

# Project 6 – Indicator Evaluation

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***Abstract***—Making money by investing is a difficult task as there are countless stimuli which impact the market. Technical indicators have become a necessity as they provide insight into a stock and its expected behaviors. There exist hundreds of technical indicators to choose from, but this report will look at five. Bollinger bands, Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), On-Balance Volume (OBV), Vortex.

## 1 TECHNICAL INDICATORS

Technical indicators are used by traders every day to provide knowledge to the investor about the expected behavior of the market. The reason having knowledge about a stock or some fund in the market is that if you know how it behaves, you can then exploit that knowledge to make money. No single technical indicator can tell you everything you need to know about the market and likewise no single technical indicator is always correct. Most investors use combinations of technical indicators to guide them into profitable decisions within the market.

### 1.1 Bollinger Bands

Bollinger bands were created by John Bollinger in the 1980's. Bollinger bands place a line above and below a moving average of some market. The lines create a type of limiting area of that market and if the prices go beyond the lower or upper bound, this would be considered a significant event. Bollinger bands became popular because it incorporates multiple indicators in one simple graph, such as the simple moving average (SMA) as well as volatility. The simple moving average is calculated based on some specified period, such as a 14-day SMA would use 14 days in its calculations. The volatility is indicated by space between the upper and lower band. I currently calculate buying signals without using volatility explicitly in the calculations. Using volatility, I will be able to adjust the strategies based on the allowable risk.

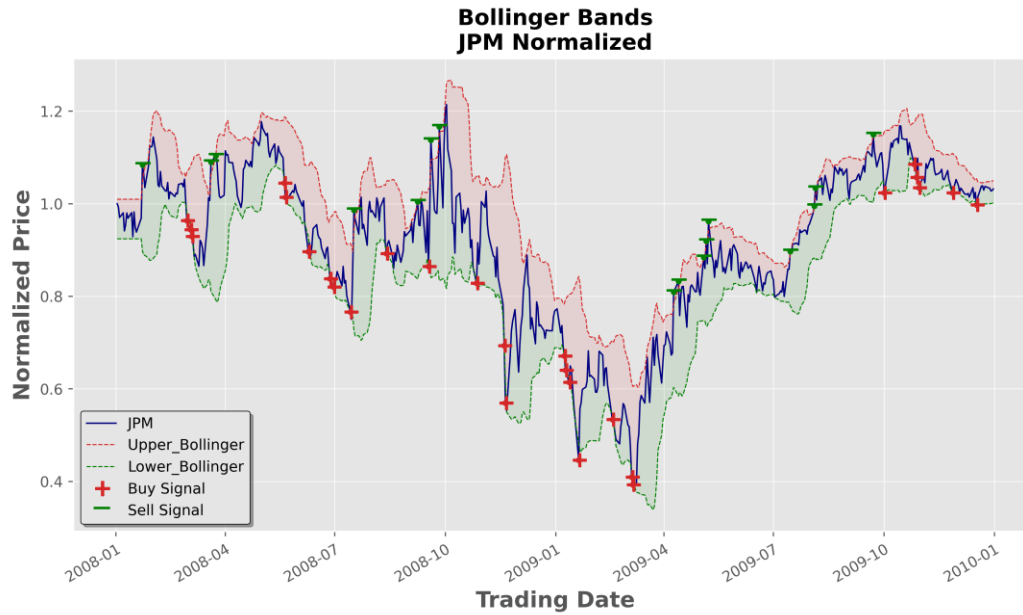
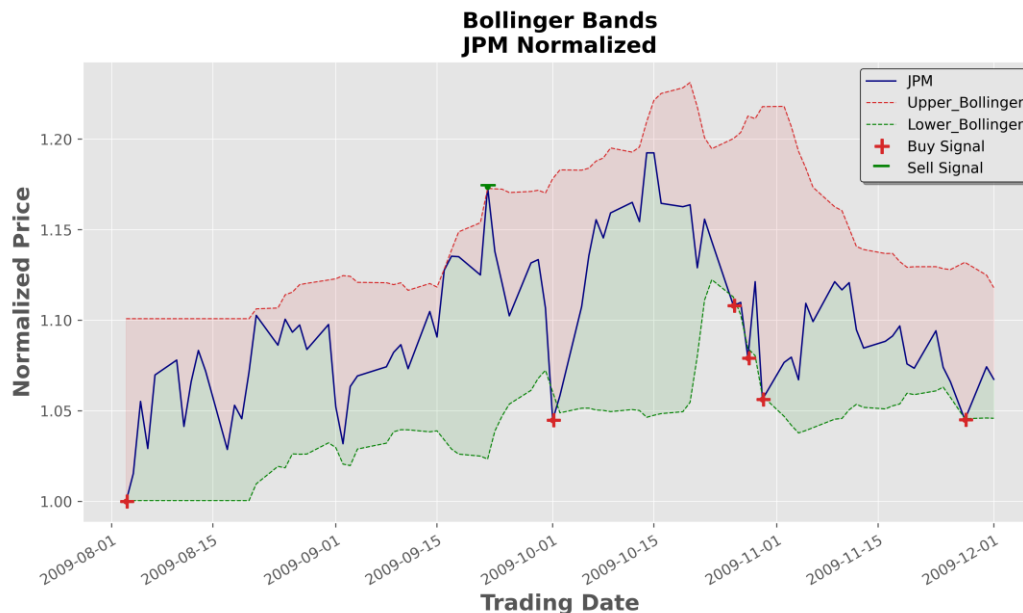


