Machine Learning for Trading: Manual Strategy Report

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1 Technical Indicators

For this assignment, I have used the following indicators:

1. **Simple Moving Average (SMA)**
   Simple Moving Average is a smooth but lagging indicator of price. It is calculated by taking the rolling mean of the normalized stock prices. I have taken the rolling mean with a window of 20 (SMA-20) as my indicator. I plot the normalized stock price, the SMA, and the price to SMA ratio in my graph.

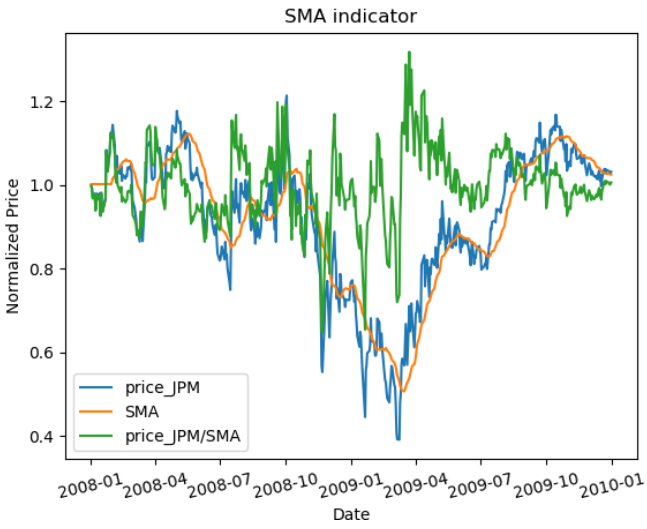

Figure 1: Simple Moving Average

2. **Bollinger Bands**
   Bollinger Bands are technical indicators that are plotted 2 standard deviations above and below the rolling mean (SMA-20). The standard deviation is also calculated on a rolling basis. All calculations are done on the normalized prices. The Bollinger Bands can be calculated by adding/subtracting (2*standard deviation) to/from the rolling mean.

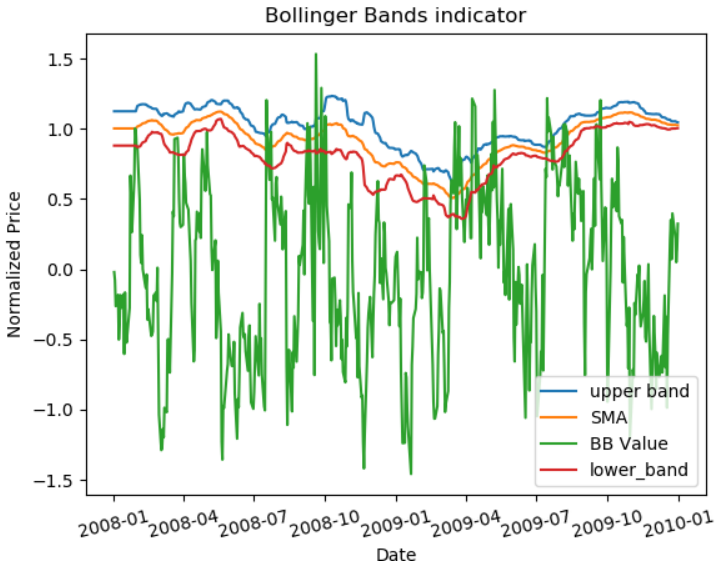

Figure 2: Bollinger Bands

3. **Commodity Channel Index**
   Commodity Channel Index is a technical indicator that measures the current price level relative to an average price level over a given period of time. The CCI values can be used to identify the start of a downtrend or an uptrend. CCI can be calulated by dividing the difference between the price and the SMA by the standard deviation. (plot on next page)

4. **Momentum** Momentum is a technical indicator that measures the change of price of a financial instrument over a given time span. It can be calculated by finding the ratio of the current price and the price at a given window size in the past, and subtracting 1 from that ratio. (plot on next page)

2 Theoretically Optimal Strategy

For a theoretically optimal strategy, we have to consider that we can see into the future, that is, we can make the trading decisions for today based on the

