Assignment 6: Indicator Evaluation
CS7646

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INTRODUCTION

There are four types of technical indicators: trend, momentum, volume, and volatility. In this project, we will explore Bollinger Bands® (% B), Moving Average Convergence Divergence (MACD), Relative Strength Index (RSI), On Balance Volume (OBV) and Momentum that includes above four types of technical indicators.

Experimentation details:

- Data: Historical stock prices
- Symbol: JPM.
- Time period: January 1, 2008 to December 31, 2009.
- Starting cash: $100,000.
- Allowable positions: 1000 shares long, 1000 shares short, 0 shares.
- Benchmark: The performance of a portfolio starting with $100,000 cash, investing in 1000 shares of JPM and holding that position.
- There is no limit on leverage.
- Rolling window: 14 days
- Transaction costs: Commission: $0.00, Impact: 0.00.

1 TECHNICAL INDICATORS

1.1 Bollinger Bands® % (BBP): Volatility

Bollinger bands are a measurement of a stock's volatility. By leveraging the rolling standard deviation—specifically, 2 SD above and below the simple moving average —we can get a sense of the volatility based on when the current stock intersects the bands.

The bands are good thresholds for acting on price excursions, allowing short spikes and deviations in the stock price. The reason why 2 SD is a good value is because it naturally varies with the volatility of the stock.

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Upper Band = SMA + (2* Stdev)

Lower Band = SMA - (2* Stdev)

% B (BBP) = (Price - Lower Band)/ (Upper Band - Lower Band) *100
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Signal: Points at which a stock crosses to the outside of its Bollinger bands then re-enters are often considered to be trading opportunities.

- Buying position: when the stock falls below the 2 SD band, that is a buying opportunity. % B is less than 0.

- Selling position: when the stock spikes above the 2 SD band and dips back in, that is a selling opportunity. % B is greater than 1.