Figure 1— Bollinger bands for the stock 'JPM'.

### 1.1.1 Calculation

To calculate the Bollinger bands for some market, you will need the price of that stock over the time period which the bands are desired. First calculate the simple moving average over a 14-day period — 14 days is a typical window for SMA — then calculate the standard deviations of that simple moving average. This will leave empty data at the beginning because it is unable to calculate the standard deviation until the initial time period has been processed. Fill 'nan' values using forward fill and then backfill.

### 1.1.2 Application of Bollinger Bands



**Figure 2**—Closer look at Bollinger Bands buying and selling indicators

To use Bollinger bands as technical indicators there are various things to look at. The blue line is the normalized prices of the JPM stock from 08-01-2009 to 12-1-2009. The two dotted lines are the Bollinger bands which correspond to, two standard deviations above the 14-day simple moving average. When the stock prices move beyond the bands, this would be a significant indicator for the stock. Combining the %B which is the price of the stock minus the bottom Bollinger band all divided by the volatility of the band. We get technical indicators for buying and selling, marked with a “-” and “+” respectively.

### 1.2 Relative Strength Index

Relative strength index (RSI) was developed by J. Welles Wilder in their 1978 book *‘New Concepts in Technical Trading Systems’*. The relative strength index provides a quick look at a market’s strength or weakness. Typically, this indicator is not used by itself but as a subcomponent of a group of technical indicators. The RSI is typically calculated using a 14-day lookback and has two thresholds, one for overbought and one for oversold. The overbought threshold is typically at 70 and the oversold threshold is typically at 30. When a stock’s RSI exceeds the overbought threshold, this indicates to the investor to sell their stock. The reason

this is an indicator for selling is that if the stock is overbought then there exists market pressure for that stocks price to lower. Selling before the price goes down would yield the most profit. When the RSI goes below the oversold threshold, this is indicative to buy because being oversold means there is less availability than what is demanded. This suggests that the market pressure would cause the stock price to increase due to the lower supply. Buying the stock before the stock price rises, would be another way make a profit.

