Manual Strategy

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Indicators

Three indicators are used in the manual strategy:

1. Bollinger Bands

2σ Bollinger Bands are calculated for the adjusted closing price. The specific indicator used is the Bollinger Bands %B or Percent Bandwidth, calculated from the upper and lower bounds of the bands on the adjusted closing price using a 20 day simple moving average. This indicator quantifies where the price is in relation to the bands. The formula for this indicator is:

$$\%B = \frac{\text{Price} - \text{Lower Band}}{\text{Upper Band} - \text{Lower Band}}$$

The general trading signals from this indicator are defined as follows:

- Buy when the %B breaks below 0
- Sell when the %B breaks above 1

Figure 1 shows the plot for the indicator for the JPM symbol. The greyed-out areas of the plot represent the bounds defined by the 2σ Bollinger Bands. The green lines represent the thresholds for the trading signals used in the Manual Strategy.

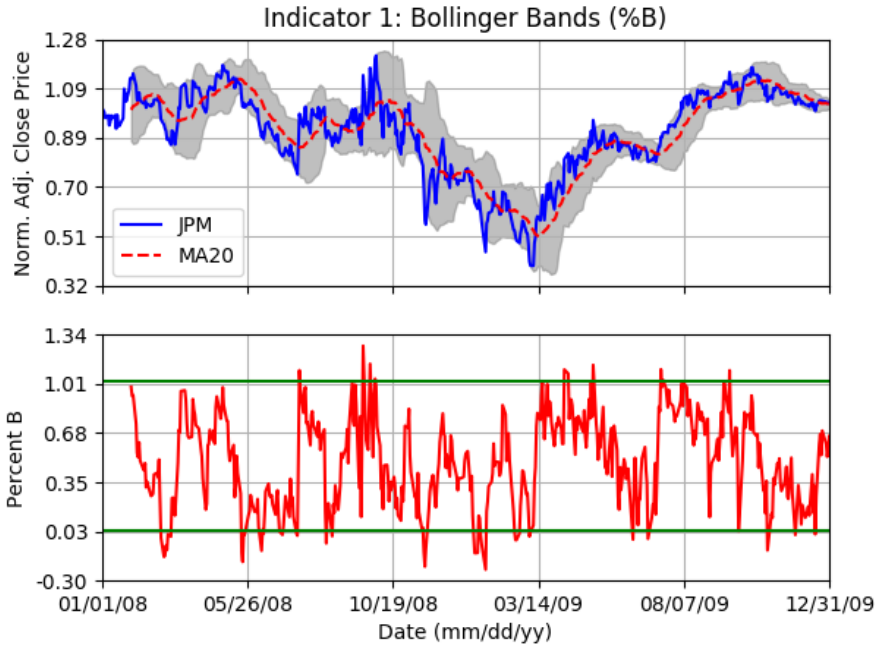

Figure 1: Indicator 1

2. Momentum

The momentum identifies the trend in price change comparing the closing price to the closing price n periods away. In this case a 20 day period is defined, so the momentum is calculated as:

$$M = \frac{\text{Price}_{\text{ i}}}{\text{Price}_{\text{ i}-20}}$$

The momentum is standardized by subtracting its mean and dividing by its standard deviation. The trading decisions are based on the crossover from 0 on the standardized momentum:

- Buy when the momentum crosses above 0
- Sell when the momentum crosses below 0

Given that it's a single threshold indicator, a zero-crossing detector is used to get the trade dates and a determination of the direction of the crossing is made to distinguish buy and sell signals.

Figure 2 shows the plot for this indicator. The green line is the crossover point for the trade signals.

