# Project 6: Indicator Evaluation

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*Abstract*—This report presents the development and analysis of a theoretically optimal trading strategy as well as testing fice technical indicators for JPM stock over the period from January 1, 2008, to December 31, 2009. The technical indicators — Bollinger Bands %B, Relative Strength Index (RSI), Commodity Channel Index (CCI), Momentum, and Moving Average Convergence Divergence (MACD) Line — that can be used to inform trading decisions. The performance of the theoretically optimal strategy is compared against a benchmark buy-and-hold strategy over the same period. Results indicate that the theoretically optimal strategy significantly outperforms the benchmark in terms of cumulative return.

## 1 IMPLEMENTATION OF TECHNICAL INDICATORS

This section details the computation of the five technical indicators used in the trading strategy. Each indicator is designed to provide insights into price movements and potential trading signals. The descriptions are detailed to enable reproduction of the indicators based on the explanations provided.

### 1.1 Bollinger Bands %B

Bollinger Bands are a type of price envelope technical analysis indicator developed by John Bollinger. They consist of a Simple Moving Average (SMA) and two bands placed some multiple of standard deviations above and below the SMA. This shows the volatility of the price based on the distance between the two bands. The %B indicator measures the relative position of the price within these bands.

#### 1.1.1 *Calculation Steps*

The calculation involves computing the 20-day SMA of the closing prices, calculating the 20-day rolling standard deviation, determining the upper and lower bands by adding and subtracting two times the standard deviation from the SMA, and finally computing the %B indicator as:

$$\%B = \frac{\text{Price} - \text{Lower Band}}{\text{Upper Band} - \text{Lower Band}}$$

### 1.1.2 *Usage and Buy/Sell Signals*

A %B value close to 0 indicates the price is near the lower band, suggesting a potential oversold condition and a buy signal. Conversely, a %B value close to 1 indicates the price is near the upper band, suggesting a potential overbought condition and a sell signal. Figure 1 illustrates how the price of JPM interacts with the Bollinger Bands and how the %B indicator reflects these movements.
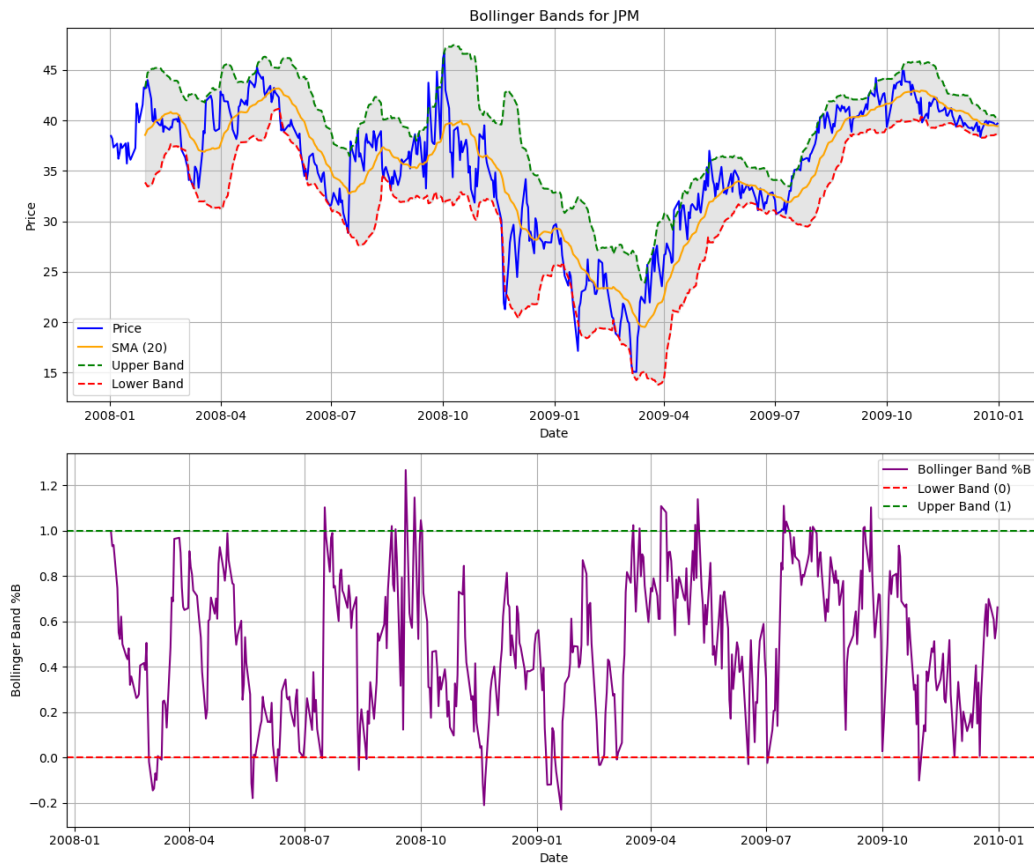


*Figure 1*—Bollinger Bands and %B for JPM. The upper plot shows the price, SMA, upper band, and lower band. The lower plot illustrates the %B indicator.