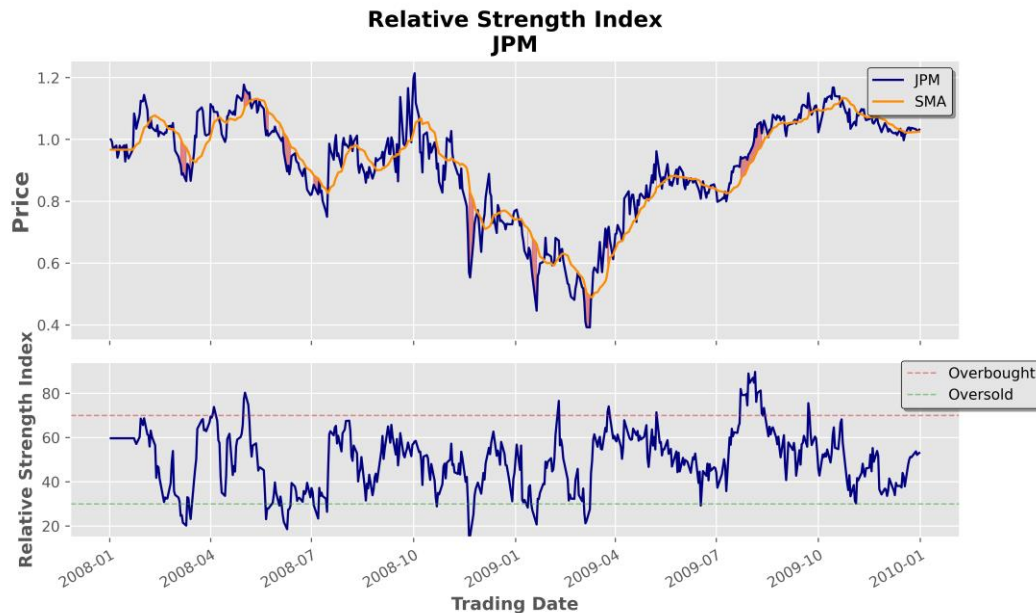


Figure 3 — Relative Strength Index 'JPM'.

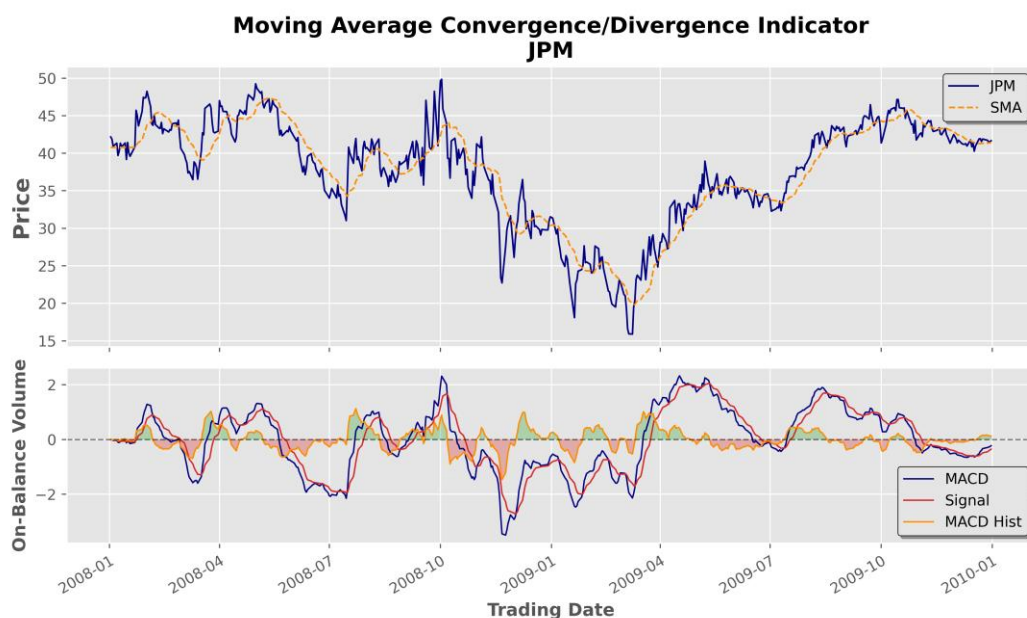
### 1.2.1 Calculation

RSI is calculated using two different simple moving averages, both use 14-day windows. The first is for days when the stock has upward trends and the second is when the stock has downward trends. Then you divide the upward by the downward to get the relative strength. To calculate the RSI, you then take 100 minus 100 divided by one plus the relative strength.

