CS7646 Project 6: Indicator Evaluation

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***Abstract*—** This report contains two sections. Section one explains my theoretically optimal strategy to trade the JPM stock while given portfolio and parameter constraints. Section two explains the strategy behind five different trading indicators and steps to create them.

1 THEORETICALLY OPTIMAL STRATEGY

1.1 Introduction

My goal is to create a theoretically optimal strategy to produce the best portfolio results using the JPM stock symbol, a time period from January 1, 2008 to December 31, 2009 and $100,00 in cash. Additionally, I am constrained to a max holding of 1000 shares long or short. Therefore, my max stocks traded is constrained to 2000 shares and minimum stocks traded is 0 shares. Each trade has zero commission and impact related costs.

1.2 Methodology

Given that I have historical prices of JPM and I am also able to see future prices of JPM, I can use the future value to determine my next trade. Day one of trading I have no other option other than purchase 1000 shares of JPM. Starting from day two, I have the option of buying, selling or holding shares of JPM by not trading. By looking at the future value on day three, I can determine my trading decision. If on day three the value of JPM is greater than the value of JPM today, then I will buy until my holding is no greater than 1000 shares. In this case, I already hold 1000 shares of JPM, even if the price of day three was greater than the value today, my only option is to hold and make no trades. Whereas, if the value of JPM on day three is less than the value of JPM today, then I will sell my current shares of JPM and short the stock until my holding is no less than -1000 shares. If I already have -1000 shares then I will not be able to sell or short anymore, so my only option is to

hold. If I am currently holding 0 shares then I will be able to either buy or sell 1000 shares of JPM. If I have -1000 shares then I can buy 2000 shares, whereas if I have 1000 shares then I can sell a maximum of 2000 shares. On the last day of the trading period, no action is required and I will hold the remaining stocks in my portfolio.

1.2 Methodology & Experiments

Benchmark values follow the historical price of JPM and are produced from buying 1000 shares of JPM on day one and holding them until the end of the period. TOS portfolio values are updated each day, based on the cash plus stock value in holdings. From *Figure 1* and *Table 1* , it can be seen that the TOS portfolio performs statistically better than benchmark portfolio. From this, we can also note that active portfolio management proves effective.

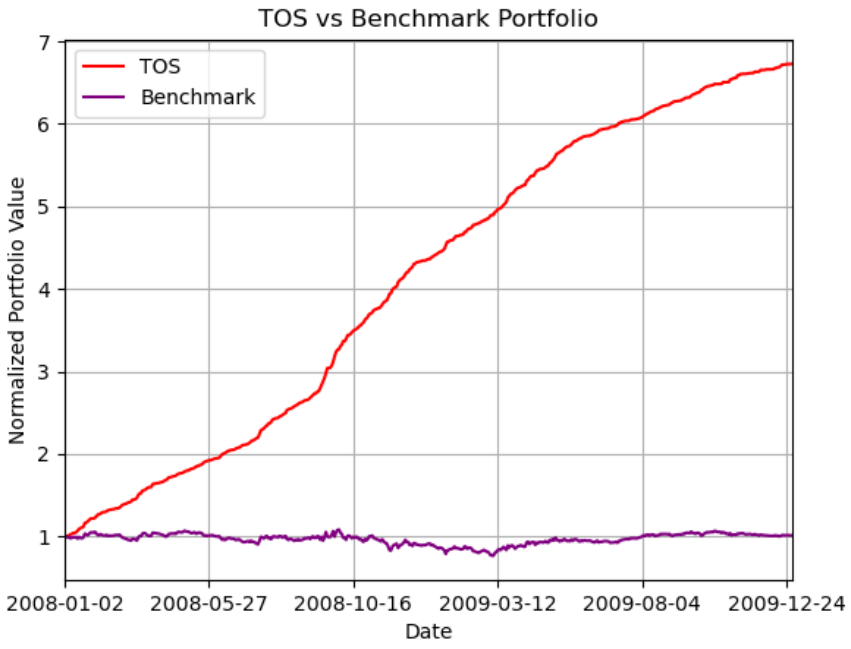

Figure 1 - Normalized Theoretically Optimal Strategy values vs Benchmark Portfolio values based on JPM stock price

