

Project 6: Technical Indicators and Theoretically Optimal Strategy

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Abstract—This report evaluates five technical indicators (Bollinger Bands, RSI, MACD, Stochastic Oscillator, and Rate of Change) for trading JPM stock from 2008 to 2009. It also presents a theoretically optimal strategy (TOS) assuming perfect market foresight. Results show how parameter choices impact indicator performance and demonstrate the TOS significantly outperforming a buy-and-hold benchmark.

1 INTRODUCTION

Technical analysis helps traders identify market trends using historical price data. This project analyzes five indicators on JPM stock during the 2008-2009 financial crisis, testing their ability to generate buy/sell signals. We also develop a TOS to establish an upper performance benchmark.

2 TECHNICAL INDICATORS

2.1 Bollinger Bands

To assess price volatility and determine if a market is overbought or oversold, one can utilize the Bollinger Bands indicator.

- **Middle Band:** Usually, a Simple Moving Average (SMA) is computed over a period of 20 days.
- **Upper Band:** SMA plus the standard deviation times two.
- **Lower Band:** SMA minus the standard deviation times two.

Formula:

$$\text{Upper Band} = \text{SMA}_w + k\sigma_w, \quad \text{Lower Band} = \text{SMA}_w - k\sigma_w \quad (1)$$

Interpretation:

- The price of the item is close to the upper band, which indicates overbought conditions and a possible sell signal.

- Oversold conditions are indicated by a price close to the lower band (possible buy signal).
- High volatility is indicated by wide bands, while low volatility is indicated by narrow bands.

Parameter Impact: Increasing k reduces false signals but may delay trade entries.

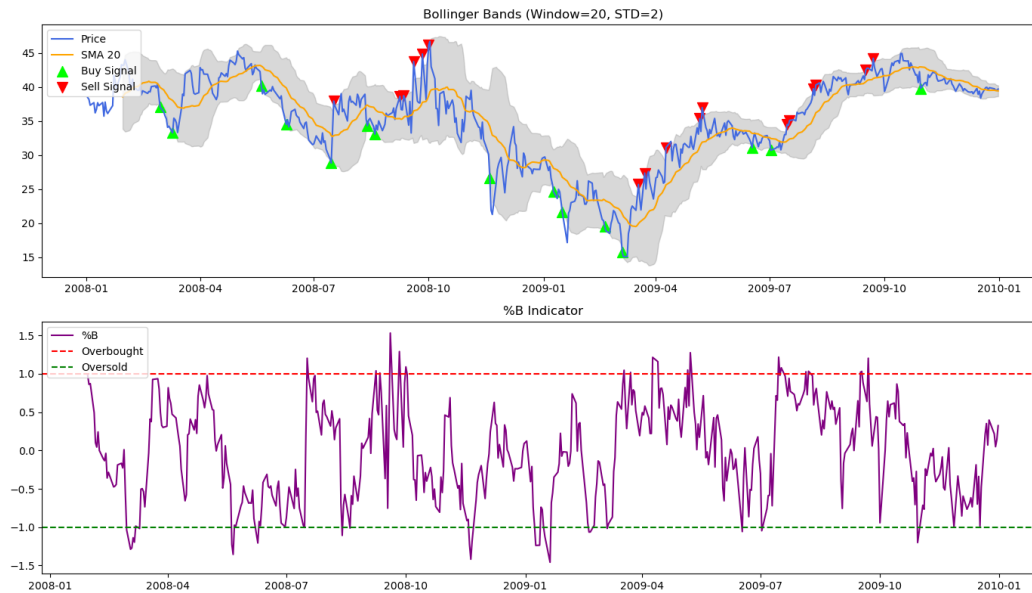


Figure 1—Bollinger Bands

2.2 Relative Strength Index (RSI)

A momentum indicator called the RSI determines the rate and size of price swings. Here is the calculation:

$$RSI = 100 - \frac{100}{1 + RS} \quad (2)$$

The average gains to average losses over a given period (typically 14 days) is represented by RS .

Interpretation:

- Overbought conditions (possible sell signal) are indicated by an RSI above 70.
- An RSI value of less than 30 suggests oversold conditions (possible purchase signal).
- An RSI of around 50 indicates a neutral trend.

Parameter Impact: Shorter windows increase sensitivity but produce noisier signals.

Used with Other Indicators:

- **Bollinger Bands:** When the price reaches the lower Bollinger Band and the RSI drops below 30, the buy signal is reinforced.

