Fall 2021 – Project 6: Indicator Evaluation

Michael Lukacsko
mlukacsko3@gatech.edu

***Abstract*—This project looks at two different stock trading concepts. First is a theoretically optimized trading strategy (TOS) vs a benchmark trading strategy. The TOS assumes the trader can peek into the future. Hence, it enables the trader to buy/sell/hold at the most advantageous time knowing what will happen to the stock price. The benchmark strategy, however, buys and holds for a length of time. The second and last concept is trading indicators. These tools are leveraged to make market trends clear as well as to forecast potential trends in the stock market.**

1 INDICATORS

The indicators used for this project are all mathematically calculated based on the security's adjusted closing price and are limited to a date range of January 1 2008 to December 31 2009. In general, indicators are used to predict future prices. The security used in this project is that of JPMorgan Chanse and CO and traded on the New York Stock Exchange (NYSE) as JPM. For this project, I utilized the following technical indicators:

1) Simple Moving Average (SMA)
2) Bollinger Bands
3) Momentum
4) Moving Average Convergence/Divergence (MACD)
5) Volatility

1.1 Simple Moving Average (SMA)

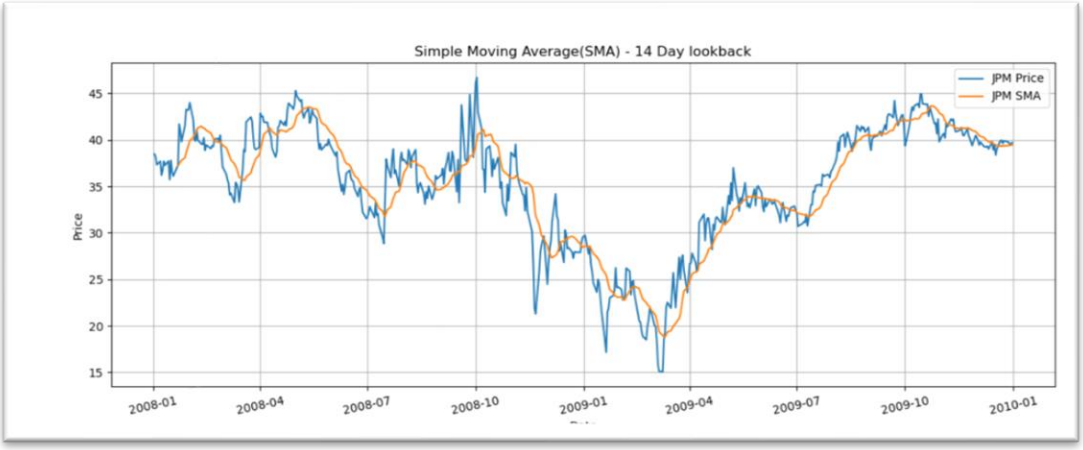
The simple moving average indictor displayed below simply calculates the average price over the given date range (1/1/2008 – 12/31/2009) using a 'lookback' period. The period used here is 14 days. This means the adjusted closing price of the stock is summed over a 14 day period and then divided by 14. Mathematically, this can be calculated as:

$$\mathbf{SMA = (A_1 + A_2 + A_3 \ldots + A_n) / n}$$

Where: 'A_n' is price of JPM at period n and 'n' is the total number of periods.

In addition to the SMA, I elected to plot the adj. closing price of JPM as well. A SMA is used for many reasons, but primarily to observe whether the price of a stick is trending up or down. A SMA is easier to interpret because a lot of the extreme high/low volatility has been smoothed out. As such, a smoother SMA can be expected over a longer period. The reduction of noise and smoothness of the line can be seen in the SMA implementation below.

SMA's are also used as an indicator of support and/or resistance to moving prices When the price of a stock is above the moving average, it generally indicates strong support and, as a result, a decline in price might have difficulty falling below the SMA price. Alternatively, if the price of a stock is below the SMA, it tends to experience stronger resistance to raising prices and can sometimes struggle to move above the SMA.



