

# Project 6: Indicators and TOS

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## INDICATORS

### Exponential Moving Average (EMA)

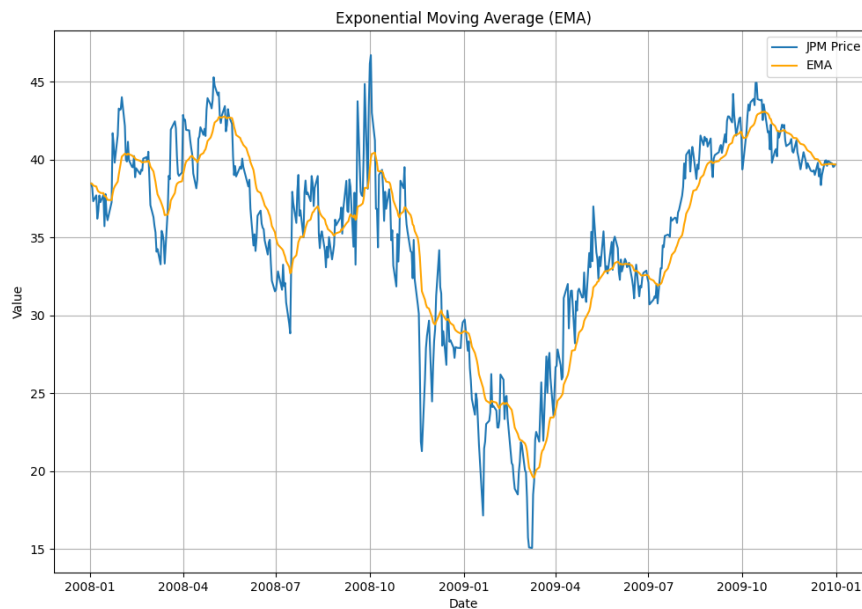
The Exponential Moving Average (EMA) is a pivotal tool in financial analysis, offering a smoothed depiction of price data over a defined period. Unlike the Simple Moving Average (SMA), the EMA assigns greater weight to recent prices, rendering it more responsive to recent price changes.

The EMA calculation incorporates a smoothing factor ( $\alpha$ ) and the previous day's EMA value:

$$EMA_{today} = (Price_{today} * \alpha) + (EMA_{yesterday} * (1 - \alpha))$$

Here,  $Price_{today}$  represents the closing price for the current period,  $EMA_{yesterday}$  denotes the EMA value for the previous period, and  $\alpha$  signifies the smoothing factor, computed as  $\frac{2}{N+1}$ , where N signifies the number of periods.

The EMA, designed to mitigate lag, assigns greater significance to recent price data. As a result, it exhibits heightened sensitivity to recent price changes, facilitating the identification of short-term trends and potential reversals.



*Figure 1 - Exponential Moving Average (EMA) indicator chart*

Traders utilize EMAs across various contexts:

1. **Trend Identification:** EMAs aid in identifying trends in price movements. A price consistently above the EMA implies an uptrend, while prices below the EMA suggest a downtrend.
2. **Support and Resistance Levels:** EMAs serve as dynamic support and resistance levels. During uptrends, the EMA often acts as support, while during downtrends, it functions as resistance.
3. **Crossover Signals:** Crossings between short-term and long-term EMAs furnish buy and sell signals. A bullish crossover arises when the short-term EMA surpasses the long-term EMA, signaling a potential buying opportunity. Conversely, a bearish crossover suggests a potential selling opportunity.
4. **Trend Confirmation:** Traders corroborate trend strength using EMAs alongside other indicators. For instance, if the price lies above the EMA and both EMAs are ascending, it validates the bullish trend.

5. **Trade Entry and Exit Points:** EMAs guide traders in determining optimal entry and exit points. Entering a long position upon the price crossing above the EMA and exiting when it drops below can facilitate efficient trend capture.

### Momentum

Momentum is a pivotal concept in technical analysis, gauging the pace of price changes over a specific period to derive insights into trend strength and generate trading signals.

Mathematically, momentum is calculated using the following formula:

$$\text{Momentum} = \text{Close}_{\text{current}} - \text{Close}_{\text{previous}}$$

Where  $\text{Close}_{\text{current}}$  is the closing price of the current period, and  $\text{Close}_{\text{previous}}$  is the closing price of the previous period. This straightforward formula indicates whether prices are rising or falling and at what rate they are changing.

