PROJECT 6: INDICATOR EVALUATION

Malcolm Nathaniel Ng Bao Kun
mkun6@gatech.edu

1.1 Indicators

1.1.1 *Exponential Moving Averages (EMAs)*

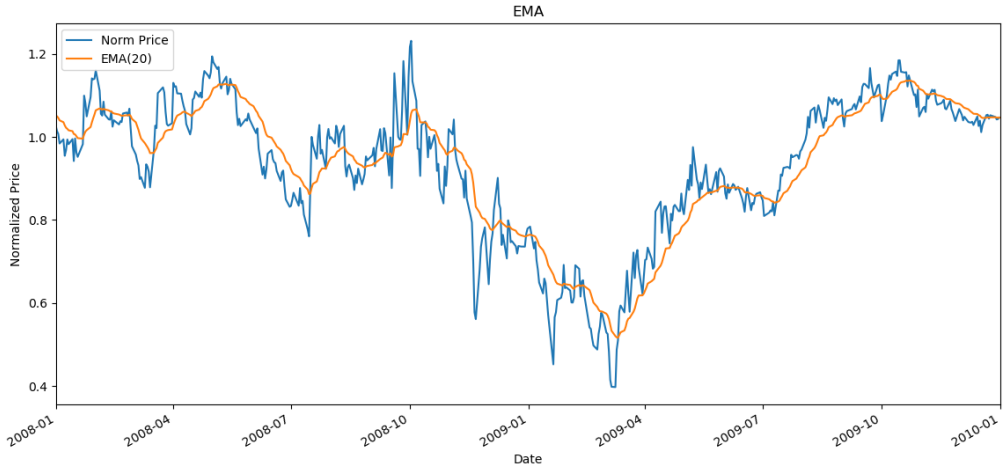

Figure 1— JPM Normalized Price with EMA(20), Time period between Jan 2008 to Dec 2009

In general, moving averages are lagging trend indicators that help define potential support and resistance levels or identify up and down trends. Specifically, EMAs apply weights to recent prices to reduce lagging (Moving averages, 2021).

Given 10-day EMA(10), we first take the simple moving averages (SMAs) for the initial EMA value: *Initial SMA: 10-period sum / 10*

Second, calculate the weighting multiplier

$Multiplier$: $(2\ /\ (Time\ periods\ +\ 1)\ )\ =\ (2\ /\ (10\ +\ 1)\ )\ =\ 0.1818\ (18.18\%)$

Third, calculate the EMA for each day by taking the delta of the initial EMA value and today

EMA: $\{Close\ -\ EMA(previous\ day)\}\ x\ multiplier\ +\ EMA(previous\ day)$

Unlike the SMAs, EMAs are more reactive to new prices so when used with other indicators it can help traders make a confirmation on the trend direction. Some of the possible signals that can be generated is where the current prices crosses through the EMA or when we see strong diversion from the EMA. For buy signals, we can look at points where EMA > prices by a significant number, vice versa for sell signals where prices > EMA. Usually, we can use in conjunction with momentum indicators to generate a stronger signal by looking at the price momentum together with price crossing that EMA. The indicator set up also depends on the time frame trader is looking to trade for short-term 12- and 26-days EMAs while 50- and 200--days EMAs for long-term trend indicators.

1.1.2 *Momentum*

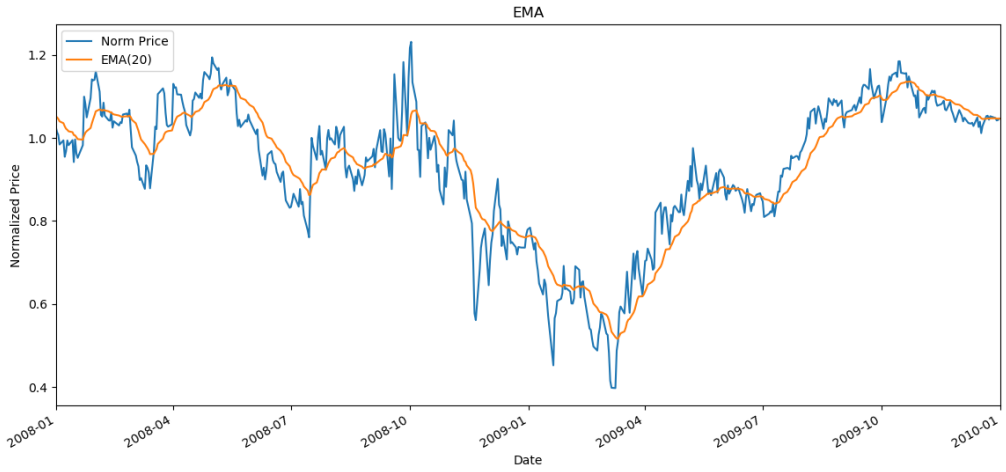

Figure 2a — JPM Normalized Price with EMA(20), Time period between Jan 2008 to Dec 2009