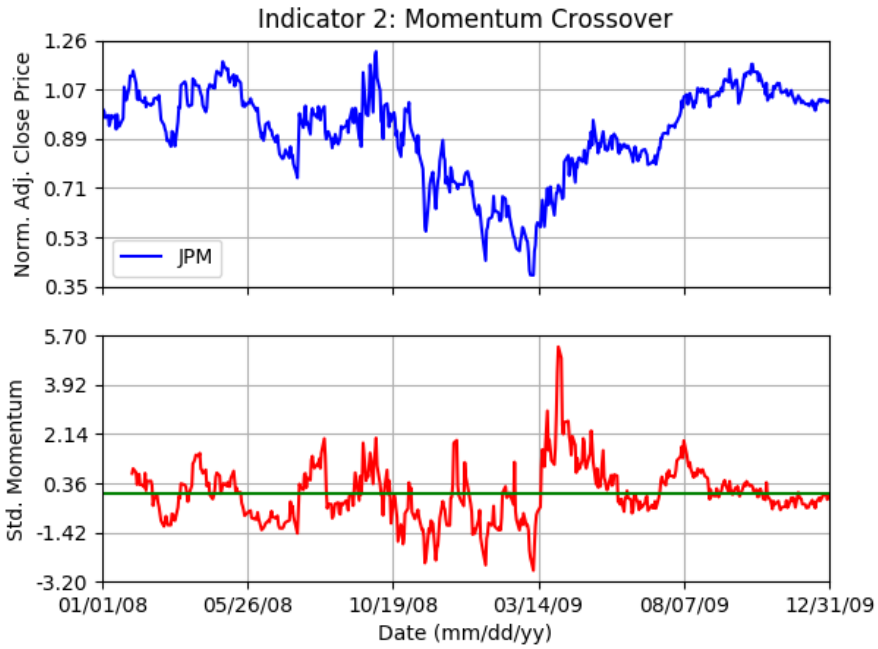

Figure 2: Indicator 2

3. SMA Ratio

The SMA Ratio between two different moving averages is used as the third indicator. The crossover between both moving averages triggers the decision to buy or sell, so 1 is subracted from the ratio so that a zero-crossing detection can be used in a similar fashion to the momentum indicator.

$$\text{SMA}_{\text{ratio}} = \frac{\text{SMA}_1}{\text{SMA}_2} - 1$$

The trading decisions are based on the ratio:

- Buy when the ratio crosses above 0
- Sell when the ratio crosses below 0

Figure 3 shows the resulting indicator, as well as the two moving averages tuned for the manual strategy after testing several values.

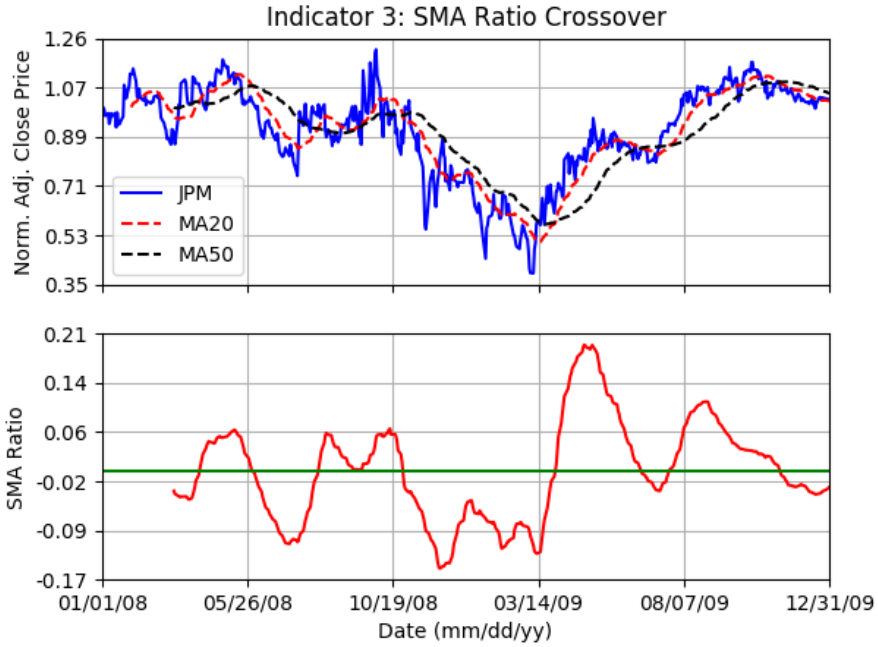

Figure 3: Indicator 3

Best Strategy

The best strategy is to take a decision on the current day of whether to buy or sell stock based on the price for the following day (peeking a day into the future). The strategy is failry simple, if the price for the next day is higher than the price of the current day then a buy order is triggered. If the price for the next day is lower than the price of the current day then a sell order is triggered. No commission or trade impacts are considered for this simulation.

Figure 4 shows the resulting portfolio value over the in-sample period for the strategy described above. As expected, the performance is very large, almost 7 times larger, given that the ability of peeking into the future makes trading too easy.