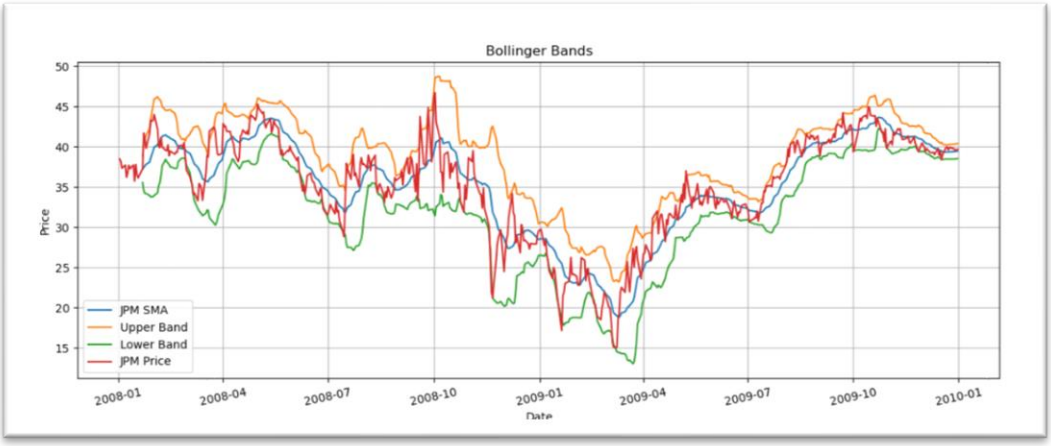
1.2 Bollinger Bands (BB)

In many cases, a simple moving average is employed with other indicators. One such case is my implementation of Bollinger Bands (BB). The BSs displayed below make use of an upper and lower band, each being a representation of the SMA adjusted by a standard deviation equal to two. Also included in the graph is the stocks adjusted daily closing price. Programmatically, BBs can be implemented as follows:

BB_Upper = MA + (m * σ[TP,n])

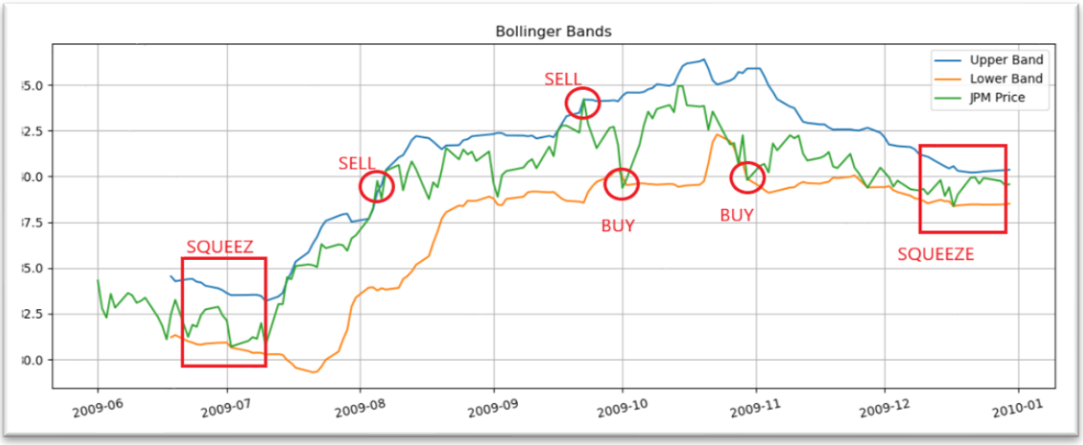
BB_Lower = MA - (m * σ[TP,n])

Where: MA is the moving average, 'm' is the number of standard deviations, and 'σ[TP,n]' is the standard deviation over the last n periods..