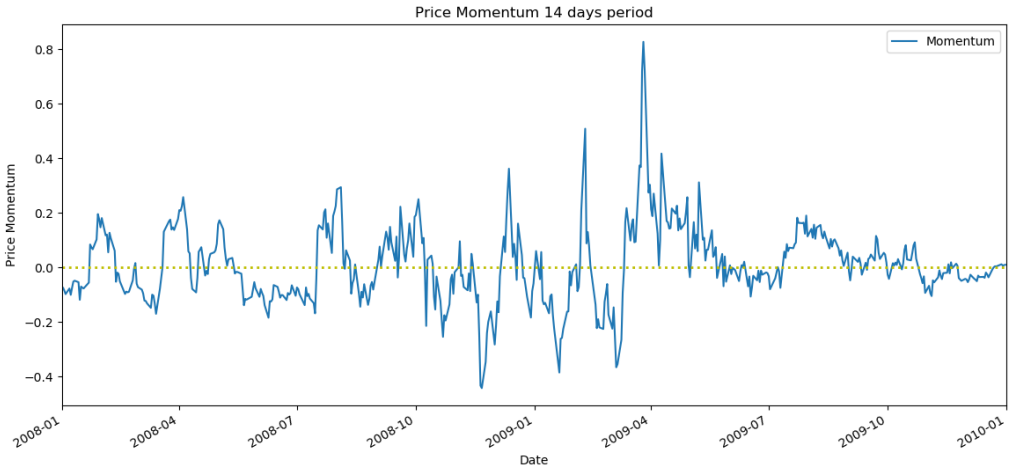

Figure 2b — Price momentum 14 days period plot

Momentum indicators are used to determine the strength or weakness of a stock's price changes (Team, 2021). Using them to help traders easily identify the areas where potential reversals and catch trends early before it forms. It compares the current price with previous price from a number of periods ago as depicted in the following equation (Momentum, 2021).

To calculate momentum, take today*[t]* prices over *N days* minus 1
momentum[t] = (price[t]/price[t-N]) - 1

Momentum indicators are usually used with trend indicators such as SMAs and EMAs. Figure 2b, depicts the movement of price momentum that moves above and below 0. From Figure 2a and 2b, during the time period 2009-03 to 2009-04 we observed a strong rate of change for the price momentum and upward trend line of the EMA. So we can say that when price momentum > 0 together with a strong uptrend direction we can use it for the buy signal likewise when price momentum < 0 with a downtrend direction we can use it for the sell signal. But we have to note that it can take a few more periods above or below the zero line before a trend is affirmative.

1.1.3 *Bollinger™ Bands and %*

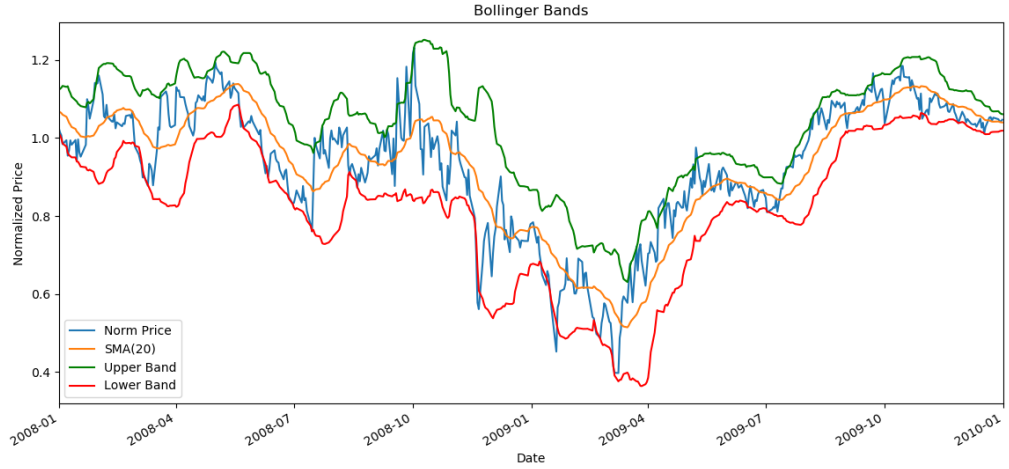

Figure 3a — JPM Normalized Price with SMA(20), Bollinger Bands, Time period between Jan 2008 to Dec 2009