Returns	Cumulative Return	Standard Deviation of Daily Return	Average Daily Return
Benchmark	0.0123	0.017004	0.000168
Portfolio	5.7284	0.004593	0.003800

Table 1 - Cumulative Return, Standard Dev of Daily Return, and Average Daily Return of Benchmark and TOS Portfolio Values

2 INDICATORS

2.1 Introduction

Given the stock symbol JPM and a time period from January 1, 2008 to December 31, 2009, I created five technical indicators. The indicators are as follows: Bollinger Band Percentage (BBP), Exponential Moving Average (EMA), Momentum, Relative Strength Index (RSI) and Moving Average Convergence/Divergence (MACD).

2.1.1 Bollinger Band Percentage

Bollinger Band® is an indicator used to identify if a stock is overbought or oversold. In *Figure 2*, the upper band is set to 100% and lower band is set to 0%. Generally, there are three lines in the Bollinger bands: upper, middle and lower. The middle band, the simple moving average (SMA) is calculated over an inputted timeframe. In this case, I used a look back period of 20 days to calculate the SMA. The upper and lower bands are then calculated through two standard deviations away from the middle band. When the upper band is reached, the stock is overbought. When the lower band is reached, the stock is oversold. The calculation for the Bollinger band is as follows:

$$\text{BOLU} = \text{MA}(\text{TP}, n) + m * \sigma[\text{TP}, n]$$
$$\text{BOLD} = \text{MA}(\text{TP}, n) - m * \sigma[\text{TP}, n]$$
where:
$\text{BOLU} = \text{Upper Bollinger Band}$
$\text{BOLD} = \text{Lower Bollinger Band}$
$\text{MA} = \text{Moving average}$
$\text{TP (typical price)} = (\text{High} + \text{Low} + \text{Close}) \div 3$
$n = \text{Number of days in smoothing period (typically 20)}$
$m = \text{Number of standard deviations (typically 2)}$
$\sigma[\text{TP}, n] = \text{Standard Deviation over last } n \text{ periods of TP}$

The indicator Bollinger Band Percentage, takes the percentage of difference between the price and lower band and difference between the upper and lower band.

Given the formula: **%B = [(Price – Lower Band) / (Upper Band – Lower Band)] * 100.**

Referring back to *Figure 2*, it can be seen that at each time period in which the price breaks past the band percentage, it is followed by a period of stock value increase if oversold and period of stock value decrease if overbought.