Bollinger Bands are typically used by traders to analyze volatility and whether the price is high or low signaling a time to buy or sell a stock. Regarding volatility, trader looks at BBs for what is referred to as a squeeze. This occurs when the bands move closer together and limit the moving average. Pictured in the graph that follows, the squeeze signifies a period of low volatility and can indicate a future period of higher volatility and, as a result, a potential trading opportunity. On the other hand, when the bands move further apart, traders might elect to exit a trade because it is more likely there will be a period in which volatility decreases.

As previously mentioned, BBs can also signal when the price is high or low, hence, making the event a profitable time to buy or sell. Known as a breakout, this indication happens when the price of a stock goes above the upper band signaling a strong time to sell, and where the price dips below the lower band signaling a strong buying opportunity. Some examples of a breakout, along with the squeeze, can be seen below. The graph below uses a subset of data from the previous graph, between June 1, 2009 and December 31 2009, to more clearly show the presence of breakouts and the squeeze.



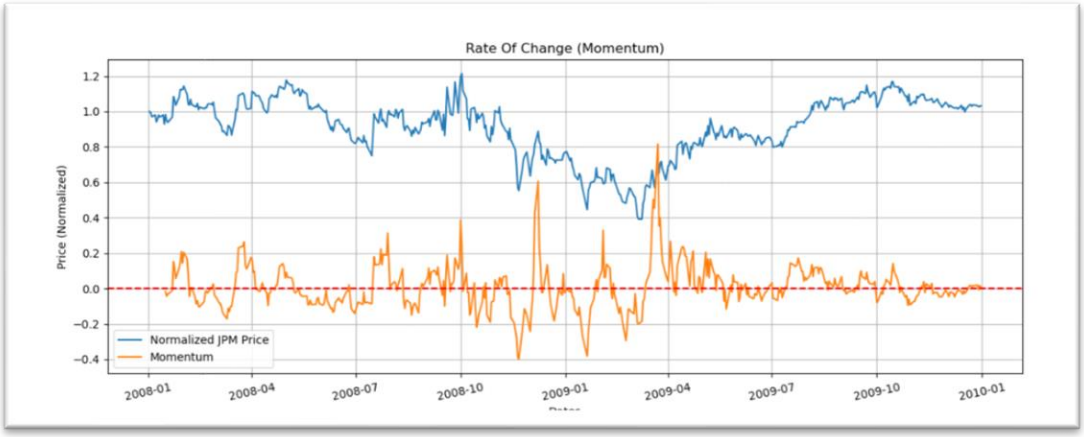
1.3 Rate Of Change (ROC) Momentum

Rate Of Change (ROC) momentum is a measurement of change in stock price between the current price and the price over a configurable number of periods. ROC momentum indicators are plotted against a zero line to distinguish positive and negative values. When price changes are on the upside, the indicator moves above the zero line into positive territory. When price changes are on the downside, this measurement moves below the zero line into negative territory. Traders use positive momentum above the zero line to indicate the presence of buying pressure, while negative momentum below the zero line often coincides with the presence of selling pressure. The following formula can be used to calculate ROC momentum:

Momentum = V – V_x

Where: 'V' is the stock price, and 'x' is the number of days in the period.

For the below implementation, a 10 day period was used which is considered the industry standard. Additionally, I normalized JPMs stock value for this comparison and subtracted 1 from the calculation such that the zero line would be visible. Some statisticians will multiply the calculation above by 100 to show values as a percentage. For my purpose, the advantage is visible; the normalized stock price is easier to compare using normalized stock data and subtracting 1