## 1.3 Moving Average Convergence Divergence

Moving average convergence divergence (MACD) indicator was created in the 1970's by Gerald Appel. MACD has many aspects which come together to produce a robust technical indicator. There are three main parts, the MACD line, the signal line and the histogram. The MACD line is the difference a 12-day and

26-day exponential moving average. The signal line is a 9-day exponential moving average of the MACD line and the histogram is the difference between the MACD line and the signal line.



**Figure 4**—MACD for JPM.

There exist many methods for using MACD to identify opportunities to enter or exit a market. One of the methods used looks at the signal line and the MACD line. When the signal line crosses and is going above the MACD line, this would indicate a selling point. When the signal line crosses and goes below the MACD this would be a buying point. Another method which traders use is following the MACD histogram in conjunction with the MACD and signal line. A trade may follow the signal line and MACD line for buying and selling but will also look at the histogram to determine if they should take the immediate gain or loss versus holding and selling at a later point. The way this works is that if the histogram shows a selling position, the difference below zero indicates how significant the changes in the stock are. The more offset from zero the value to less likely this type of fluctuation will occur again.

#### 1.4 On-Balance Volume

On-Balance Volume (OBV) was created by Joe Granville and published in their book '*Granville's New Key to Stock Market Profits*'. To calculate the OBV you

need to track the closing price and volume of the stock over your time period. To calculate the OBV for a particular day, you look at the closing price of the current day and the previous day. If the current day closing price is above the previous day, then the OBV for that day is the previous day OBV + the current volume. If the current closing price is below the prior closing price, then the OBV for that day is previous day OBV – the current volume.

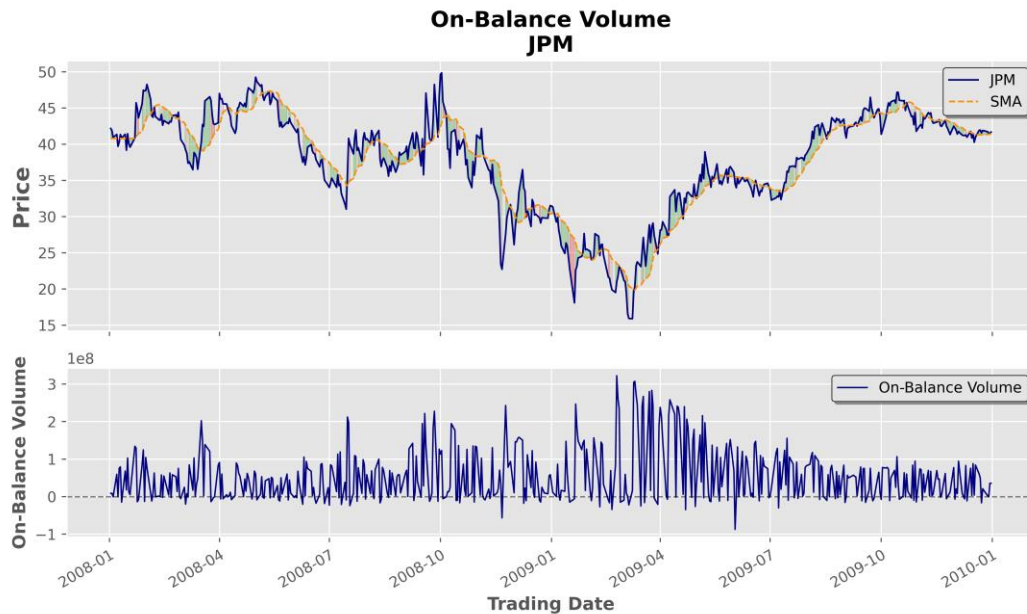


Figure 5—On-Balance Volume indicator 'JPM'.