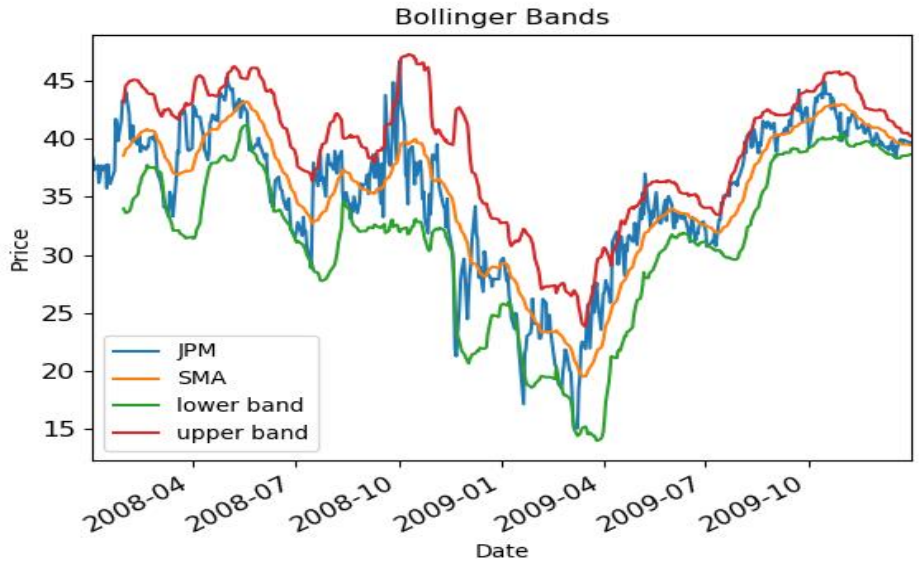

Figure 1: This figure shows Bollinger Bands for JPM

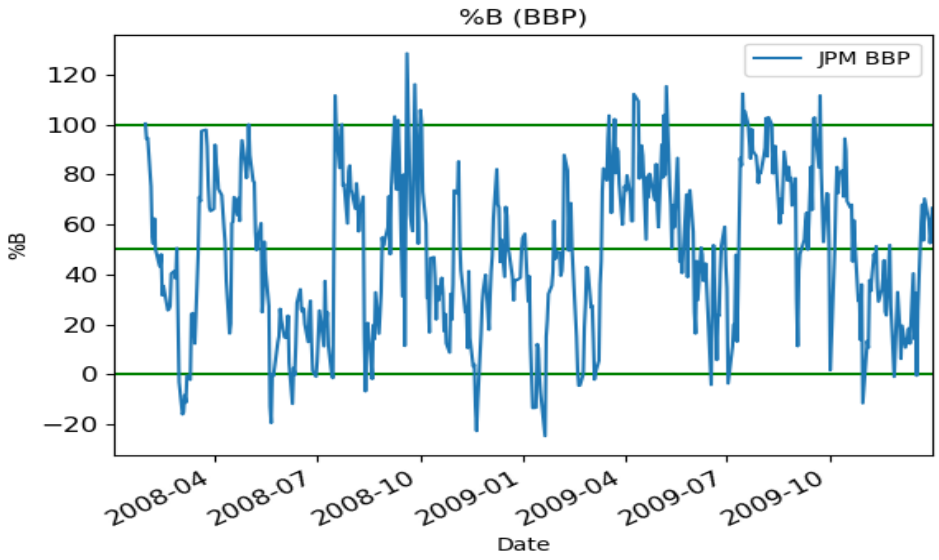

Figure 2: This figure shows Bollinger Bands Percentage for JPM

The %B for JPM is calculated, and above chart clearly indicates the buying (less than 0) and selling (greater than 1) opportunities for JPM during the period.

1.2 Moving Average Convergence Divergence (MACD): Trend/Momentum

The MACD is trend-following and momentum indicator that shows the relationship between two moving averages of a stock's price by subtracting the longer moving average from the shorter one.

The MACD line is calculated by subtracting 26-day Exponential Moving Average (EMA) from the 12-day EMA. This is called as the MACD line. Closing prices are used for these moving averages. The Signal line is the 9-day EMA of MACD line. The difference between the MACD line and Signal line helps create a histogram which shows divergence and convergence. The histogram is positive when the MACD line is above its signal line and negative when the MACD line is below its signal line.

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MACD Line: (12-day EMA - 26-day EMA)

Signal Line: 9-day EMA of MACD Line

MACD Histogram (or indicator): MACD Line - Signal Line
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Signal:
- Buying position: The histogram (red line in below chart) is positive when the MACD line is above its signal line. When the MACD histogram is greater than 0, it can be a potential buying position.

- Selling position: The histogram (red line in below chart) is negative when the MACD line is below its signal line. When the MACD histogram is less than 0, it can be a potential selling position.

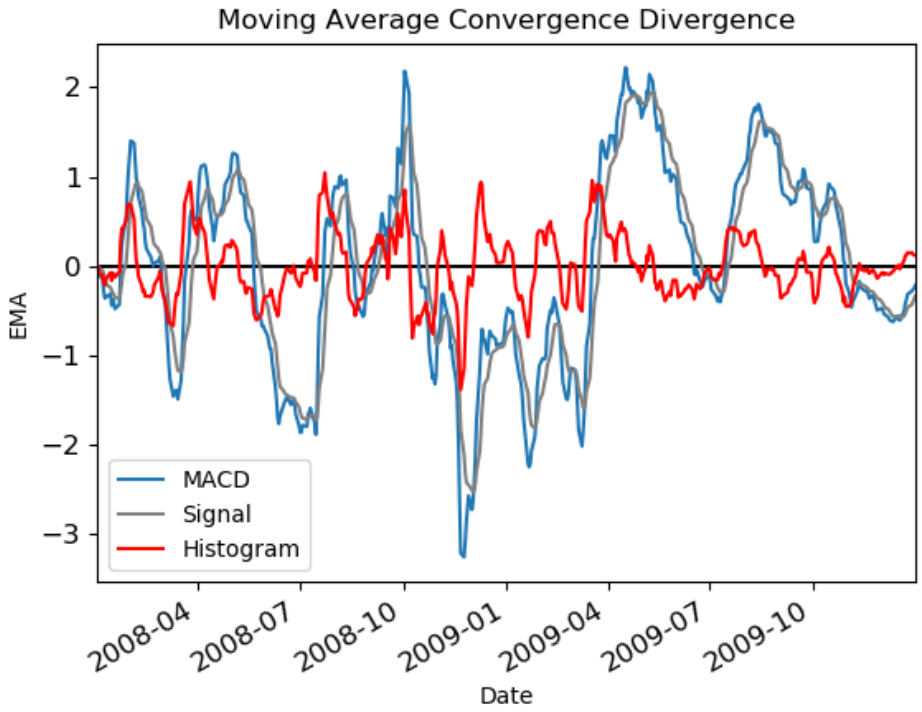

Figure 3: This figure shows MACD (12 days – 26 day EMA), Signal line (9 day EMA of MACD) and MACD histogram (MACD – Signal) for JPM