1.4 Moving Average Convergence/Divergence (MACD)

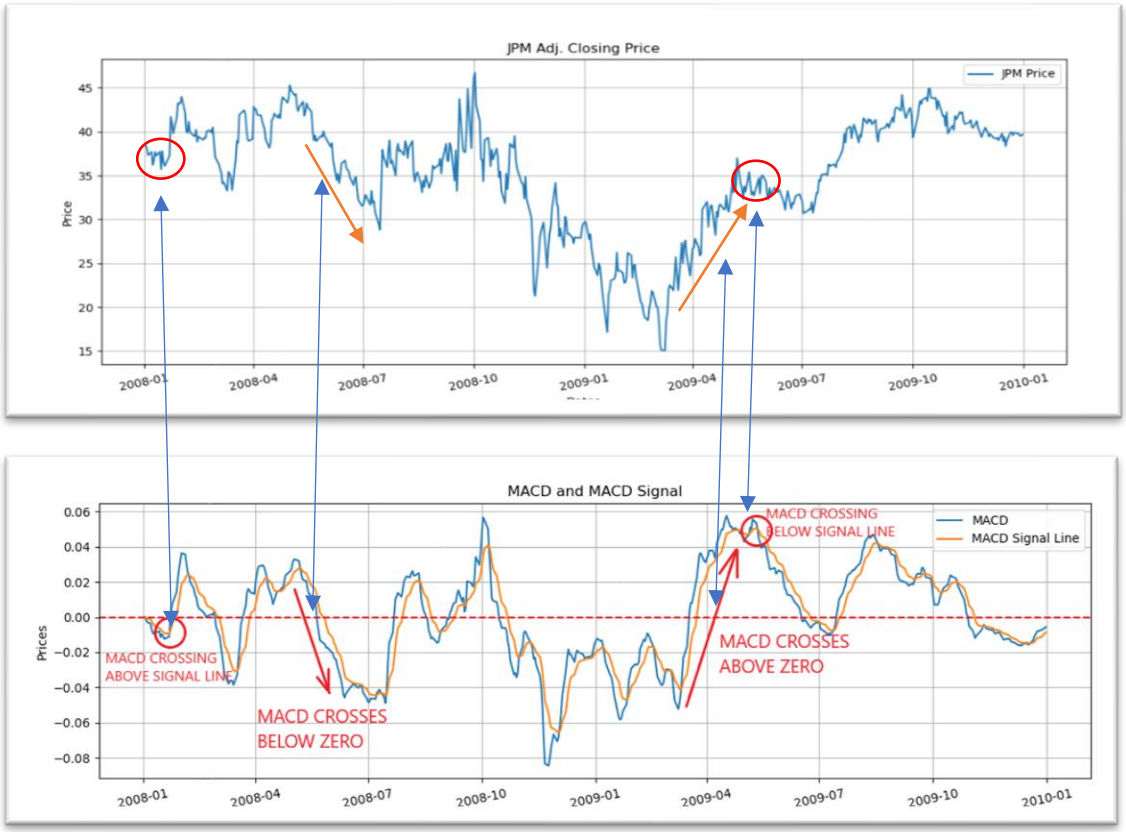
MACD indicators is categorized as another type of momentum indicator. Like Bollinger Bands, MACD uses two lines, however, the lines of a MACD indicator represent the relationship between two exponential moving averages (EMA). The first line plotted for a MACD indicator is the difference between the 12 period EMA and 26 period EMA and is commonly referred to as the MACD line. The second line plotted for this indicator is called the signal line. It is the 9 period EMA of the MACD line. The MACD and signal line can be calculated using the following formula:

MACD = 12 period EMA – 26 period EMA

Signal Line = 9 period EMA of MACD

MACD indicators are used to signal a bullish or bearish market. A MACD line crossing above the zero line signals bullish conditions, while a MACD line crossing below zero signals bearish condition. Additional signs bullish conditions exist are when the MACD crosses from below the signal line to above it. Inversely, the signaling of bearish conditions occur when the when the MACD crosses from above the zero line to below it.

In the below graphed MACD implementation, the blue line representing the MACD is seen crossing the zero line where arrows exist. When compared to the included graph of JPM's adj. closing price, we can see how this indictor signals a buy when the signal crosses above the zero line and a sell when crossing below it. Moreover, where the signal line (orange) crosses below the MACD line, another signal to sell is indicated. When the MACD line crosses above the signal line, a strong buy indication exists.