OBV creates buying and selling signals buy confirming trends in the market. An example of this is that if your stock price is increasing you may look at the OBV to confirm that the stock price will continue to increase, conversely you see that it is unlikely and decide to exit the market.

### 1.5 Vortex Indicator

The vortex indicator was developed by Etienne Botes and Douglas Siepmann and contains many parts, each with multiple subparts. The first is to calculate the trend of the market. The positive trend is calculated by taking the current high of the stock and subtracting the prior low of the stock. The negative trend takes the current low and subtracts the prior high. Then 14-day rolling summation for both the positive and negative trends. The second part is calculating the true range for each day. This is done by taking the largest value of three

calculated values. The first value is the current high minus the current low. The second value is the absolute value of the current high minus the previous close. The final value is the absolute value of the current low minus the previous close. Then calculate a 14-day summation over the true range. The final part is to normalize the trends. To normalize the positive trend the 14-day summation of positive trends is divided by the 14-day true range. To normalize the negative trend the 14-day summation of negative trends is divided by the 14-day true range.

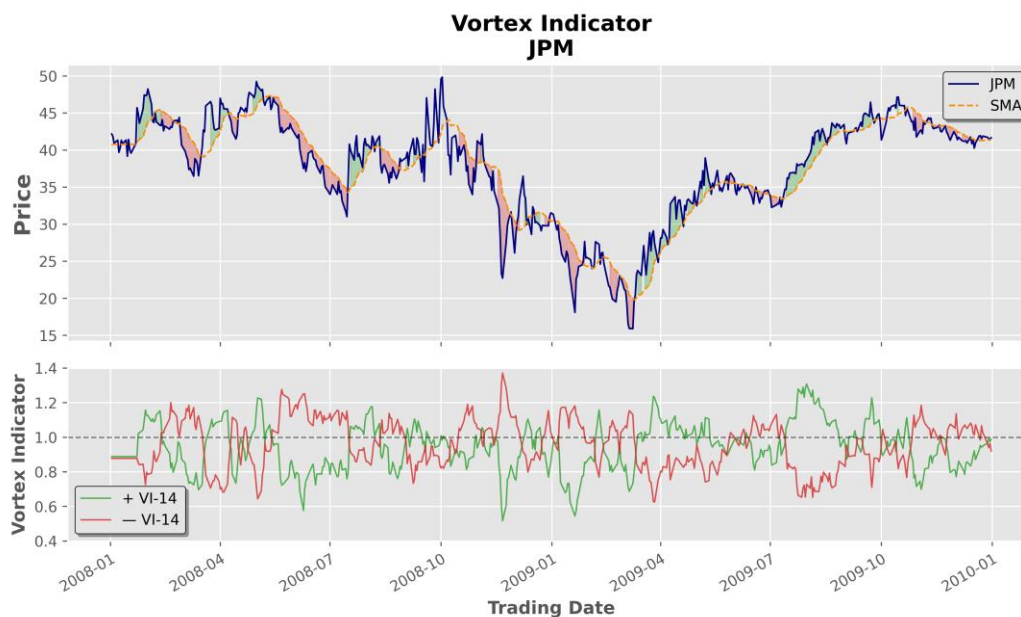


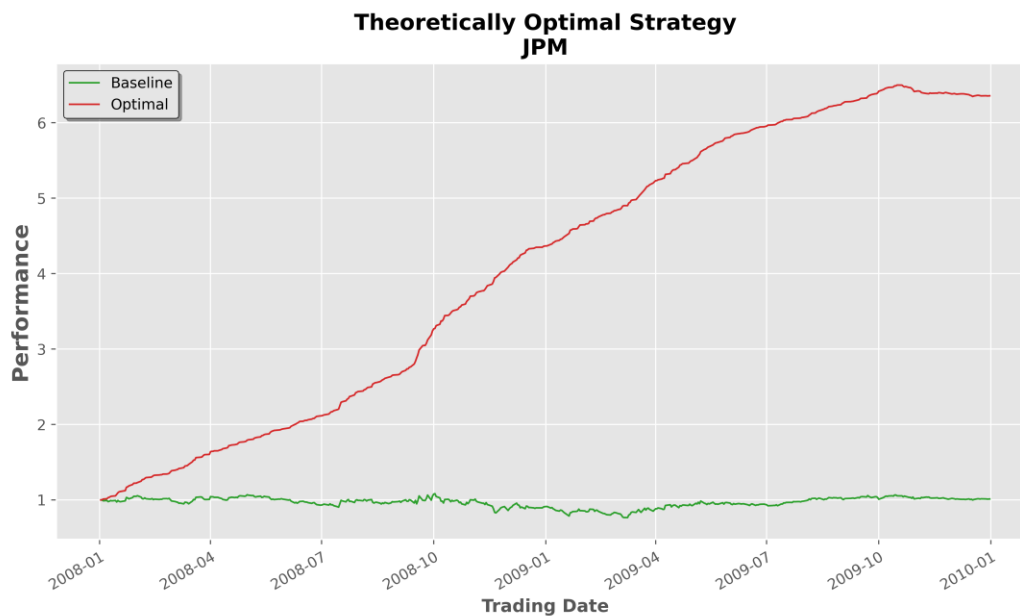
Figure 6— Vortex indicator 'JPM'.

The vortex indicator is one of the more complicated to calculate but one of the easiest to interpret. When the red line for  $-VI_{14}$  is on top, this indicates a time period to have sold and when the green line for  $+VI_{14}$  is on top, this indicates a time period to have bought. Specifically, the buying and selling signals are when the  $-VI$  and  $+VI$  cross, depending on their direction dictates the type of signal. If they cross and the  $-VI$  is going upward and the  $+VI$  is going downward, this would be a signal to sell. If they cross and the  $-VI$  is going downward and the  $+VI$  is going upward, this is a signal to buy.

## 2 THEORETICALLY OPTIMAL STRATEGY

The theoretically optimal strategy uses information which is unobtainable for investors. It also makes some assumptions about the environment. The

