Fall 2021 – Project 6: Indicator Evaluation

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***Abstract—***This project looks at two different concepts. The first is a theoretically optimized trading strategy (TOS) vs a benchmark strategy. The TOS assumes the trader can peek into the future. Hence, enabling the trader to buy/sell/hold at the most advantageous time by 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.

# indicators

The indicators used for this project are all mathematically calculated based on the security’s adjusted closing price and encompass 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

## 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’. The lookback 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:

**SMA = (A1 + A2 + A3 … + An) / n**

Where: ‘An’ 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 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. Hence, 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 struggle to move above the SMA.

Chart, line chart, histogram

Description automatically generated

## 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 Bollinger Bands 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])**

Chart, line chart, histogram

Description automatically generatedWhere: MA is the moving averaged, ‘m’ is the number of standard deviations, and ‘σ[TP,n]’ is the standard deviation over the last n periods using the stock price, ‘TP’.

Bollinger Bands are typically used by traders to analyze the 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. A 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 exit a trade because it is more likely there will be a period where volatility decreases.

As previously mentioned, Bollinger Bands can also signal when the price is high or low, hence, making the incident a profitable time to buy or sell. Known as a breakout, an indicator 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, between June 1, 2009 and December 31 2009, to more clearly show the presence of breakouts.

Chart, line chart

Description automatically generated

## Rate Of Change (ROC) Momentum

Rate Of Change 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 – Vx** where ‘V’ is the stock price, and ‘x’ is the number of days in the period.

For the below implementation graphic, a 10 day period was used which is considered the industry standard. Furthermore, I normalized JPMs stock value for this comparison and subtracted 1 from the calculation about 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

Chart, line chart

Description automatically generated

## Moving Average Convergence/Divergence (MACD)

MACD indicators is classified 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. The first line plotted for a MACD indicator is the difference between the 12 period exponential moving average (EMA) and 26 period EMA and is 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 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 to above the signal line. Inversely, the signaling of bearish conditions occur when the when the MACD crosses from above to below the signal line.

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.

Graphical user interface, chart, line chart

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Chart, line chart

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## Volatility

Volatility is a visual representation referring to the level of risk as it relates to the 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 direction 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 =**

Chart, histogram

Description automatically generatedWhere ‘xi’ is the value of the i-th point, ‘x’ is the mean value of the prices, and ‘n’ is the number of points.

# theoretically optimal strategy

This part of the assignment looks at a portfolio’s performance assuming I, the trader, can peek into the future. This is compared to a benchmark portfolio where a security is purchased and held. By being able to foretell what the stock price 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 values of my trading to 2000 and -2000 respectively. Also important to note is that we have 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 about 500% better as compared to the benchmark strategy.

Chart, line chart

Description automatically generated