The MACD line oscillates above and below the zero line, which is also known as the centerline. These crossovers signal that the 12-day EMA has crossed the 26-

day EMA. Positive MACD indicates that the 12-day EMA is above the 26-day EMA. Positive values increase as the shorter EMA diverges further from the longer EMA. This means upside momentum is increasing. Negative MACD values indicate that the 12-day EMA is below the 26-day EMA. Negative values increase as the shorter EMA diverges further below the longer EMA. This means downside momentum is increasing.

1.3 Relative Strength Index (RSI): Momentum

RSI is an popular momentum indicator. RSI oscillates between zero and 100. RSI measures the magnitude of recent price changes to evaluate overbought or oversold conditions in the price of a stock. RSI can also be used to identify the general trend.

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Avg. Gain = Sum of Gains over the past 14 periods / 14
Avg. Loss = Sum of Losses over the past 14 periods / 14
RS = Avg. Gain / Avg. Loss
RSI = 100 - (100 / (1+RS))
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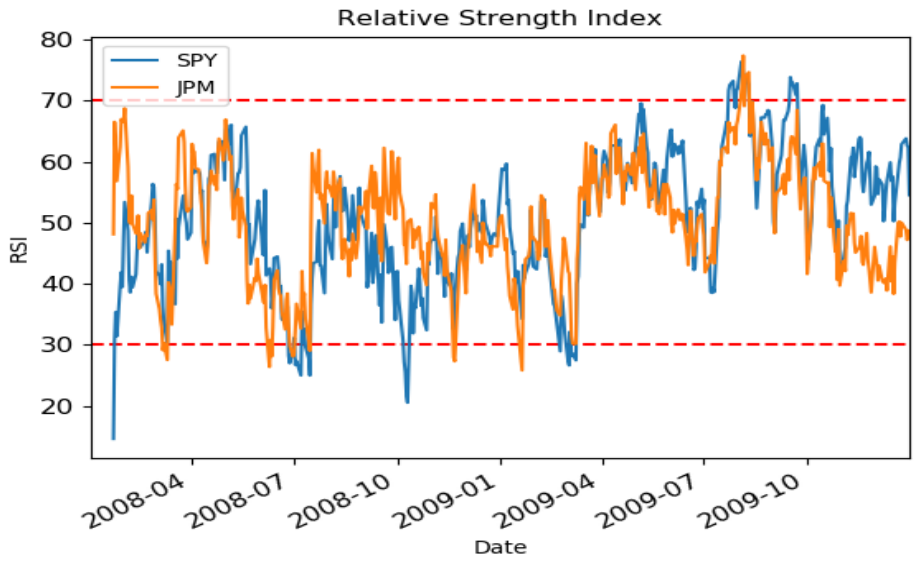

Figure 4: This figure shows the Relative Strength Index for JPM and SPY. Used the exponential average of RSI. It has the same tendencies with rolling average but less overbought and oversold triggers.

Signal:
- Buying position: when the RSI for the stock is below 30 and the RSI for SPY is greater than 30, it indicates a buying opportunity (market is oversold).

- Selling position: when the RSI for the stock is above 70 and the RSI for SPY is less than 70, it indicates a selling opportunity (market is overbought).

RSI is plotted on a vertical scale from 0 to 100. Values above 70 are considered overbought and values below 30, oversold. When prices are over 70 or below 30 and diverge from price action, a warning is given of a possible trend reversal. Signals can also be generated by looking for divergences, failure swings and centerline crossovers.

1.4 On Balance Volume (OBV): Volatility

On Balance Volume (OBV) measures buying and selling pressure as a cumulative indicator, adding volume on up days, and subtracting it on down days.

The On Balance Volume (OBV) line is simply a running total of positive and negative volume. A period's volume is positive when the close is above the prior close and is negative when the close is below the prior close.

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If the closing price is above the prior close price, then:

Current OBV = Previous OBV + Current Volume

If the closing price is below the prior close price, then:

Current OBV = Previous OBV - Current Volume

If the closing prices equals the prior close price, then:

Current OBV = Previous OBV (no change)
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Signal:

- Buying position: when OBV rises when volume on up days outpaces volume on down days. OBV reflects positive volume pressure that can lead to higher prices. Expect prices to move higher if OBV is rising while prices are either flat or moving down.