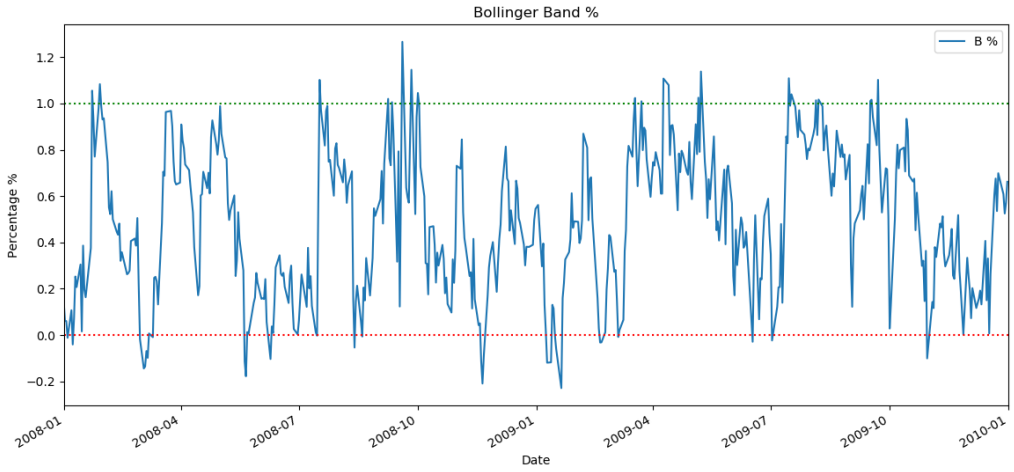

Figure 3b — Bollinger Band %

Bollinger™ Bands (BB) introduce +/- 2 standard deviations (SD) away from a SMA(20) of a stock's price that comprises the upper band and lower band. John Bollinger developed the indicator to generate oversold or overbought signals. It can also be used to determine the strength of the trend (Bollinger, 2021).

To calculate the BB, first is to compute the stock's SMA usually set at 20 periods. The lookback period for the SD is the same as the SMA. The upper band is 2 SD above the SMA line, the lower band is 2 SD below the SMA line.

To calculate $BB\ \% \ = \ (Price \ - \ Lower\ Band)/(Upper\ Band \ - \ Lower\ Band)$

The BB can be used in conjunction with a MACD or RSI indicator for a stronger signal confirmation. To identify a buy signal, a stock can be oversold where BB % < 0 and MACD's turn up and cross above the signal line or RSI < 30. Likewise to identify sell signals, a stock can be overbought where BB % > 1 and the MACD's turn down and cross below the signal line.

1.1.4 *Relative Strength Index*

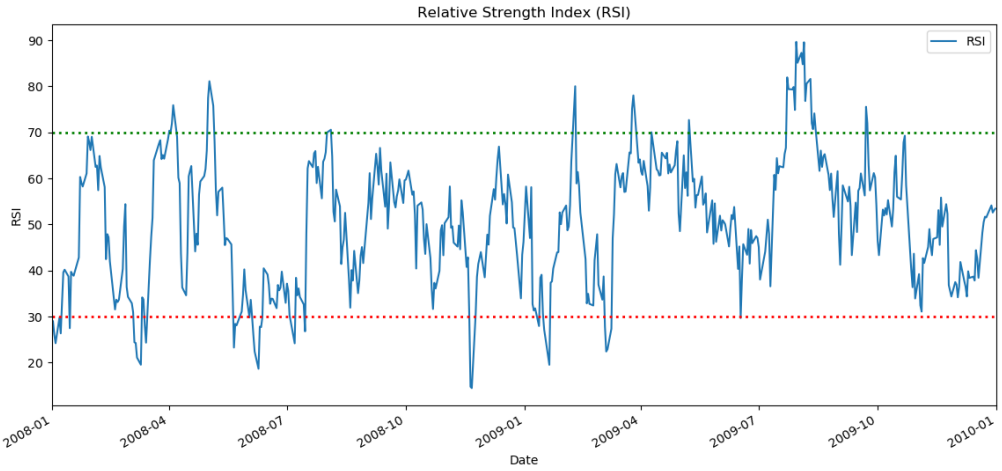

Figure 4— Relative Strength Index

The Relative Strength Index (RSI) is a momentum oscillator that measures the speed and change of price movements between 0 and 100.