## 1.2 Relative Strength Index (RSI)

The Relative Strength Index (RSI) is a momentum oscillator that measures the speed and change of price movements. It oscillates between 0 and 100 and is used to identify overbought or oversold conditions.

### 1.2.1 *Calculation Steps*

RSI is calculated by computing the average gains and losses over a 14-day period, calculating the relative strength (RS) as the ratio of average gain to average loss, and then computing the RSI using the formula:

$$\text{RSI} = 100 - \left( \frac{100}{1 + \text{RS}} \right)$$

### 1.2.2 *Usage and Buy/Sell Signals*

An RSI below 30 suggests oversold conditions and a potential buy signal, while an RSI above 70 indicates overbought conditions and a potential sell signal. Figure 2 shows the RSI values for JPM, highlighting periods where the stock may be overbought or oversold.
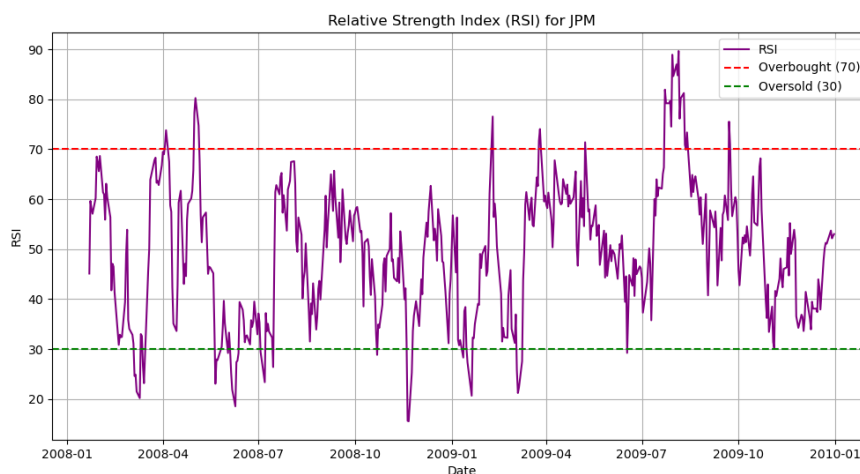


*Figure 2*—RSI for JPM, indicating overbought levels above 70 and oversold levels below 30.

### 1.3 Commodity Channel Index (CCI)

The Commodity Channel Index (CCI) measures a security's deviation from its statistical mean. It is useful for identifying cyclical trends in securities.

#### 1.3.1 *Calculation Steps*

CCI is calculated by determining the typical price (which, for equities with only closing prices, is the closing price), computing the 20-day SMA of the typical price, calculating the mean deviation, and then computing the CCI using:

$$\text{CCI} = \frac{\text{Typical Price} - \text{SMA}_{20}}{0.015 \times \text{Mean Deviation}_{20}}$$

#### 1.3.2 *Usage and Buy/Sell Signals*

A CCI below -100 indicates the asset is oversold, suggesting a potential buy signal. A CCI above +100 indicates the asset is overbought, suggesting a potential sell signal. Figure 3 displays the CCI values for JPM, showing potential trading signals based on the indicator.
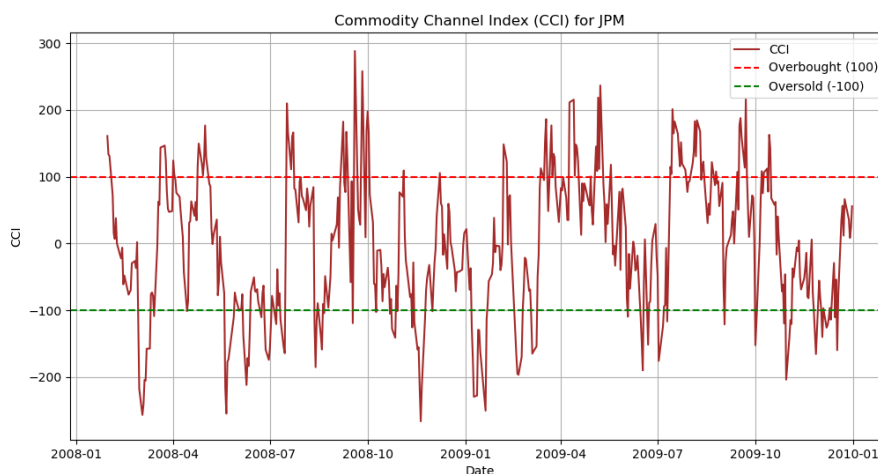


*Figure 3*—CCI for JPM, with overbought and oversold thresholds at +100 and -100, respectively.

