# Project 6: Indicators and TOS

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## 1 INDICATORS

This section assesses multiple indicators in the proceeding sub-sections on the stock ticker JPM between January 1, 2008, and December 31, 2009. Some charts may not list the full date range as only dates with data for both the indicator metrics and stock prices are shown.

### 1.1 Golden Death Cross

The Golden Cross or Death Cross is an indicator seeking to capture underlying turns in the market price. The strategy leverages two simple moving averages ("SMA") representing short-term ("ST") 20 – day and long-term ("LT") 50-day average. SMA is calculated as $\sum_{d=0}^{n} Price_d \; / \; n$ with $d$ representing days and $n$ as the total number of days. A buy signal occurs when the ST trends upwards and surpasses the LT; this is referred to as a Golden cross. Conversely, a Death Cross and sell signal happens when the ST trends downwards and then dips below the LT. (Li, 2021)

In figure 1, strong sell signals occurred in the second quarter of 200 when the ST crossed the LT in a downward trend. Further, strong buy signals occurred in the later part of the first quarter in 2009 when the ST overtook the LT.

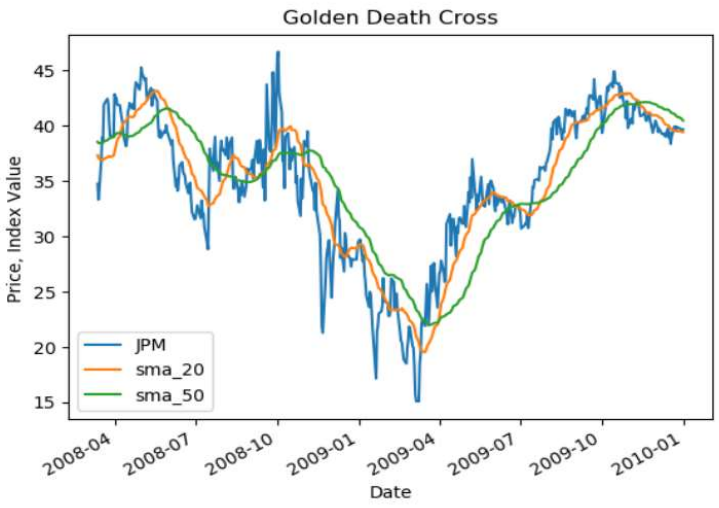

*Figure 1*— JPM stock price compared to simple moving averages of 20 and 50 days for the Golden Cross Strategy.

### 1.2 Exponential Moving Average

Like a simple moving average, an exponential moving average ("EMA") seeks to capture underlying trends of stock price data. However, the EMA does not react as sharply to large swings in the underlying price of the stock. EMA is calculated using Pandas' DataFrame.EMW function. When the stock trends upwards and crosses the EMA, this provides an indication of growth in the stock price and suggests a buy signal. The opposite is true for when the stock price trends down and goes below the EMA.

Figure 2 shows an EMA of a 30-day period. In quarter 4 of 2008, the stock price dives below the EMA and continues to plummet until the later part of quarter 1 in 2009. However, it is interesting to note that during this period, there are multiple false flags.

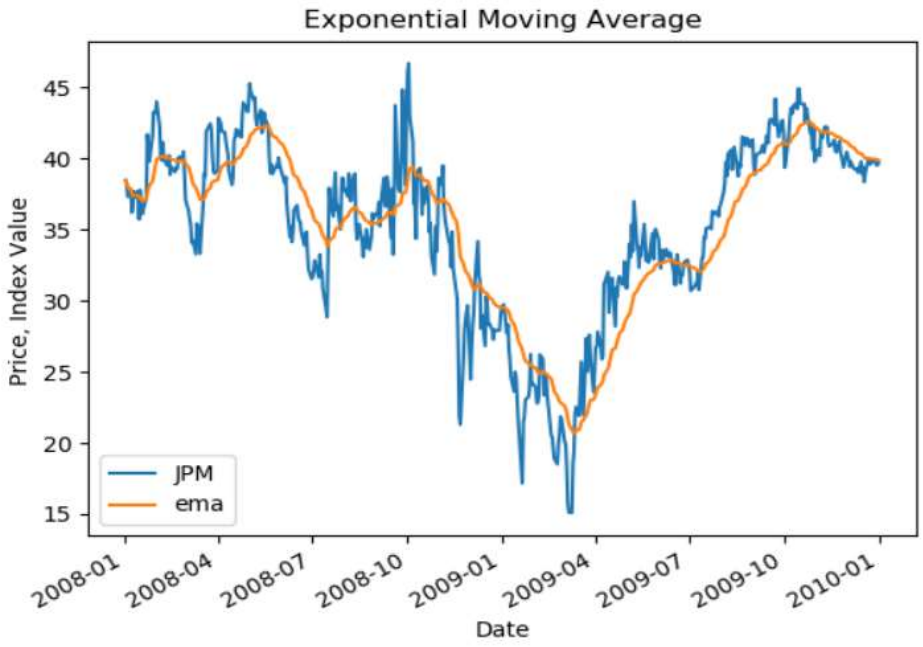


*Figure 2*— JPM stock price compared to a 50-day EMA.