RSI calculation has two portions the **RS** and **Average Gain/Loss**. According to Wilder the RSI is calculated based on 14 periods.

To calculate average gain/loss, we calculate the average gain/loss where Sum of Gains(Loss) over the past 14 periods / 14. Then, take Average Gain / Average Loss to compute RS. Finally, $RSI \ = \ 100 \ - \ 100/1 \ + \ RS$

RSI is a rather versatile indicator; it can be used alone or with other trend indicators like the SMAs/EMAs or MACD for divergences signalling or the BB. For buy signal, we can identify opportunities when the RSI < 30 or oversold together with an upward trend from the SMAs/EMAs. For sell, when RSI > 70 or overbrought together with a downward trend from the SMAs/EMAs. Similarly when MACD's turn up and cross above the signal line or RSI < 30 that can also be a buy signal, or MACD's turn down and cross below the signal line or RSI > 70 can be a sell signal (RSI, 2021).

1.1.5 *Moving Average Convergence Divergence*

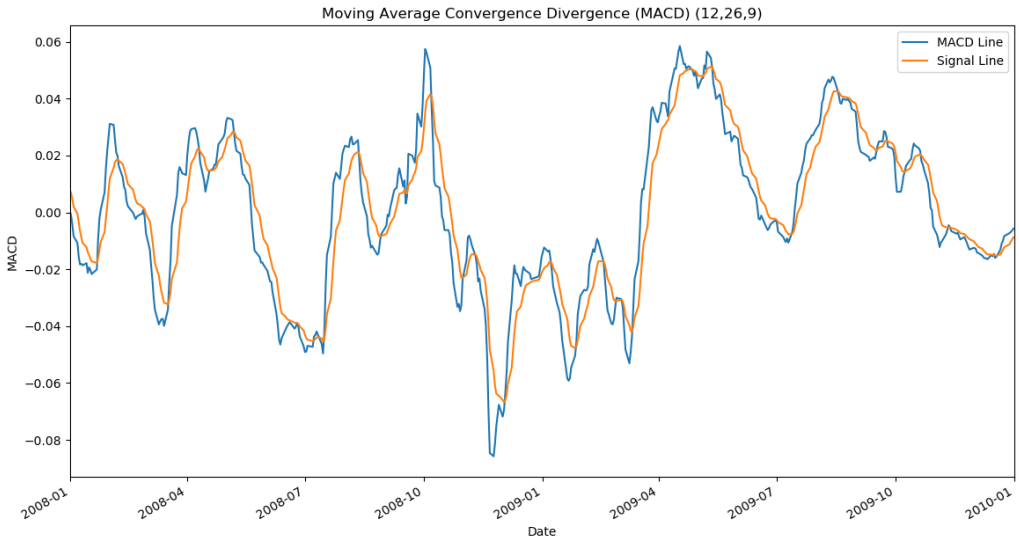

Figure 5 — Moving Average Convergence Divergence

The Moving Average Convergence Divergence oscillator (MACD) is a simple and effective momentum indicator that also can be used for trend following.

To calculate the MACD,

$$MACD\ line\ =\ EMA(12)\ -\ EMA(26)$$

$$Signal\ line\ =\ EMA(9)\ of\ MACD\ line$$

The MACD moves above and below the zero line as the moving averages converge, cross and diverge. As the MACD is unbounded, the RSI is usually used to help identify overbrought and oversold levels. When the MACD is positive that means EMA(12) aboves the EMA(26), also means upside momentum is

increasing, when negative where EMA(12) below the EMA(26) it means downside momentum is increasing. There are three types of signals commonly used such as signal line and centerline crossovers and divergences. For the signal line crossover, a typical buy signal is when the MACD line crosses over the signal line and when the signal line is above the MACD which is a sell signal. For centerline, a typical buy is when the MACD line > 0 and a sell signal when MACD line < 0. For divergences, a buy signal can be identified when the MACD forms a higher low from previous low called the bullish divergence. And to sell when the MACD forms a lower high from previous high called bearish divergence (MACD, 2021).