### 1.4 Momentum

Momentum measures the rate of change in the price of a security. It highlights the speed at which the price is moving over a given period.

### 1.4.1 *Calculation Steps*

Momentum is calculated by selecting a lookback period (in this case, 10 days) and computing:

$$\text{Momentum} = \frac{\text{Price}_t}{\text{Price}_{t-n}} - 1$$

where $\text{Price}_t$ is the current price and $\text{Price}_{t-n}$ is the price $n$ days ago.

### 1.4.2 *Usage and Buy/Sell Signals*

Increasing momentum indicates accelerating upward price movement, suggesting a buy signal. Decreasing or negative momentum indicates slowing or downward price movement, suggesting a sell signal. Figure 4 illustrates the momentum of JPM's stock price over time.
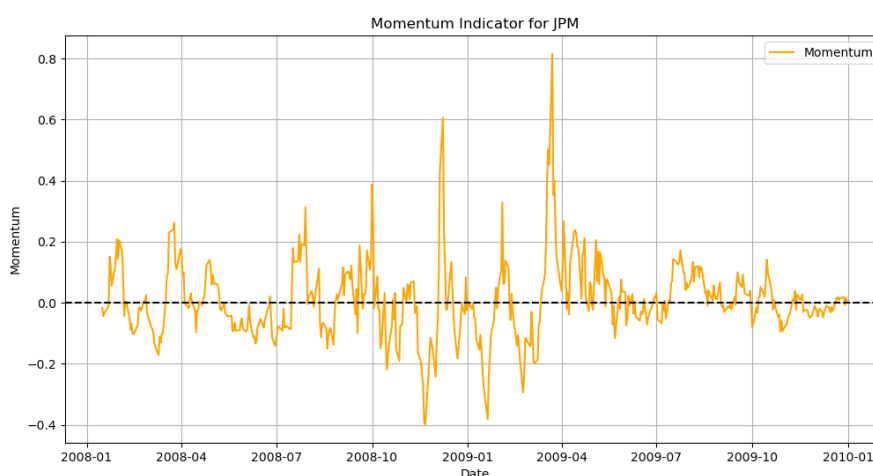


*Figure 4*—Momentum indicator for JPM, highlighting periods of increasing or decreasing momentum.

## 1.5 Moving Average Convergence Divergence (MACD) Line

The MACD is a trend-following momentum indicator that shows the relationship between two moving averages of a security's price.

### 1.5.1 *Calculation Steps*

MACD is calculated by computing the 12-day and 26-day Exponential Moving Averages (EMAs) of the closing prices and then calculating the MACD Line as:

$$\text{MACD Line} = \text{EMA}_{12} - \text{EMA}_{26}$$

### 1.5.2 *Usage and Buy/Sell Signals*

A positive MACD Line suggests bullish momentum, while a negative MACD Line suggests bearish momentum. Crossovers of the MACD Line above or below zero can signal changes in trend direction. Figure 5 shows the MACD Line in relation to JPM's stock price.
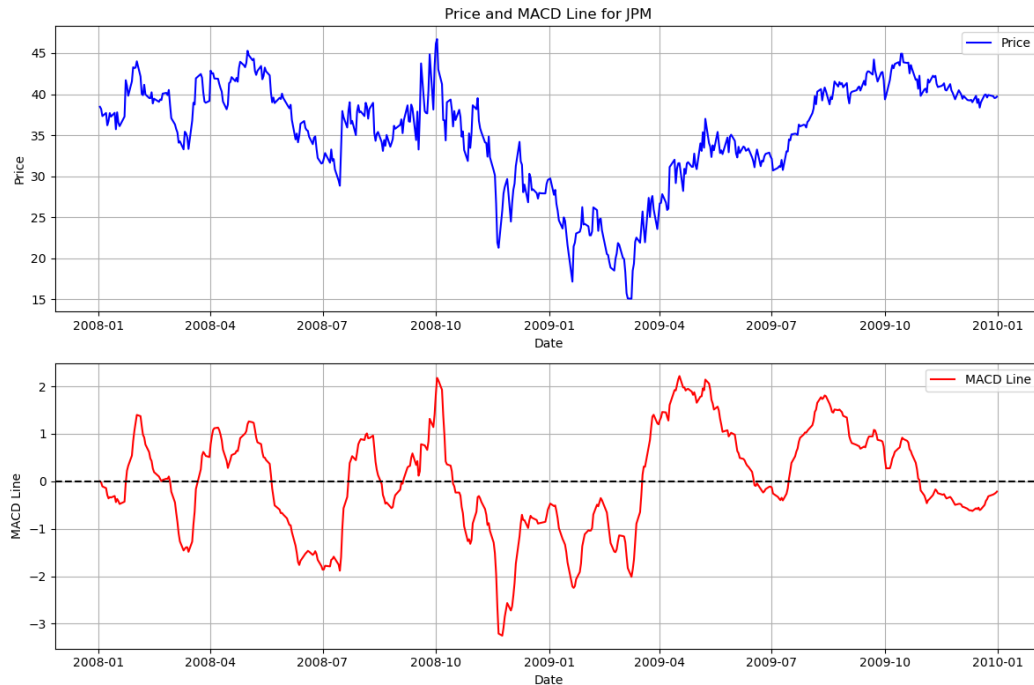