- Selling position: OBV falls when volume on down days is stronger. Falling OBV reflects negative volume pressure that can foreshadow lower prices. Expect prices to move lower if OBV is falling while prices are either flat or moving up.

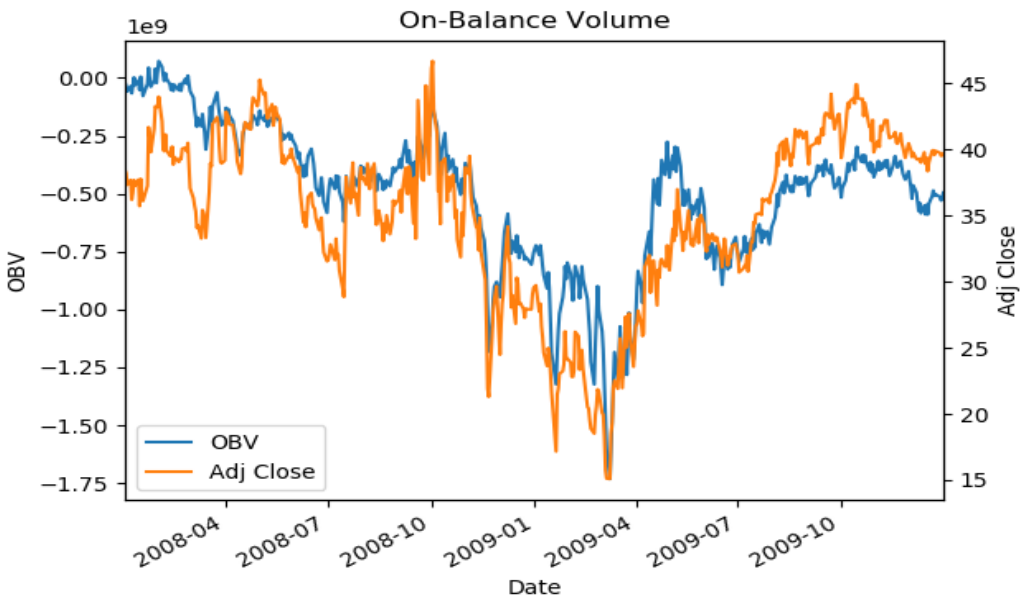

Figure 5: This figure shows OBV along with closing price for JPM

Note: Used adjusted volume (volume * (adjusted closing price / closing price)) to reflect adjustments including stock split.

The absolute value of OBV is not important. We noticed that OBV is based on closing prices. Therefore, closing prices should be considered when looking for divergences or support/resistance breaks.

1.5 Momentum

Momentum is one of the simplest indicators; it is the rate of change of a stock. It shows how much has the price changed over a certain number of days. Positive values of momentum indicate that the stock price is on the rise. Negative values of momentum indicate that the stock price is on the fall.

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Momentum[t] = (price[t] / price [t - n]) - 1
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Signal:

- Buying position: when the momentum is greater than 0, it indicates a buying opportunity.

- Selling position: when the momentum is less than 0, it indicates a selling opportunity.

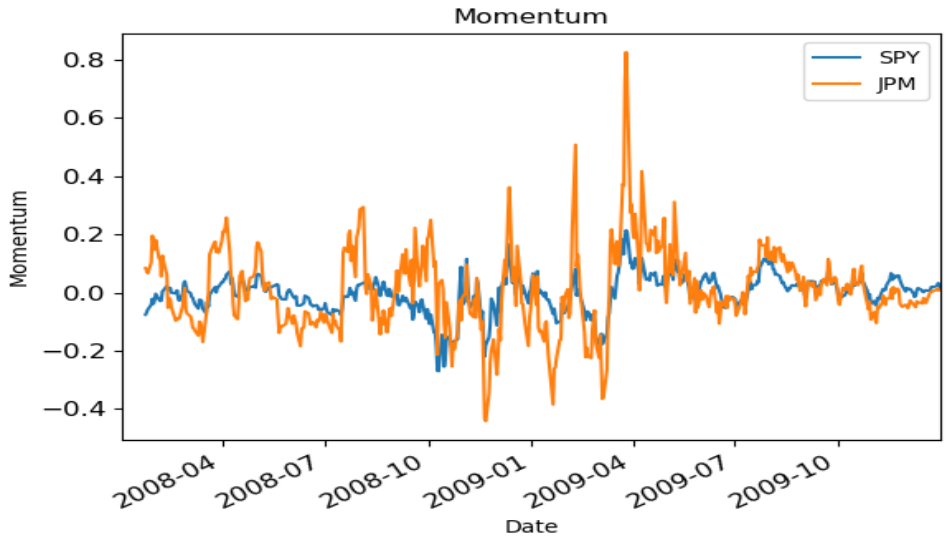

Figure 6: This figure shows the momentums for JPM and SPY.