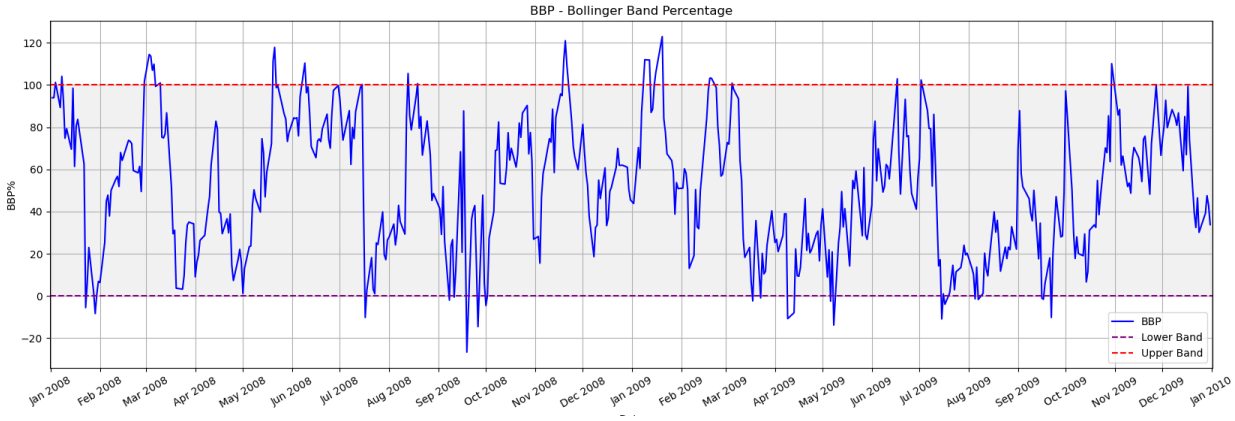

Figure 2 - Bollinger Band Percentage (20 day lookback period)

2.1.2 Exponential Moving Average

Exponential Moving Average is a version of a moving average that is different from simple moving average as it places weight on recent data. It is a technical indicator used to indicate buy and sell signals. In *Figure 3*, when the price of JPM is greater than the EMA, it can be seen as a bullish sign as it indicates an upward trend. Whereas, when the price is less than EMA, it can be seen as a bearish sign as it indicates a downward trend. In the figure, a 20 day look back period is used, which places emphasis on short term buy/sell signals. As you increase, the look back period, the weight will be more distributed and highlight long term trends. The formula for EMA is as follows:

$$EMA_{\text{Today}} = \left(\text{Value}_{\text{Today}} * \left(\frac{\text{Smoothing}}{1+\text{Days}}\right)\right) + EMA_{\text{Yesterday}} * \left(1 - \left(\frac{\text{Smoothing}}{1+\text{Days}}\right)\right)$$

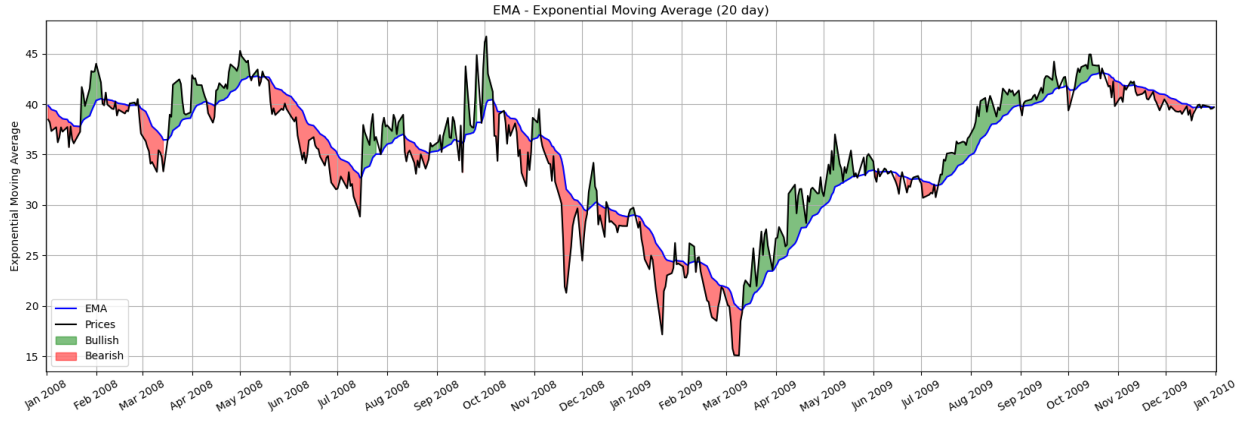

Figure 3 - Exponential Moving Average (20 day lookback period)

2.1.3 Momentum

Momentum or Momentum Oscillator indicator is used to measure the rate of speed or strength of price shifts. It is used to identify trends in the stock price, where a strong positive momentum indicates a buy signal as the momentum increases, we can expect the stock value. However, a strong negative momentum indicates a sell signal.

The formula for momentum is: **(current closing price) - (closing price x_num of periods ago)**, where x is equal to the look back period.