1.2 Theoretically Optimal Strategy (TOS)

The TOS strategy takes into account that you are allowed to peek forward to future prices. By doing so, we will buy when tomorrow prices will be higher than today prices and sell when tomorrow prices are lower than today prices. The set up of the TOS strategy is straightforward, at any point of time the portfolio holding can only be long + 1000 shares or short -1000 shares or 0 shares. The allowable trading volume can go up to +/- 2000 shares. Given the parameters of a single stock symbol, start date and end date of the trading periods and starting value of the portfolio and 0 commission and price impact during transaction.

For the benchmark setup, a buy of 1000 shares is done on the first day and held till the last trade day.

The machine will generate the trade orders indexed by date, whose values represent trades for each trading day. Which is then translated to a typical order data frame of the single stock respective buy/sell and the share quantity. The trades data frame will contain the trade shares transaction cost of each trade, the holdings dataframe will contain the daily portfolio holdings which is later used to compute the daily portfolio values.

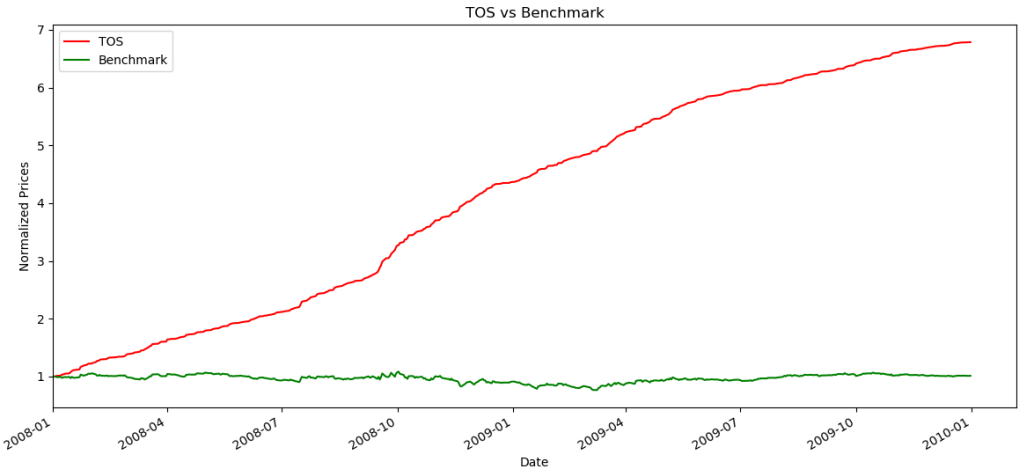

Figure 6— Theoretically Optimal Strategy vs Benchmark

Table 1—TOS and benchmark performance metrics

	TOS	**Benchmark**
Cumulative returns	5.7861	0.0123
Mean of daily returns	0.0038	0.0002
Stdev of daily returns	0.0045	0.0170

2 REFERENCES

1. *Bollinger bands*. Bollinger Bands [ChartSchool]. (n.d.). Retrieved October 25, 2021, from https://school.stockcharts.com/doku.php?id=technical_indicators%3Abollinger_bands.
2. *%B indicator*. %B Indicator [ChartSchool]. (n.d.). Retrieved October 25, 2021, from https://school.stockcharts.com/doku.php?id=technical_indicators%3Abollinger_band_perce.
3. *MACD (moving average convergence/divergence oscillator)*. MACD (Moving Average Convergence/Divergence Oscillator) [ChartSchool]. (n.d.). Retrieved October 25, 2021, from https://school.stockcharts.com/doku.php?id=technical_indicators%3Amoving_average_convergence_divergence_macd.
4. *Momentum indicator (MOM) - technical indicators - indicators and signals*. TradingView. (n.d.). Retrieved October 25, 2021, from https://www.tradingview.com/scripts/momentum/.
5. *Moving averages - simple and exponential*. Moving Averages - Simple and Exponential [ChartSchool]. (n.d.). Retrieved October 25, 2021, from https://school.stockcharts.com/doku.php?id=technical_indicators%3Amoving_averages.
6. *Relative strength index (RSI)*. Relative Strength Index (RSI) [ChartSchool]. (n.d.). Retrieved October 25, 2021, from https://school.stockcharts.com/doku.php?id=technical_indicators%3Arelative_strength_index_rsi.
7. Team, T. I. (2021, June 9). *Momentum indicates stock price strength*. Investopedia. Retrieved October 25, 2021, from https://www.investopedia.com/articles/technical/081501.asp.