The interpretation of momentum revolves around the idea that price trends tend to persist in the direction of their momentum. Positive momentum, marked by rising prices, suggests the likelihood of continued upward trends. Conversely, negative momentum, characterized by falling prices, hints at potential downward trends. Traders keenly observe divergences between price movements and momentum indicators to anticipate shifts in trend directions.



*Figure 2 - Momentum indicator chart*

Momentum indicators serve several key purposes:

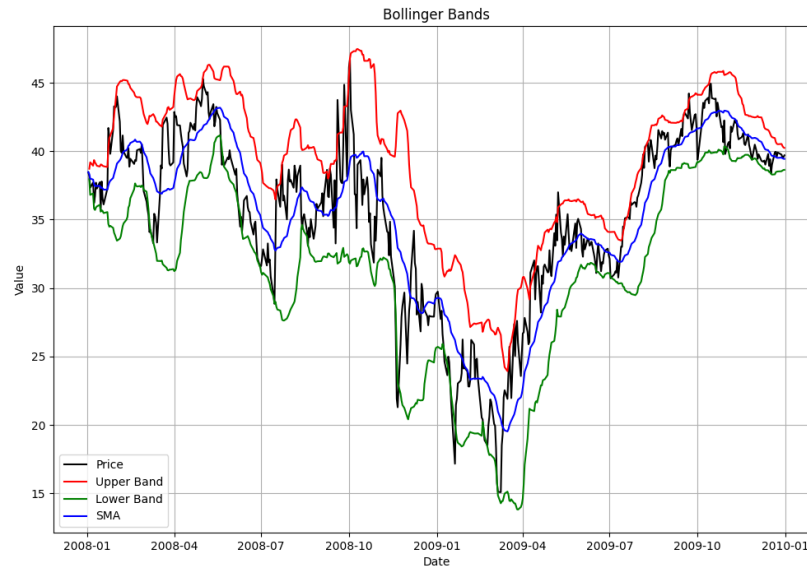
1. **Trend Confirmation:** They affirm the strength of existing trends. Rising prices coupled with increasing momentum signify robust bullish trends, while declining momentum amidst rising prices might indicate weakening bullish momentum and potential trend reversals.
2. **Overbought and Oversold Conditions:** Extreme momentum levels often signify overbought or oversold market conditions. High positive momentum may signal rapid price increases, potentially leading to pullbacks, while high negative momentum may indicate swift price declines, possibly prompting rebounds.
3. **Divergence Analysis:** Divergence between price and momentum indicators can be indicative of impending trend reversals. For instance, when prices record higher highs but momentum registers lower highs, it suggests waning bullish momentum and a possible trend reversal to the downside.
4. **Crossover Signals:** Traders frequently employ momentum crossovers, where the momentum indicator surpasses or falls below a predefined threshold, to generate buy or sell signals. A momentum crossing above a specific level may signal a buying opportunity, while dipping below that level may indicate a selling opportunity.

In summary, momentum analysis is fundamental in technical trading strategies. It enables traders to evaluate trend strength, identify overbought or oversold market conditions, discern divergences, and generate timely buy and sell signals. Integrating momentum indicators into comprehensive trading frameworks enhances decision-making and improves overall trading outcomes.

### Bollinger Bands

Bollinger Bands, a technical analysis tool developed by John Bollinger, consists of three key components: the middle band (a 20-day simple moving average) and upper and lower bands, which are calculated based on two standard deviations

from the middle band. These bands dynamically adjust to market volatility, expanding and contracting accordingly.



*Figure 3 - Bollinger Bands indicator chart*

Bollinger Bands serve multiple purposes:

Firstly, they help identify potential overbought and oversold conditions. When prices touch or exceed the upper band, it may indicate overbought conditions, suggesting a potential sell opportunity. Conversely, when prices touch or fall below the lower band, it may signal oversold conditions, presenting a buying opportunity.

Moreover, Bollinger Bands aid in trend identification. A consistently rising price above the upper band may signify an uptrend, while a falling price below the lower band suggests a downtrend.

Additionally, the width of the bands reflects market volatility. Narrow bands indicate low volatility, while wide bands suggest high volatility. Traders often look for transitions from low to high volatility as potential trading opportunities.

Bollinger Bands can also help identify potential reversal signals. Reversals may occur when prices pierce the bands and subsequently move back within them.