### 1.3 Relative Strength Indicator

The relative strength indicator ("RSI") is a momentum indicator that measures the magnitude of recent price changes. The metric falls between 0 and 100 with upper bounds of 70 and lower bounds of 30. The strategy behind using this metric relies on trend reversals. If the RSI breaches its upper limit, then this signifies that the stock is oversold and will trend downward. This indicates a strong case for selling the stock. (Fernando, 2021) For instance, this is clear in Figure 3 during the second quarter of 2008. The RSI breaches the upper limit and comes back. During this time the stock continues to decline in price as predicted by the indicator. Similarly, the buy signal occurs when the RSI hits the lower limit and then reverses as shown in Figure 3 during the later part of the first quarter for 2009.

The RSI is calculated as $RSI = 100 - 100/(1 + (Average\ Gain/Average\ Loss))$. Average gain represents a rolling average of the last 14 days of positive returns omitting negative returns. Similarly, Average Loss is the rolling average of negative returns.

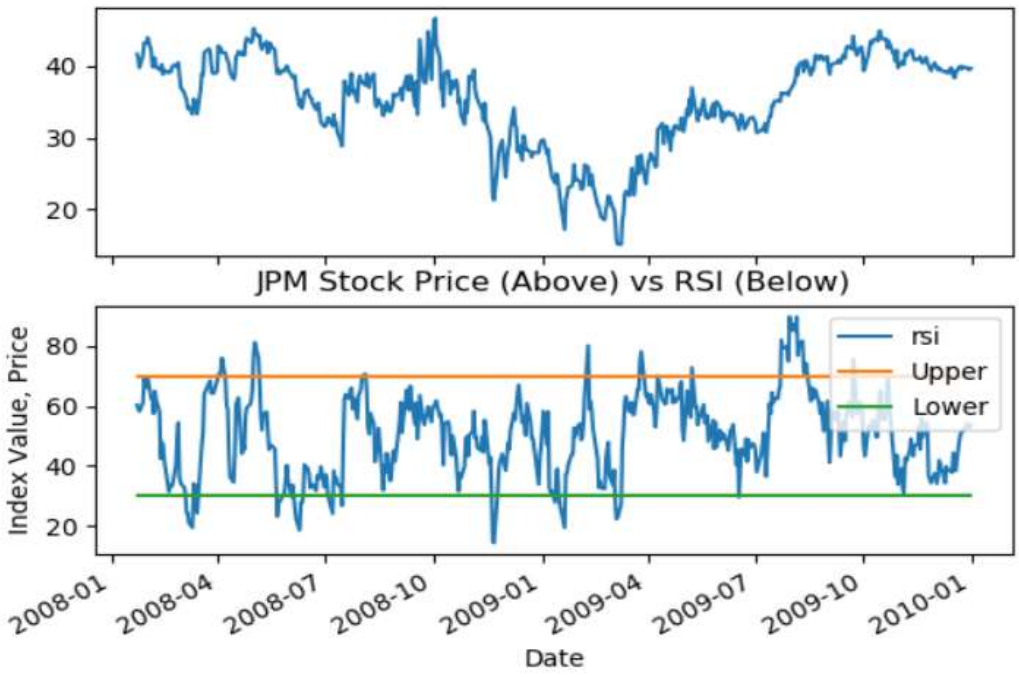


*Figure 3* — JPM stock price over RSI and corresponding RSI upper and lower bounds.