JPM Adj. Closing Price
JPM Price
Price
45
40
35
30
25
20
15
2008-01
2008-04
2008-07
2008-10
2009-01
2009-04
2009-07
2009-10
2010-01
MACD and MACD Signal
MACD
MACD Signal Line
Prices
0.06
0.04
0.02
0.00
−0.02
−0.04
−0.06
−0.08
MACD CROSSING
ABOVE SIGNAL LINE
MACD CROSSES
BELOW ZERO
MACD CROSSING
BELOW SIGNAL LINE
MACD CROSSES
ABOVE ZERO

1.5 Volatility

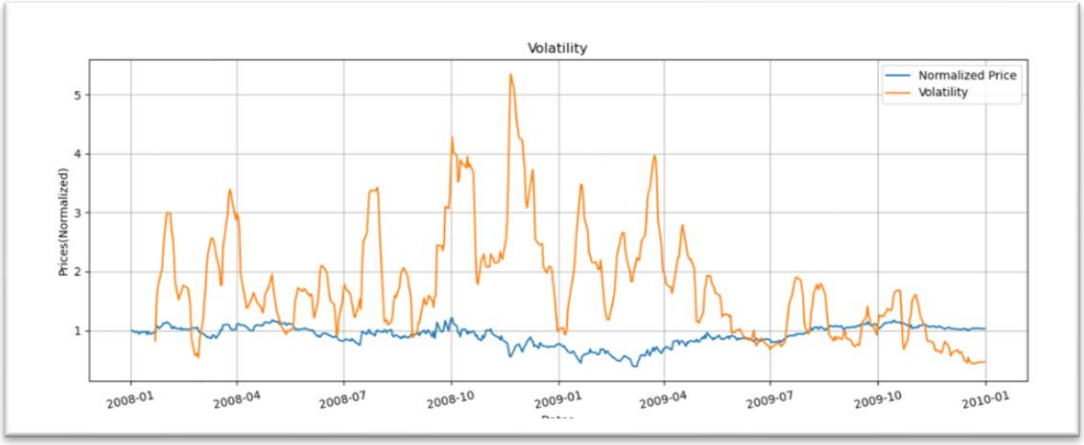
Volatility is a visual representation suggesting the level of risk as it relates to change in a securities price. Higher volatility signals intraday prices can be spread out over a greater range of values. Visually, this would look like a larger gap between a security's high and low prices. When volatility is high, this is an indicator that the price of a security can change in directions considerably over a shorter period of time. Lower volatility signals that a security's value tends to be steadier because the value does not vary considerably.

Volatility can be calculated using either standard deviation or variance. For this assignment, I used standard deviation and a 14 period lookback. Additionally, I plotted the normalized stock price of JPM. The following formula can be used to calculate volatility using standard deviation:

Volatility = $\sqrt{\sum_{i=1}^{n}(xi - \overline{x})^2/n - 1}$

Where: 'xi' is the value of the i-th point, 'x' is the mean value of the prices, and 'n' is the number of points.

As described above, we can see more dramatic changes in price where volatility is high. Where volatility is lower, we can see that the change is JPMs normalized stock price did not experience an extreme upward/downward momentum.