*Figure 5*—Price and MACD Line for JPM. The MACD Line crossing above zero may indicate a bullish signal, while crossing below zero may indicate a bearish signal.

## 2 THEORETICALLY OPTIMAL STRATEGY (TOS)

### 2.1 Strategy Creation and Assumptions

The theoretically optimal strategy aims to maximize returns by exploiting perfect future knowledge of stock prices. The key assumptions are that the strategy has perfect foresight, there are no transaction costs, and there are position limits of +1000 (long) or -1000 (short) shares.

## 2.2 Strategy Description

On each trading day, the strategy compares the next day's price to the current day's price. If the future price is higher, it buys enough shares to reach a +1000 share position. If the future price is lower, it sells enough shares to reach a -1000 share position. If already at the position limit or if the future price is equal to the current price, it maintains the current position. This approach ensures the strategy is always optimally positioned to benefit from known price movements.
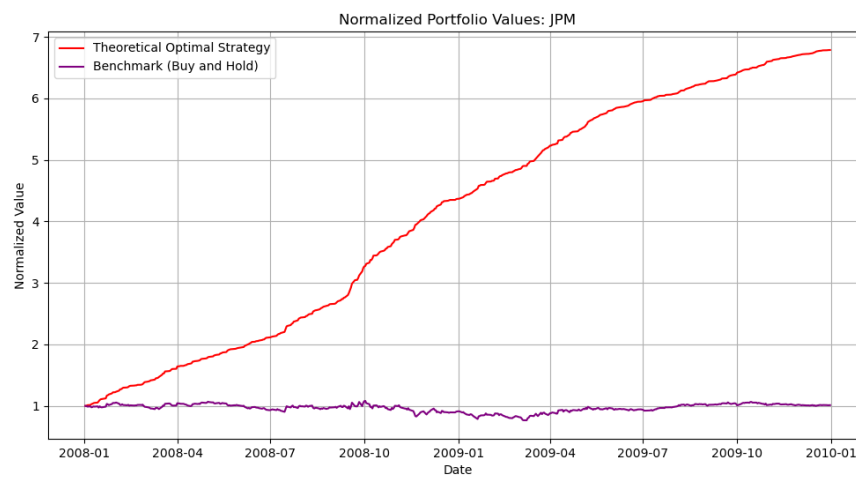
## 2.3 Performance Comparison



*Figure 6*—Normalized portfolio values of the theoretically optimal strategy and the benchmark.

Figure 6 compares the performance of the TOS against a benchmark buy-and-hold strategy.

## 2.4 Performance Metrics

*Table 1*—Performance metrics of the TOS and Benchmark for JPM.

| Metric | TOS | Benchmark |
|---|---|---|
| Cumulative Return | 5.786100 | 0.012300 |
| Standard Deviation | 0.004548 | 0.017004 |
| Mean Daily Return | 0.003817 | 0.000168 |

Table 1 presents the key performance metrics for both the TOS and the benchmark strategy, demonstrating the superior performance of the TOS.

## 3 CONCLUSION

In this project, we implemented five technical indicators to analyze JPM's stock price movements and inform trading decisions. Each indicator provided unique insights into market conditions and potential trading signals. The indicators proved valuable in capturing market signals and could be used to develop practical trading strategies. However, in real-world applications, these strategies would need to account for transaction costs, market impact, and the uncertainty inherent in price movements. These indicators could be used to predict price movements. The theoretically optimal strategy, leveraging perfect future knowledge, significantly outperformed the benchmark, achieving a cumulative return of 5.786100 compared to the benchmark's 0.012300. While the TOS is not feasible in real-world trading due to the impossibility of predicting future prices with certainty and the presence of transaction costs, it serves as a benchmark for evaluating the potential effectiveness of trading strategies informed by technical indicators.