In *Figure 4*, I used a look back period of 20. It can be seen that from March 2009, to June 2009 there was strong positive momentum. In this period, the stock value sharply increased, but we can see that as the momentum peaked, its growth gradually decreased until the momentum grew in the other direction and the stock value dipped.

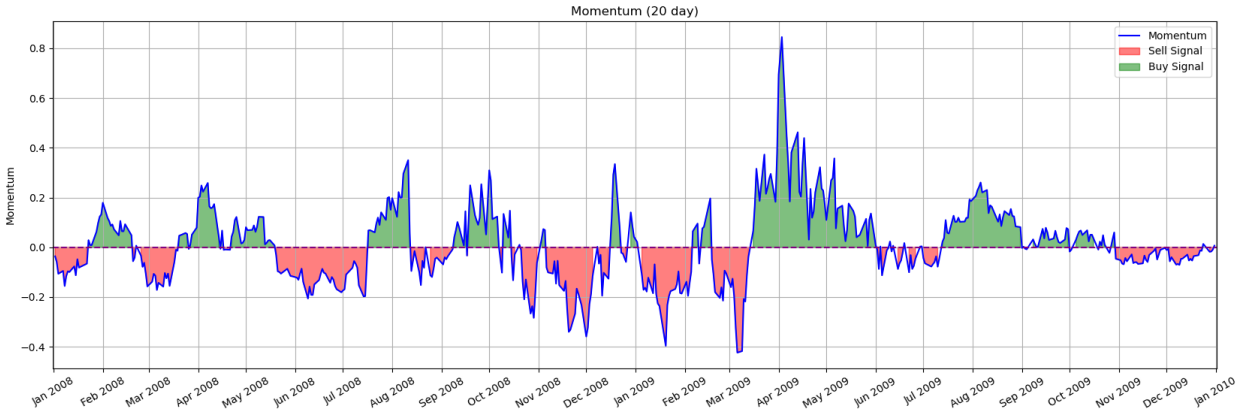

Figure 4 - Momentum (20 day lookback period)

2.1.4 Relative Strength Index

Relative Strength Index (RSI) is a type of momentum indicator. It measures the change and the speed of change of the stock value. It is used as an indicator for overbought or oversold condition by setting the upper bound RSI to 70 to indicate overbought and lower round RSI to 30 to indicate oversold.

The formula requires two steps and is as follows:

$$RSI_{\text{step one}} = 100 - \left[\frac{100}{1+\frac{\text{Average gain}}{\text{Average loss}}}\right]$$

In step one, we calculate the average gain or loss in the given look back period of 14 days. When calculating average gain, periods of price decreases are given a zero value. When calculating

average loss, periods of price increases are given a zero value. These values are then used in step two to calculate the final RSI value.

$$RSI_{\text{step two}} = 100 - \left[\frac{100}{1+\frac{(\text{Previous Average Gain}\times 13)+\text{Current Gain}}{((\text{Previous Average Loss}\times 13)+\text{Current Loss})}}\right]$$

In *Figure 5*, RSI values between 30 to 70 are located within a neutral zone. In the areas shades red or green, the RSI indicates either the stock is overbought or oversold, respectively. When the stock is overbought it indicates a sell signal and when oversold it indicates a buy signal.