Figure 4: Results for Best Strategy

Table 1 shows the resulting stats for the best strategy for the in sample data. The portfolio has higher cumulative return, average daily return and Sharpe ratio, as well as a volatily ~4 times smaller than the benchmark.

Table 1: Metrics for in-sample data for best strategy

	CR	ADR	SDDR	SR
Portfolio	5.7844	0.003816	0.004548	13.319836
Benchmark	0.0123	0.000168	0.017004	0.156918

Manual Strategy

The manual strategy is based on the 3 indicators outlined in the first section of this report, the buy and sell signals are triggered on the following conditions:

$$\text{buy} \quad \text{if} \begin{cases} \%B < 0.03 \\ M_{i-1} < M_i \\ \text{SMA}_{\text{ratio}i-1} < \text{SMA}_{\text{ratio}i} \end{cases}$$

$$\text{sell} \quad \text{if} \begin{cases} \%B > 1.03 \\ M_{i-1} > M_i \\ \text{SMA}_{\text{ratio}i-1} > \text{SMA}_{\text{ratio}i} \end{cases}$$

If either of the 3 conditions in each case is true then a buy signal is issued on that day. A list of orders is built from this and then the dates where there are conflicting orders are removed, consecutive buy or sell orders are also removed (only the first one in a sequence is kept).

The only tunable parameter in this strategy was the threshold for the %B indicator, several values were manually tested until the values of 0.03 and 1.03 were selected as adequate based on the performance of the portfolio vs the benchmark.

Figure 5 shows the resulting portfolio versus the benchmark as well as the buy and sell signals based on the strategy discussed before.

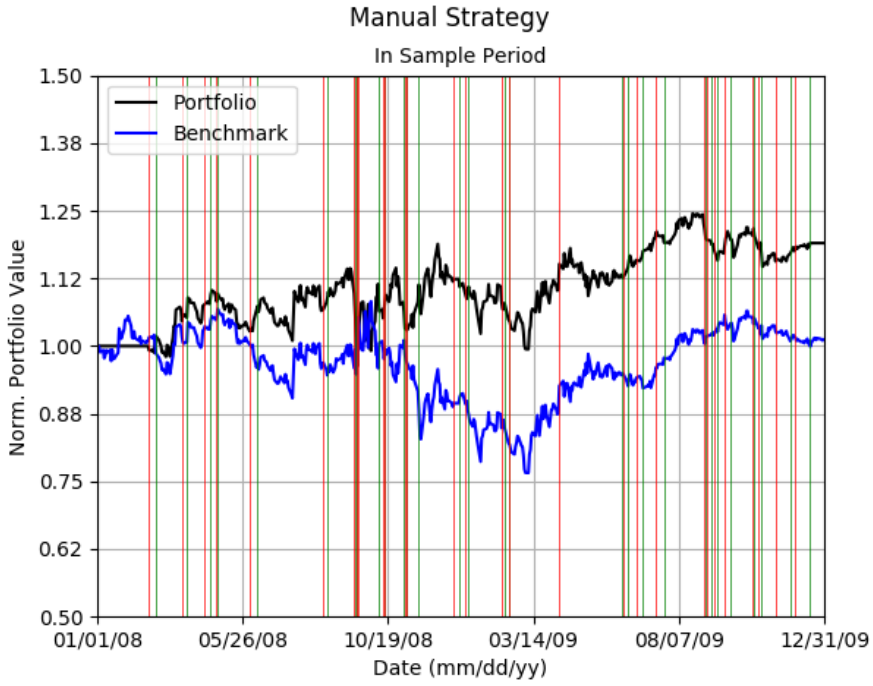

Figure 5: In-sample Results for Manual Strategy

It can be seen that the performance of the portfolio is better with respect to the benchmark in the in-sample period, the gain in the normalized portfolio value is not as large as with the best strategy but it is still considerably better than the benchmark.

It is interesting to note that there is a period of high volatility in the stock near October 2008 (reflected in the benchmark) when there is a large number of trade orders and the performance of the portfolio is marginally

better at best, this could be indicative that the current strategy is not robust against high volatilty periods. Nonetheless, simple as it is, the selected strategy outperforms the benchmark most of the time.