### 1.4 Money Flow Index

The Money Flow Index ("MFI") is an indicator used to identify overbought or oversold signals much like the RSI. However, the MFI leverages more data points like volume, low of the day, and high of the day in an interesting ensemble. Also, the bounds are different with the lower bound being 20 and the upper bound being 80. (Mitchell, 2021)

MFI is calculated in a series of dependent calculations:

$$MFI = 100 - 100/(1 + Money\ Flow\ Ratio)$$

$$Money\ Flow\ Ratio = Sum(14\ day\ positive\ Raw\ Money\ Flow) / Sum(14\ day\ negative\ Raw\ Money\ Flow)$$

$$Raw\ Money\ Flow = Typical\ Price * Volume$$

$$Typical\ Price = (High + Low + Adj\ Close) / 3$$

For the Money Flow Ratio formula, negative Raw Money Flows are calculated as any Raw Money Flows that were the result of negative returns of the Typical Price. If the return for that day was negative, then that day's Raw Money Flow was counted as a negative flow in the 14-day rolling sum calculation. The positive flows work the same way but for of course positive returns and flows.

A buy signal occurs when the MFI reaches the lower bound and reverses. Alternatively, when the MFI reaches the upper bound, this is a sell signal.

Like the RSI, the MFI has some predictive power. In Figure 4 during the second quarter of 2008, MFI crosses the upper bound and indicates that the stock is overbought. However, the number of crosses decreased compared to RSI. MFI personally feels like a stronger indicator of being overbought or sold than RSI.

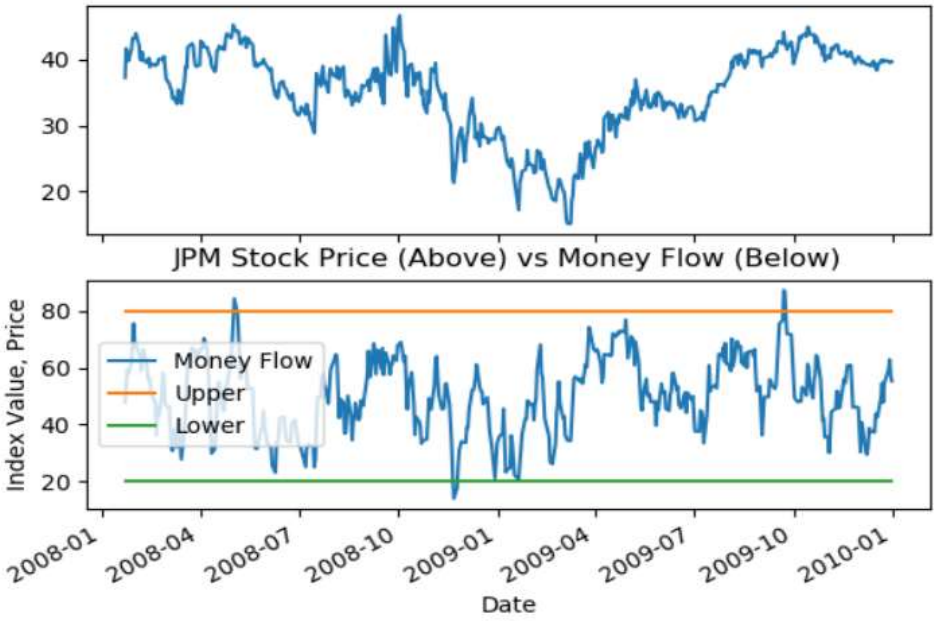


***Figure 4*** — JPM stock price over MFI and corresponding upper and lower bounds.

### 1.5 MACD

Like RSI, the intent of Moving Average Convergence Divergence ("MACD") indicator is to identify whether the market is oversold or overbought. It is comprised of several EMAs whereas RSI is using the ratio of positive and negative returns.

The MACD is the difference between a short-term EMA of 12 days and a long-term EWA of 26 days. Further, an EMA of 9 days on the MACD determines the buy or sell signal once it crosses the MACD line. (Fernando, 2021)

In figure 5, the signal appears to cross the MACD line numerous times but does detect most large price swings. For instance, in the last quarter of 2008, the signal line crosses the MACD line slightly after the stock plumets to its low mid-way through the quarter.