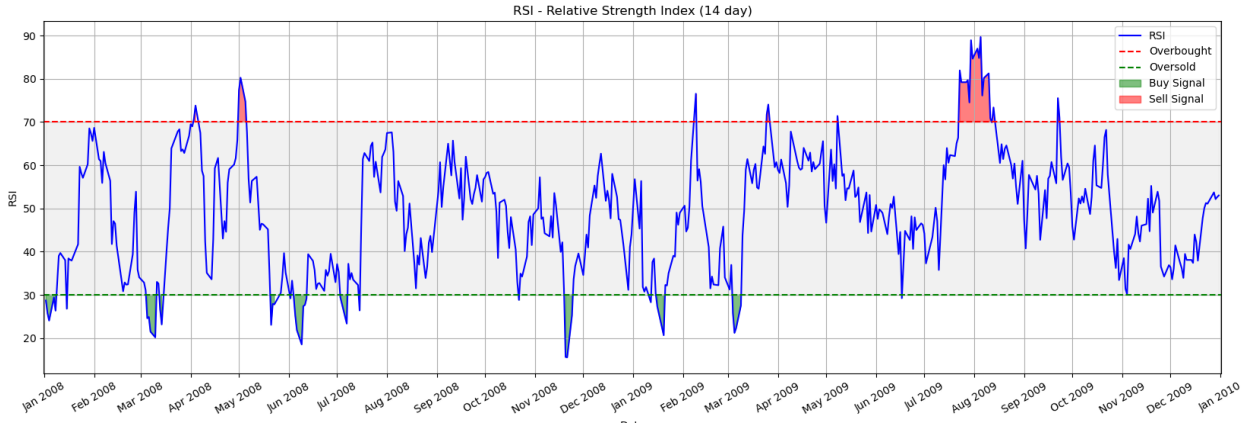

Figure 5 - Relative Strength Index (20 day lookback period)

2.1.5 Moving Average Convergence/Divergence

Moving Average Convergence/Divergence (MACD) is another type of momentum indicator. MACD requires two look back periods of short and long to apply it to the stock value. Given a short look back period of 12 days and a long look back period of 26 days. Using this formula: **MACD=(12-Period EMA)−(26-Period EMA)**. We can generate the MACD line and compare it with the signal line, which is the EMA 9 of MACD. The signal line is then generated by taking the EMA of the MACD and signal look back period, which is 9 days.

In *Figure 6*, when the MACD line is greater than the signal line then it indicates a buy signal. When the MACD line is less than the signal it indicates a sell signal. I've also included a

histogram of MACD to allow for further analysis. The histogram indicates convergence or divergence between the MACD and signal line. Increasingly positive histogram values indicate convergence and is a bullish sign and negative histogram values indicate divergence and is a bearish sign.

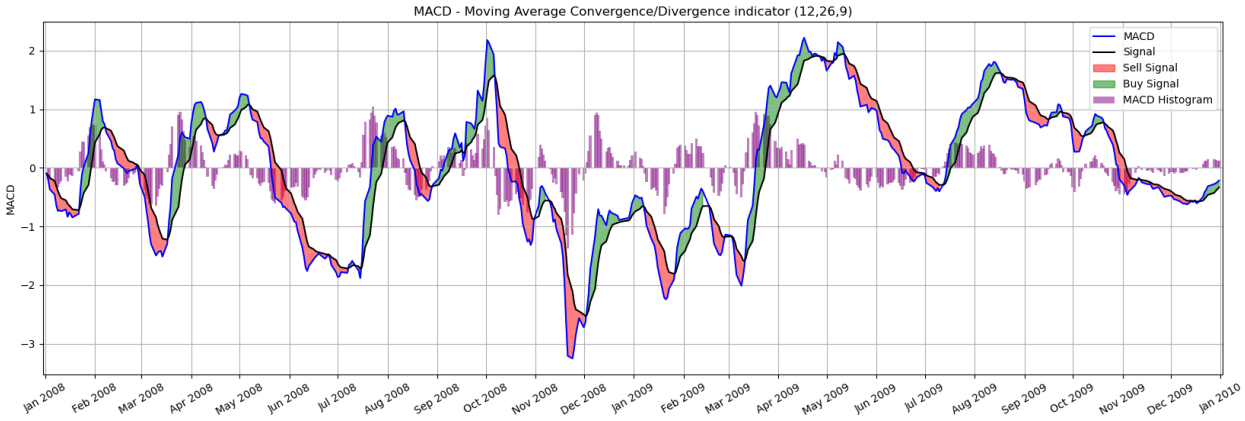

Figure 6 - Moving Average Convergence/Divergence(12 day short period, 26 day long period and 9 day signal period)

3 REFERENCES

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