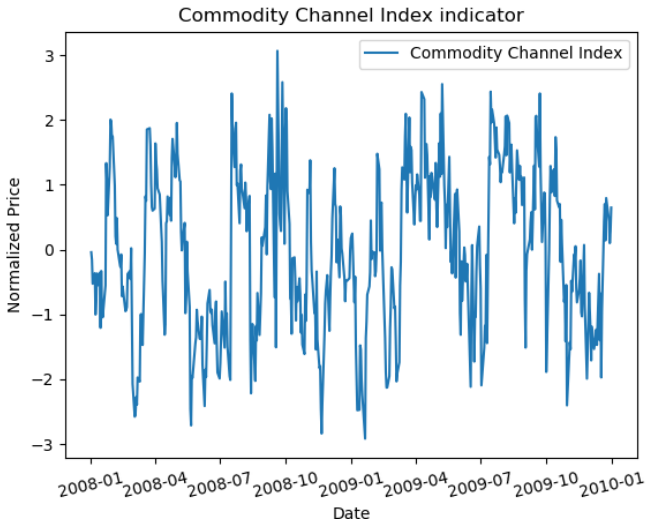

Figure 3: Commodity Channel Index

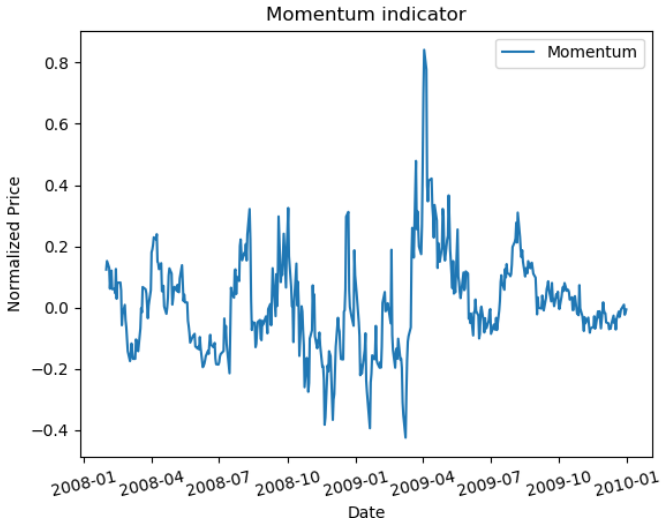

Figure 4: Momentum

stock prices of tomorrow. We have been given a starting cash of $100000, and an impact and commission of 0. Allowable positions are: 1000 shares long, 1000 shares short, 0 shares, that means that our holdings at any point can be -1000, 0, or +1000.

The strategy that I think can be optimal with the given constraints is:

- Make trading decisions based on the price of the stock the next day.
- If the price of stock tomorrow is going to be more than the price of stock today, long the stock if it can be, that is, buy 1000 shares if the current holdings are -1000 or 0.
- If the price of stock tomorrow is going to be less than the price of stock today, short it if it can be, that is, sell 1000 shares if current holdings are +1000 or 0.
- If neither of the above two conditions are met, don't do any trade on that day, that is, remove that day's entry from the trades_df dataframe.

  Here, we see that the theoretically optimal strategy clearly outperforms the benchmark.

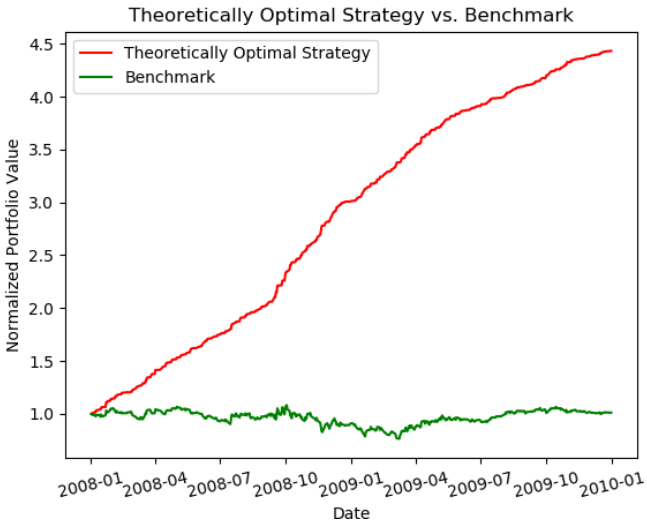

Figure 5: Theoretically Optimal Portfolio value vs. Benchmark Portfolio value

The statistics for in-sample dates for theoretically optimal strategy are as follows:

- Cumulative return = 3.4323
- Standard deviation of daily returns = 0.004881
- Mean of daily returns = 0.00297

The statistics for in-sample dates for benchmark strategy are as follows:

- Cumulative return = 0.0123
- Standard deviation of daily returns = 0.017004
- Mean of daily returns = 0.000168

3 Manual Rule-Based Trader

For a manual rule-based strategy, we have to make short or long positions, if they can be made according to our current holdings, based on manual rules that we decide according to the values of our technical indicators. This is a real-case scenario in which we can't look at the future, and there's also some transaction cost (commission=$9.95 and impact=0.005).