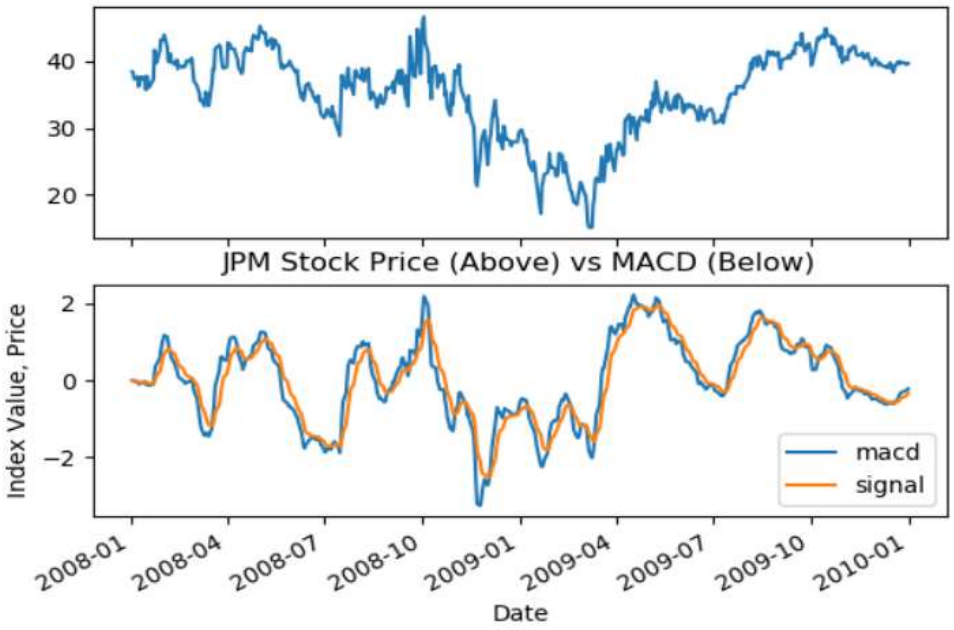


*Figure 5*— JPM stock price over MACD with signal line.

## 2 THEORETICALLY OPTIMAL STRATEGY

The theoretically optimal strategy ("TOS") determines if the next day's returns are positive or negative. If positive, the strategy goes long and performs a buy operation. Otherwise, it performs a short sale. As it is assumed, there are no commissions or fees associated with placing orders. Therefore, the design of the strategy incorporates an automatic reversal of the chosen position on the next day. If a buy occurs, the strategy exits that position the next day by selling the shares. Similarly, if a sell occurs, the next day the strategy will close the position by buying those shares.

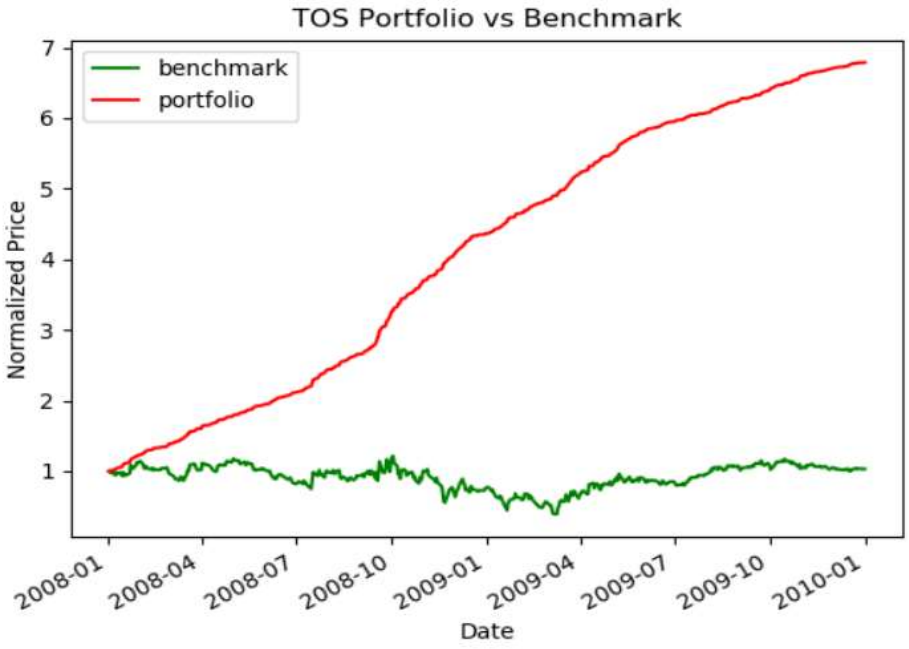


***Figure 6*** — A comparison between the TOS strategy portfolio value to the portfolio value of the Benchmark.

***Table 1*** — Portfolio statistics for the Benchmark and TOS Portfolio returns.

| **Portfolio** | **STD** | **Cumulative Returns** | **Average Returns** |
|---|---|---|---|
| Benchmark | 0.0417 | 0.032 | 0.0001 |
| TOS Portfolio | 0.0112 | 5.7861 | 0.0115 |

## 3 REFERENCES


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4. Mitchell, C. (2021, July 19). *Money flow index - MFI definition and uses*. Investopedia. Retrieved October 25, 2021, from https://www.investopedia.com/terms/m/mfi.asp.