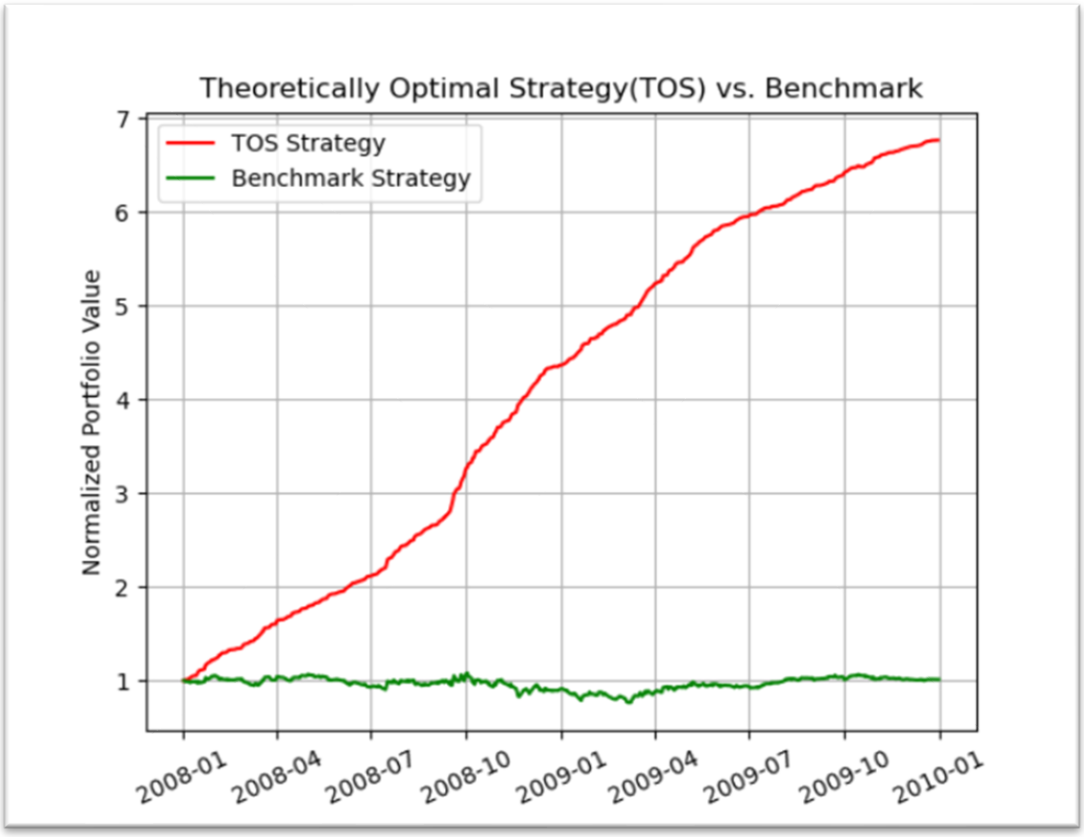


2 THEORETICALLY OPTIMAL STRATEGY

This part of the assignment looks at a portfolio's performance assuming I, the trader, can peek into the future seeing what will happen JPMs stock price the following day. This is compared to a benchmark portfolio where JPM is purchased and held. By being able to foresee what JPM will do on the following day, I ultimately know to buy or sell the stock. Our buying/selling limit, however, is capped at 1000 and -1000. Also available is a hold where no trade occurs. Additionally, at any time, we can only hold a maximum of 1000 shares and minimum of -1000 shares. This limits the trading of JPMs stock to 2000 and -2000 respectively. Also important to note is that I was given an initial starting value of $100,000, commission is $0.00, and impact is 0.0.

The strategy I used to create the TOS was to take the ratio of the current price versus the following days price and subtract 1 from it. If the resulting value is a negative, I add a positive trade indicator to my trading dataframe because, knowing the price will rise tomorrow, signals a buy. When the resulting calculation is positive, I want to sell and write a negative trade indicator to my trading dataframe. For the benchmark strategy, I simply purchase 1000 shares of stock on day 1 and hold it for the entirety of the duration tested. The result is clear, seeing into the future is an effective way to maximize returns.

Looking at the following table, we can see the TOS returned gains at an about 500% increase as compared to the benchmark strategy.



	Benchmark Strategy Returns:	Optimal Strategy Returns:
Cumulative Return	0.0123	5.7624
Avg. Daily Return	0.000168087	0.003817419
Std Daily Return	0.017004366	0.004555096
Normalized Ending Value	1.0123	6.7624
Total Ending Value	101230	676240