For this strategy, I am using the values of indicators SMA and momentum. The strategy is as follows:

- If the value of SMA is less than 0.98 or the value of momentum is less than -0.6, we go long, that is, we buy 1000 shares if the current holdings are -1000 or 0.
- If the value of SMA is greater than 1.08 or the value of momentum is greater than 0.6, we go short, that is, we sell 1000 shares if the current holdings are 1000 or 0.
- If neither of the above two conditions are met, don't do any trade on that day, that is, remove that day's entry from the trades_df dataframe.

  Here, we see that this rule-based strategy clearly outperforms the benchmark. (plot on next page)

4 Comparative Analysis

Given below is the performance of the manual rule-based trader on the out sample dates, that is, from January 1, 2010 to December 31, 2011. As can be seen from the graph, the performance of the portfolio is still better than the benchmark, but does not outperform it as well as the in-sample portfolio did. This is because our rules (indicator thresholds) are determined according to the in-sample data. Because I tried different values of SMA and momentum thresholds to obtain a better performance on the in-sample data, I overfit it. Because of overfitting, our rule-based strategy is not performing well on the out-sample data.

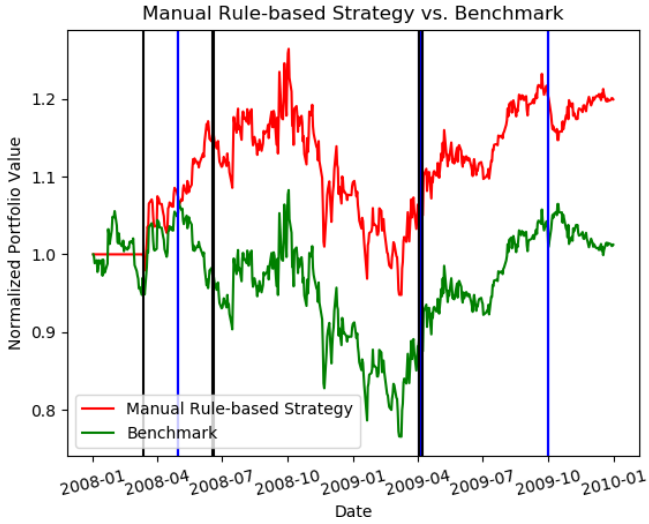

Figure 6: Manual Rule-based Strategy Portfolio value vs. Benchmark Portfolio value for In-sample dates

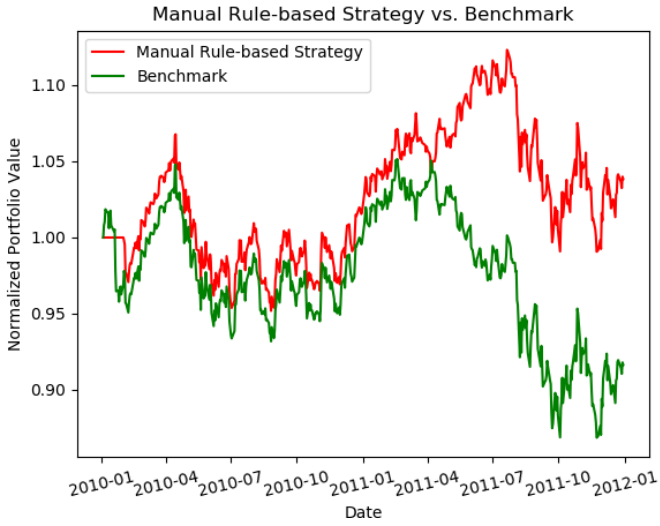

Figure 7: Manual Rule-based Strategy Portfolio value vs. Benchmark Portfolio value for Out-sample dates

Measure	**In-sample**	**Out-sample**
Cumulative Return	0.199214	0.038371
Standard Deviation	0.013977	0.007694
Mean	0.000458	0.000104