Furthermore, traders often use Bollinger Bands in conjunction with other technical indicators to confirm trading signals. For instance, if prices touch the upper band while the Relative Strength Index (RSI) signals overbought conditions, it may strengthen the sell signal.

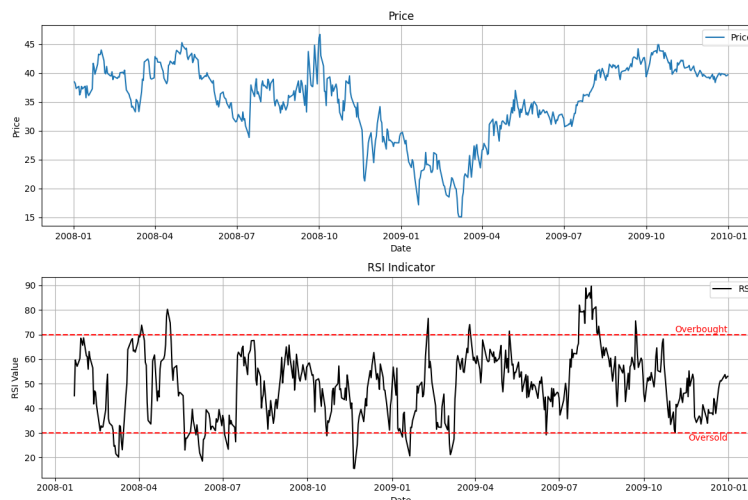
### Relative Strength Index (RSI)

The Relative Strength Index (RSI) is a momentum oscillator developed by J. Welles Wilder Jr., widely used in technical analysis to measure the speed and change of price movements. It oscillates between 0 and 100, with readings above 70 suggesting overbought conditions and readings below 30 indicating oversold conditions.

The RSI is calculated using the formula:

$$RSI = 100 - \frac{100}{1 + RS}$$

where RS (Relative Strength) is the average of x days' up closes divided by the average of x days' down closes. Typically, a 14-day period is used as the default, but this can be adjusted based on market conditions.



*Figure 4 - Relative Strength Index (RSI) indicator chart*

Traders utilize the RSI in various ways:

Firstly, it helps identify overbought and oversold conditions. Readings above 70 may signal overbought conditions, suggesting a potential opportunity to sell or take profits. Conversely, readings below 30 may signal oversold conditions, presenting an opportunity to buy or enter a long position.

Additionally, traders look for divergence between price and the RSI indicator, which occurs when the price forms higher highs or lower lows while the RSI fails to confirm those moves. This could indicate a potential reversal in the current trend.

The RSI can also be used in conjunction with other technical indicators to confirm trading signals. For instance, if the RSI indicates an overbought condition while another indicator, such as the Moving Average Convergence Divergence (MACD), also shows bearish divergence, it may strengthen the sell signal.

By combining the RSI with other indicators and considering price action analysis, traders can enhance their decision-making process and potentially improve the accuracy of their buy and sell signals.

### Moving Average Convergence/Divergence (MACD)

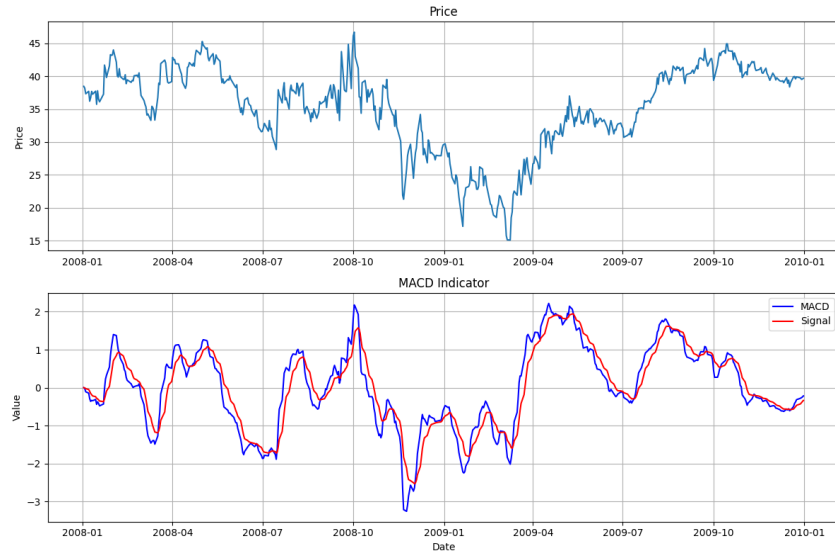
The Moving Average Convergence Divergence (MACD) is a widely used technical indicator developed by Gerald Appel, comprising the MACD line, signal line, and histogram. It analyzes trends and momentum in asset prices to generate buy and sell signals.