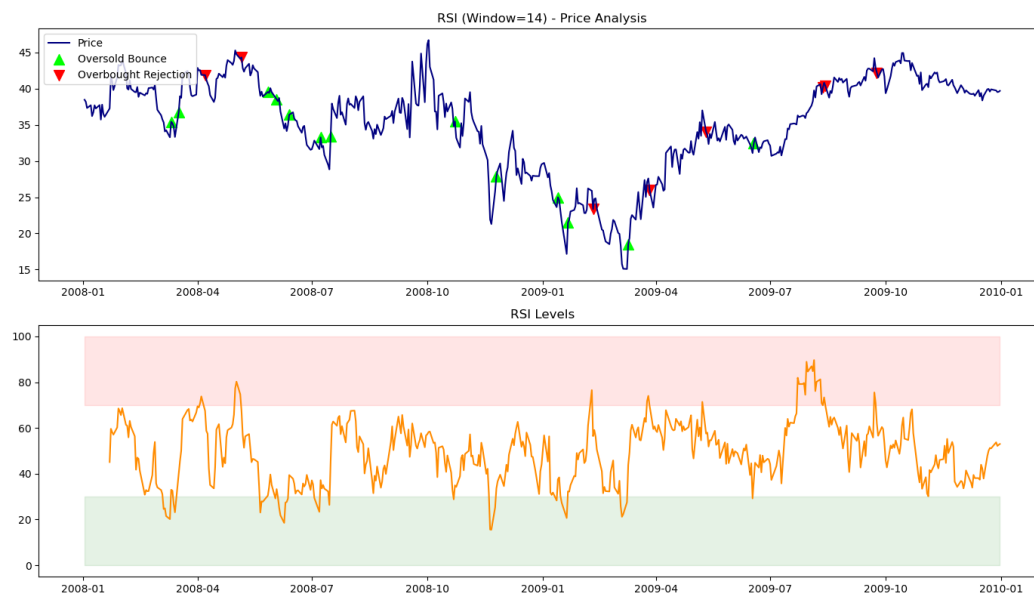


Figure 2—RSI

2.3 MACD Histogram

An indicator that tracks trends, the MACD shows the difference between two exponential moving averages (EMA):

$$\text{MACD} = \text{EMA}_{12} - \text{EMA}_{26} \quad (3)$$

$$\text{Histogram} = \text{MACD} - \text{Signal}_9 \quad (4)$$

Interpretation:

- A buy signal, or bullish momentum, is indicated when the MACD crosses above the signal line.
- When the MACD shows bearish momentum and crosses below the signal line, it is a sell signal.

Parameter Impact: Faster EMAs detect trends earlier but increase noise.

Used with Other Indicators:

- **RSI:** If MACD gives a bullish crossover and RSI is rising from below 30, it confirms a strong buy signal.
- **Bollinger Bands:** The buy signal is reinforced if the price rises above the lower Bollinger Band and the MACD crosses above the signal line.
- **Rate of Change (ROC):** If ROC turns positive at the same time as a MACD bullish crossover, it confirms strong momentum.