first being that we start out with \$100,000 portfolio value. All trades were free of commission and other penalties. It is limited to three different positions short 1000, long 1000 or 0, this allows us to make up to a 2000 stock trade when either at 1000 short or long. The major aspect of this strategy is that we are given future stock prices. This allowed for taking advantage of the next day stock price.



*Figure 7*—Theoretically optimal strategy vs the baseline.

To compute the theoretically optimal strategy is straightforward. The first step is getting the prices for the stock you are looking over the specified date range. Then you create a new column in that prices dataframe called tomorrow's prices. To get those prices you shift the 'Adj Close' by -1, this allows you to make computations on the current day and the next day for each day in the dataframe. I then created another column called 'Diff' which is the next day adjusted close minus the current day. This now provides a mapping of what days to sell being negative and days to buy being positive. This is not a direct mapping over when to buy or sell, it is a mapping to just say what days that type of order would be most beneficial.



*Table 1* — Results from the Theoretically Optimal Strategy vs Baseline.

Name	Baseline	Theoretically Optimal Strategy
Cumulative Returns	0.012299	5.3575
Daily Returns STD	0.017004	0.0046544
Daily Returns Mean	0.000168	0.0036873

How this could be used is to find alternating days of buying and selling. This will provide a very good return by themselves. The next would be coming up with a solution for days which are in groups of their specific types such as 4 days of selling, how would that be handled. I chose to take those groups and find the best combination of sells and buys. This would turn that group of 4 sells possible to 2 sells and 2 buys in different orders, or possible 1 sell on the first day, buy on the second and sell on the fourth. It was dependent on the expected returns for that group. I was not able to get a perfectly optimal strategy, but I was able to get one which provided substantial gains over the baseline.

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