The MACD line is calculated by subtracting the 26-day exponential moving average (EMA) from the 12-day EMA. The signal line, a 9-day EMA of the MACD line, smooths out fluctuations.

Traders rely on the MACD for several purposes:

Firstly, it helps identify trend direction and strength. A bullish trend is indicated when the MACD line is above the signal line, and a bearish trend when it's below.

Moreover, MACD crossovers provide buy and sell signals. A bullish crossover occurs when the MACD line crosses above the signal line, signaling a potential buy opportunity. Conversely, a bearish crossover suggests a potential sell opportunity.



*Figure 5 - Moving Average Convergence/Divergence (MACD) indicator chart*

Additionally, traders use MACD divergence, where the indicator moves counter to price action, to spot potential trend reversals.

The MACD is often employed alongside other technical indicators and chart patterns to confirm signals. For instance, a MACD buy signal accompanied by increasing trading volume strengthens the signal's validity.

### **THEORETICALLY OPTIMAL STRATEGY (TOS)**

To develop the strategy, we implemented the Theoretically Optimal Strategy (TOS) which aims to predict whether the returns for the next day will be positive or negative. The TOS involves a binary decision-making process: if the predicted returns are positive, the strategy initiates a long position by executing a buy order; conversely, if the predicted returns are negative, the strategy engages in a



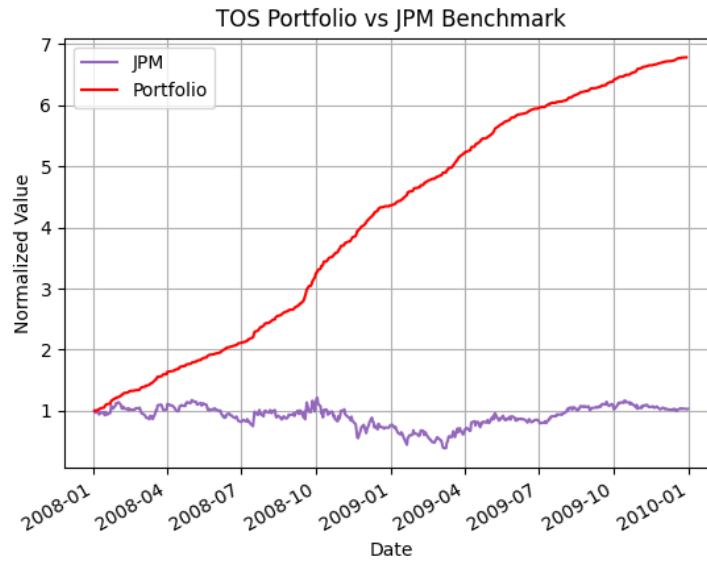
short sale. An important assumption underlying this strategy is the absence of commissions or fees associated with order placements.

The strategy incorporates an automatic reversal mechanism, allowing for the closure of the chosen position on the subsequent day. For instance, if the strategy executes a buy order today, it automatically exits the position by selling the shares the next day. Conversely, if a sell order is executed today, the strategy closes the position by buying back the shares on the following day.

To evaluate or implement the strategy effectively, one must understand its core principles and operational procedures. It involves predicting the directional movement of returns for the next day and taking corresponding long or short positions accordingly. The absence of fees and commissions simplifies the operational aspect, allowing for straightforward execution of buy or sell orders.

Assumptions made in creating this strategy include the accuracy of return predictions, the absence of transaction costs, and the efficiency of the automatic reversal mechanism. Evaluators or implementers should consider the reliability of return predictions, potential impacts of transaction costs in real-world scenarios, and the effectiveness of automatic position reversal in capturing market movements. This strategy framework provides a systematic approach to decision-making based on predicted market movements, which can be assessed

and potentially implemented in various trading contexts. Performance of the strategy is outlined below.



*Figure 6 - Theoretically Optimal Strategy (TOS) performance against JPM benchmark*

Portfolio	STD	Cumulative Rets	Average Rets
JPM	0.041841	0.034572	0.000069
TOS	0.011209	5.781700	0.011540

*Table 1 - Performance metrics of TOS vs JPM benchmark*