The above chart shows that JPM has greater degree of momentum compared to market index (SPY). The common way some traders will use momentum as an individual indicator is by assuming that a stock's momentum will continue. Compared market index momentum, momentum can be a good indicator to identify buying/selling position.

2 THEORETICALLY OPTIMAL STRATEGY (TOS)

Given that we can see the future, Theoretically Optimal Strategy (TOS) created a set of trades that represents the best a strategy could possibly do. TOS is simulated on the market time window from January 1, 2008 to December 31, 2009 and constrained by the allowable position of 1000 shares long, 1000 shares short, 0 shares. TOS will give an upper limit as the best it can perform. The benchmark

strategy is starting with $100,000 cash, investing in 1000 shares of JPM and holding that position.

Strategy:
- Buying strategy: when the next day price is higher than current price, we buy stock today until it reaches 1,000 shares long.

- Selling strategy: when the next day price is lower than current price, we sell stock today until it reaches 1,000 shares short.

Note: For TOS and Benchmark, we start to trade on January 2, 2008 when the market is open. There is no trade at the last day (December 31, 2009) since we do not know next day price.

Strategy vs. Benchmark

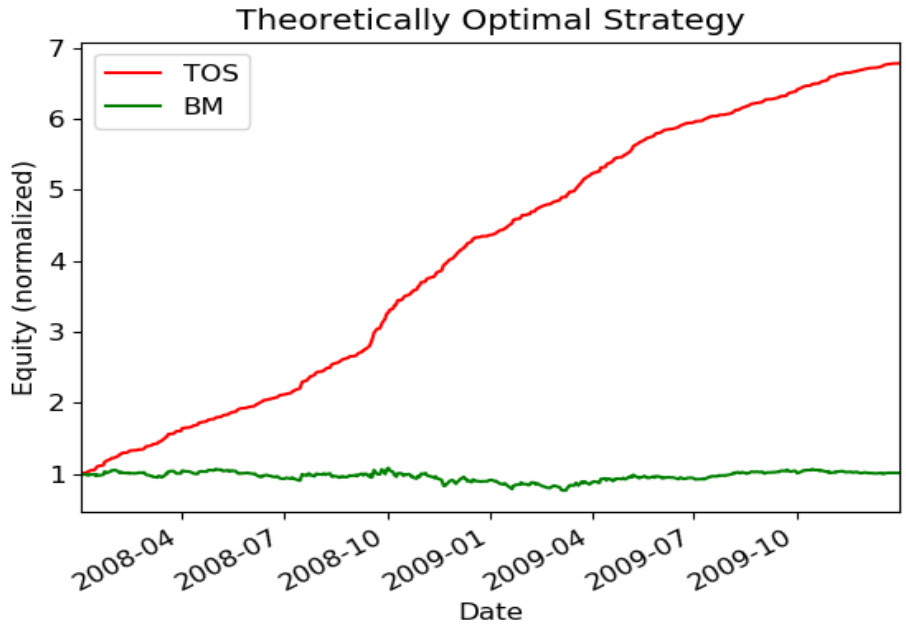

Figure 7: This figure shows performance of TOS for JPM vs. benchmark for JPM

In above chart, we noticed that the TOS provides significantly higher returns and beats the benchmark. In addition, based on below table, the mean of daily returns is 22.7 times higher for TOS. The Sharpe ratio is 84.9 times higher for TOS. The final portfolio value is $577,380 (6.7x) higher for TOS as compared to benchmark.

Portfolio Statistics

Statistics	Benchmark	TOS
Cumulative Return	1.23%	578.61%
Std of Daily Return	0.017	0.005
Avg. Daily Return	0.02%	0.38%
Sharpe Ratio	0.16	13.32
Final Portfolio Value	$101,230	$678,610

3 REFERENCES

https://school.stockcharts.com/doku.php?id=technical_indicators:introduction_to_technical_indicators_and_oscillators