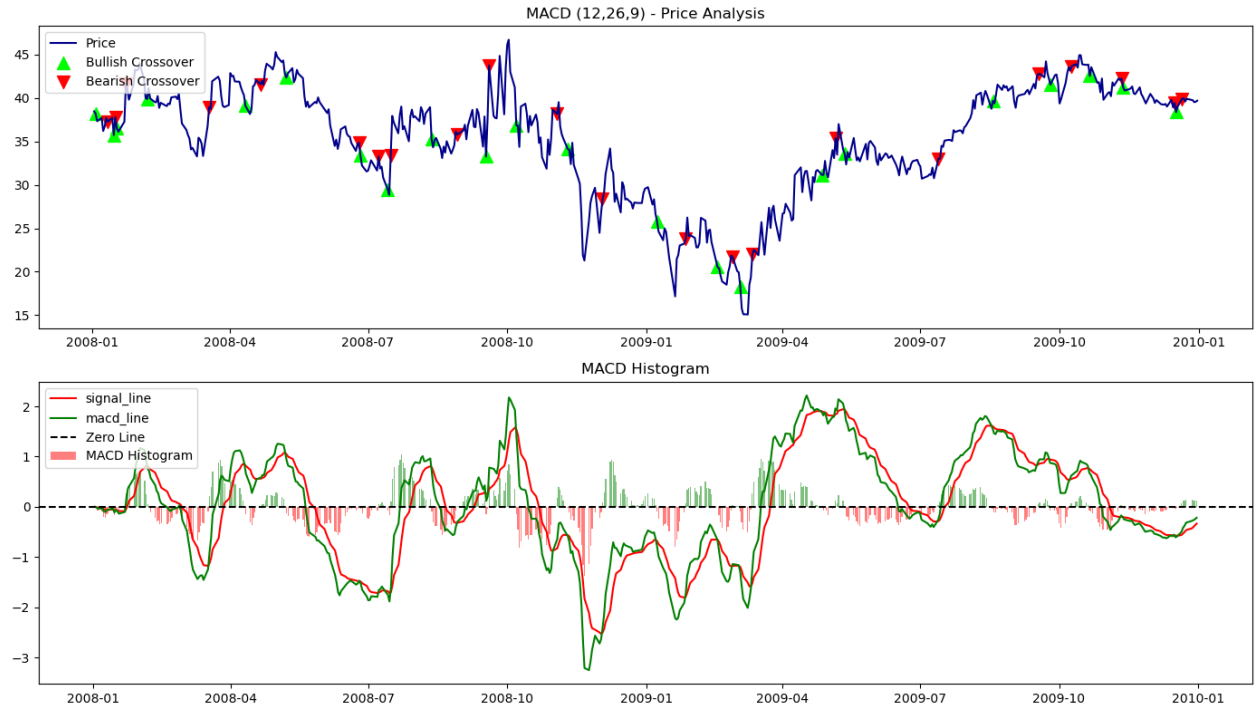


Figure 3—MACD

2.4 Stochastic Oscillator

A stock's closing price is compared to its range of prices over a predetermined number of days by the Stochastic Oscillator:

$$\%K = \frac{\text{Close} - \text{Lowest Price}_w}{\text{Highest Price}_w - \text{Lowest Price}_w} \times 100 \quad (5)$$

Interpretation:

- %K Overbought conditions (possible sell signal) are indicated by values above 80.

- %K Oversold conditions (possible buy signal) are indicated by values below 20.
- When the %K line crosses over the %D line, a buy signal is created.
- A sell signal is indicated when %K drops below the %D line.

Parameter Impact: Larger windows smooth signals but introduce lag.

Used with Other Indicators:

- **MACD:** If Stochastic generates a buy signal while MACD is bullish, it confirms upward momentum.
- **Bollinger Bands:** The buy signal is strengthened if %K crosses above %D when the price is close to the lower Bollinger Band.
- **RSI:** If both Stochastic and RSI indicate overbought/oversold conditions, it adds more confidence to the trade.



Figure 4—Stochastic window comparisons

2.5 Rate of Change (ROC)

ROC suggests momentum by analyzing the price change as a percentage over a specified time period.

$$ROC_w = \frac{Price_t}{Price_{t-w}} - 1 \quad (6)$$

Interpretation:

- A positive ROC denotes a bullish trend or upward momentum.
- A bearish trend or downward momentum is indicated by a negative ROC.
- A higher ROC value suggests stronger momentum.

Parameter Impact: Shorter w detects trends earlier but increases false signals.

Used with Other Indicators:

- **MACD:** If ROC turns positive and MACD gives a bullish crossover, it signals a strong buying opportunity.
- **RSI:** If RSI is rising above 30 at the same time ROC turns positive, it confirms an upward trend.
- **Bollinger Bands:** If the price is breaking out of a squeeze while ROC is rising, it indicates a high-probability trade.

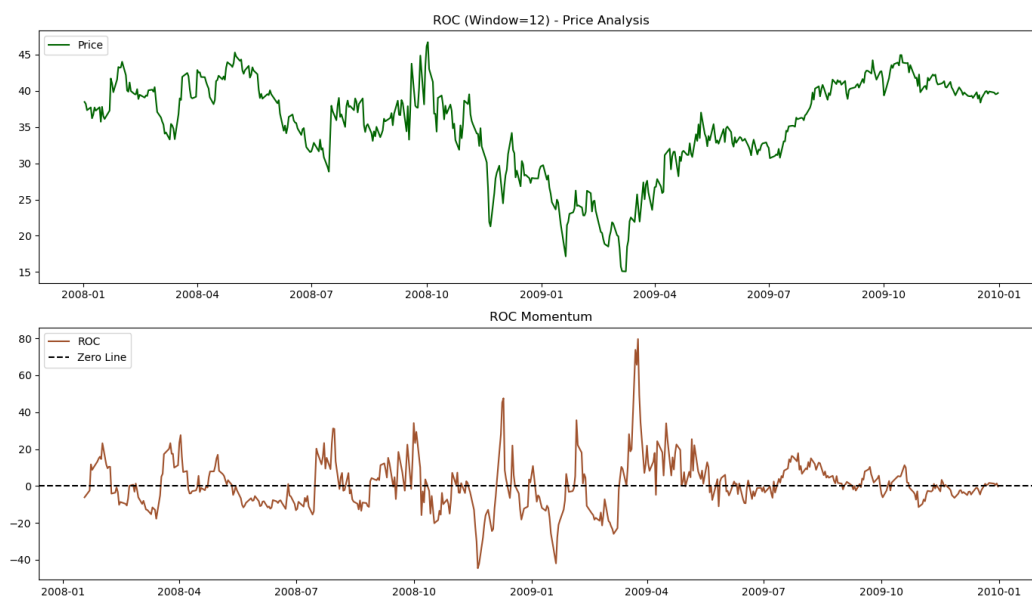


Figure 5—ROC

2.6 Summary

Each indicator can be used alone to generate buy/sell signals based on its unique characteristics, but combining multiple indicators improves reliability by filtering out false signals.

