0.083579	-0.026012
Stdev of Daily Returns	0.008500	0.008153
Mean of Daily Returns	-0.000137	-0.000019

4 STRATEGY LEARNER

The steps to construct the Strategy Learner included:

1. Classification Target (Y) Calculation: The target variable (Y) for each day will be based on the N-day return of the stock price. It will be classified as +1 (LONG), -1 (SHORT), or 0 (CASH) based on the thresholds YBUY and YSELL.

2. Feature Set (X) Construction: The features for the learner will be based on 3 technical indicators selected.

3. Learner Adaptation: The random tree regression learner would be modified to become a classification one. This involved changing how the learner makes decisions at each node in the tree.

4. Parameter Tweaking: Adjust parameters like leaf size, YBUY, Ysell, etc.

Key hyper-parameters improved:

1. YBUY and Ysell: set to be 0.05 for both. It has to be bigger than 0 but not too small as the profit must be larger than the commission fee and potential loss due to the impact.

2. N: set to be 10. Instead of being a reckless trader, the learner is expected to press the trigger when the signal is strong enough for a long time.

3. leaf size: set to be 5. As random tree was leveraged, the over-fitting could be avoided comparably. A more aggressive fitting was picked from practices.

Data Adjustment:

No adjustment has been taken as the hyper-parameter improvement has proved to be powerful enough to beat the benchmarks either in-sample or out-sample. Standardisation would be taken if more resources are given.

5 EXPERIMENT 1

The hypothesis was: Over the in-sample and out-sample periods, the strategy learner would be the best strategy, out-performing the benchmark, while the manual strategy is slightly better than the benchmark but showed a huge fall-behind compared to the learner.

The figure 6 and 7 has proved the hypothesis was true, where the learner showed a strong advantage and resilience no matter the benchmark or manual-strategy deviated.
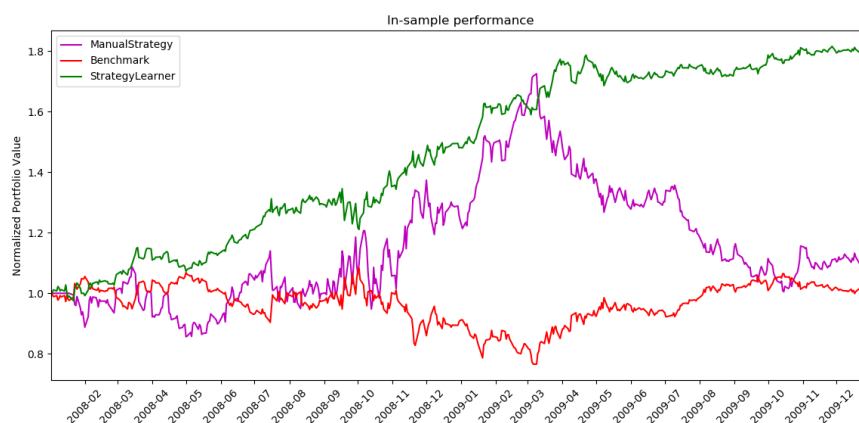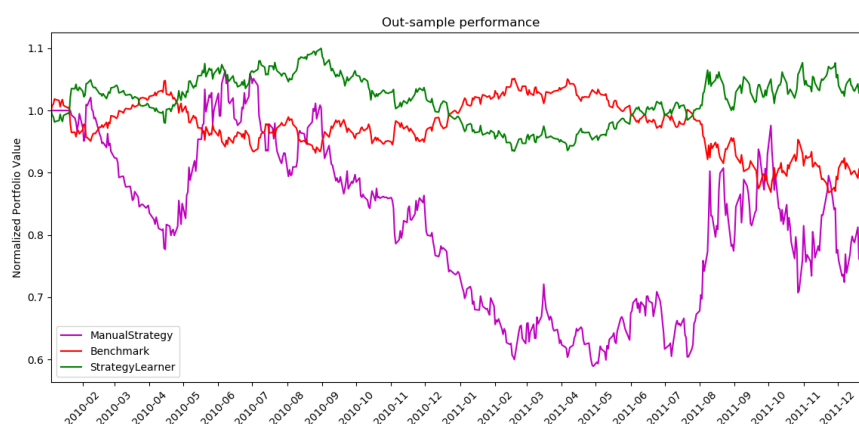

Figure 6—Experiment 1 (In-sample)

Figure 7—Experiment 1 (Out-sample)

6 EXPERIMENT 2

The hypothesis was: when the impact increases, the cumulative return would decrease and the standard daily deviation would increase. However, according to the figure 8, there was no strong relationship between impact and those two portfolio behaviour metrics.
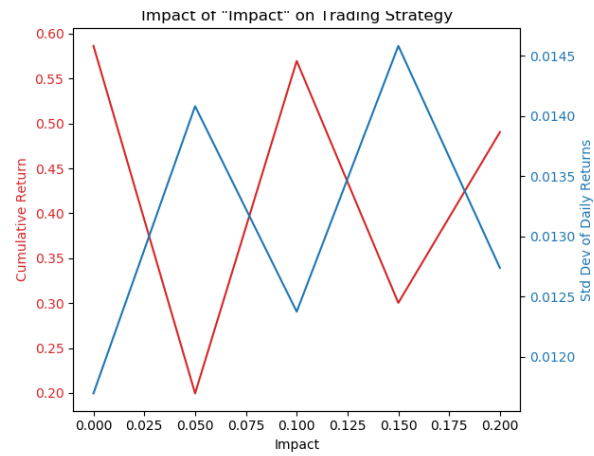

Figure 8—Experiment 2