Table 2: Metrics for in-sample data for manual strategy

	CR	ADR	SDDR	SR
Portfolio	0.190170	0.000452	0.014641	0.490254
Benchmark	0.012325	0.000169	0.017041	0.157205

Table 2 shows the stats for the portfolio and the benchmark for the in-sample period. The cumulative return is 15 times larger than the benchmark, showing that the selected manual strategy is much better than the simple holding strategy defined by the benchmark. The Sharpe ratio and average daily returns are also larger. Confirming the above comment about the volatility, the standard deviation of daily returns is just slightly better, showing that the chosen strategy is still susceptible to the volatily in the stock (which the best strategy was not).

Comparative Analysis

Figure 6 shows the normalized portfolio value for the benchmark and the portfolio with manual strategy for the out of sample period. The chosen manual strategy seems to work well, as it beats the benchmark for the whole period, although with significantly less performance than the in-sample period.

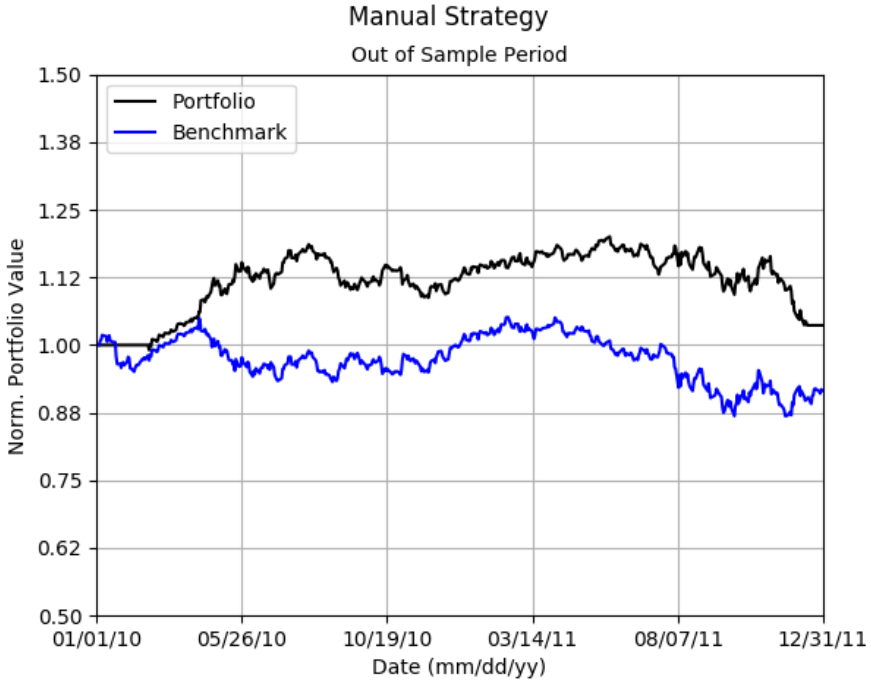

Figure 6: Out of Sample Results for Manual Strategy

Table 3 show stats for the portfolio and the benchmark for the in-sample and out of sample periods. In both periods the strategy outperforms the benchmark, although as expected out of sample performance is lower given that the tuning was done on the in-sample data alone.

Table 3: Metrics for in-sample (train) and out of sample (test) data for manual strategy

	CR	ADR	SDDR	SR
Portfolio (train)	0.190170	0.000452	0.014641	0.490254
Benchmark (train)	0.012325	0.000169	0.017041	0.157205
Portfolio (test)	0.036366	0.000095	0.006912	0.217918
Benchmark (test)	-0.083579	-0.000137	0.008500	-0.256657

The used indicators are fairly simple, so the tuning required is minimal, which may explain why the out of sample performance is still fairly good for the whole period of analysis. From these results it can be concluded that the proposed strategy, although fairly simple and conservative, yields good results in general.

It is also very evident that the benchmark strategy is not very good, for a good part of the time in both the in-sample and out of sample data the normalized porfolio value is well under 1, meaning that holding on to a single set of stocks for too long without further trade decisions based on its price is not a good idea, you will end up losing money.

The manual process of tuning the indicators, without using specialized machine learning algorithm shows how difficult it is to take market decisions, there are also many more different indicators that could have been used. A machine learning algorithm is expected to perform much better than a manually tuned ruleset.