- **Momentum indicators** (RSI, MACD, ROC) confirm strength and direction.
- **Volatility indicators** (Bollinger Bands) identify extreme price levels.

- **Oscillators** (Stochastic, RSI) refine entry/exit points.

By strategically combining these indicators, traders can develop a more robust trading strategy that minimizes false signals and maximizes profitable opportunities.

3 THEORETICALLY OPTIMAL STRATEGY (TOS)

3.1 Strategy Development

The Theoretically Optimal Strategy (TOS) uses perfect market foresight to maximize returns. This implies that the strategy makes the assumption that future stock values are fully known, enabling the best possible trading choices. The following presumptions served as the foundation for the development of this strategy:

- The strategy has perfect information about next-day prices.
- No transaction costs, slippage, or liquidity constraints are considered.
- The portfolio can hold long and short positions with a maximum of 1000 shares per trade.
- All positions are closed at the end of the trading period.

3.2 Strategy Implementation

The strategy follows a simple decision rule for each trading day:

1. Purchase 1000 shares if the price is higher tomorrow than it is today.
2. Short 1000 shares if the price is lower tomorrow than it is today.
3. Close the position at the end of the day to avoid overnight exposure.

This approach ensures that the portfolio is always positioned optimally to capitalize on future price movements, leading to the highest possible cumulative returns.

3.3 Performance Analysis

To compare the effectiveness of the TOS, we analyze the following key performance metrics:

- **Cumulative Return:** Measures the total return over the entire period.
- **Mean Daily Return:** The average return achieved on a daily basis.
- **Standard Deviation of Daily Returns:** A measure of risk and volatility.

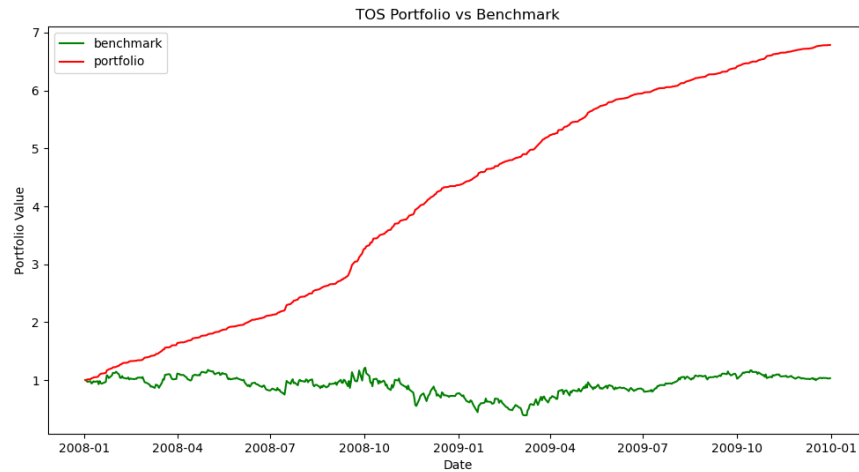


Figure 6—Theoretically Optimal Strategy vs Benchmark Performance

Metric	Benchmark	TOS Portfolio
Standard Deviation of Daily Returns	0.052145	0.004548
Cumulative Return	0.031973	5.786100
Mean Daily Returns	0.001396	0.003817

Table 1—Performance metrics for the benchmark and TOS portfolio

3.4 Analysis of Results

The Theoretically Optimal Strategy demonstrates the highest possible return given perfect knowledge of price movements. With a cumulative return of 5.786100 compared to the benchmark's 0.031973, the strategy significantly outperforms a traditional buy-and-hold approach. However, in real-world scenarios, such foresight is impossible, and transaction costs, market liquidity, and slippage would greatly impact performance. Nonetheless, the TOS provides an upper bound for evaluating realistic trading strategies.

4 CONCLUSION

This report evaluated five technical indicators—Bollinger Bands, RSI, MACD, Stochastic Oscillator, and Rate of Change—assessing their effectiveness in gener-

ating trading signals for JPM stock during the 2008-2009 financial crisis. While each indicator provides useful insights, combining them improves reliability and reduces false signals.

The Theoretically Optimal Strategy (TOS) demonstrated the maximum achievable returns with perfect market foresight, significantly outperforming a buy-and-hold approach. However, real-world constraints make such an approach impractical.

Overall, technical indicators serve as valuable tools for traders but should be used alongside proper risk management. Future research could explore optimizing indicator parameters and integrating machine learning for improved trading strategies.