

CS 7646 ML4T Project 6 Indicators TOS

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Abstract – This project developed a Theoretically Optimal trading Strategy(TOS) comparing with benchmark trading strategy and selected 5 technical indicators (price/SMA ratio, Bollinger Bands, Momentum, price/EMA ratio, and MACD) as functions that operates on Python data frame. The report describes the 5 trading strategies and compares the TOS with benchmark trading.

INDICATORS:

1.1 Price/SMA ratio

The SMA (simple moving average) of the stock is the mean value of the stock's prices in the past several days. In the example I provided, I chose 5 days SMA. The formular of 5 day's SMA is:

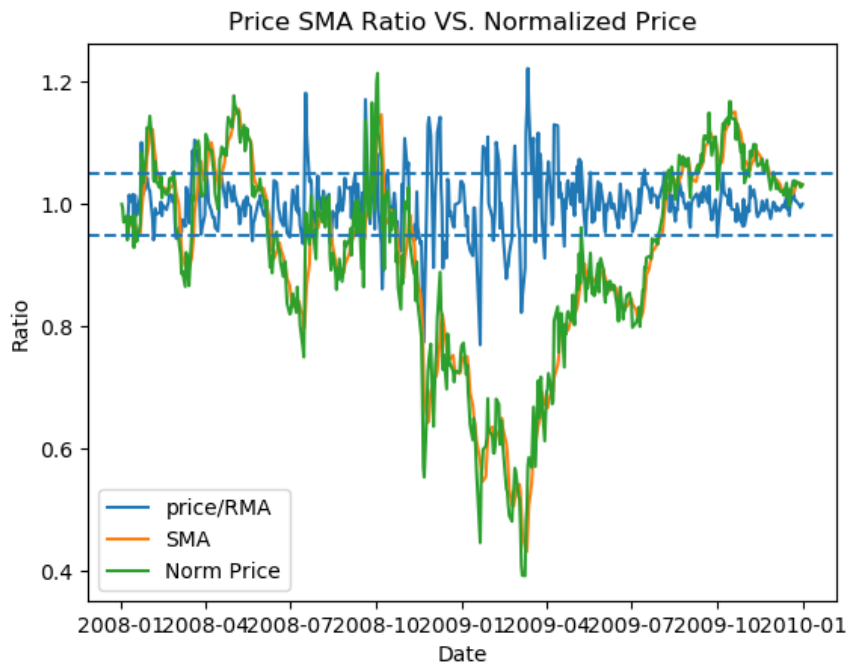
$$\text{SMA}(5) = \text{Sum}(\text{price in the last 5 days})/5$$

SMA is a simple and useful technical indicator. It is often used together with the Price, and the indicator is price/SMA ratio. The price/SMA ratio can be calculated using below formular:

$$\text{Price/SMA ratio} = \text{stock price} / \text{SMA}(n)$$

In my case I chose $n = 5$. How this indicator could provide rules in trading, is if price/SMA ratio > 1.05 , it means the stock is overbought. Thus we should decrease the holding or short the stock. When price/SMA ratio < 0.95 , it often means oversold and we should signal buying to the stock.

Below chart shows JPM's price/SMA ratio, and the normalized SMA, and the normalized stock price. When price/SMA ratio is higher than 1.05, we can signal a sold/short. When the price/SMA ratio is lower than 1.05, we can signal a buy/long.



1.2 Bollinger Band

Bollinger Band is implemented with SMA. We need to add/ take out 2 standard deviations of the prices from the original SMA line. The Formular of the upper and lower Bollinger Band is shown below:

Upper Bollinger band(n) = $SMA(n) + 2 * std(n \text{ day's price})$

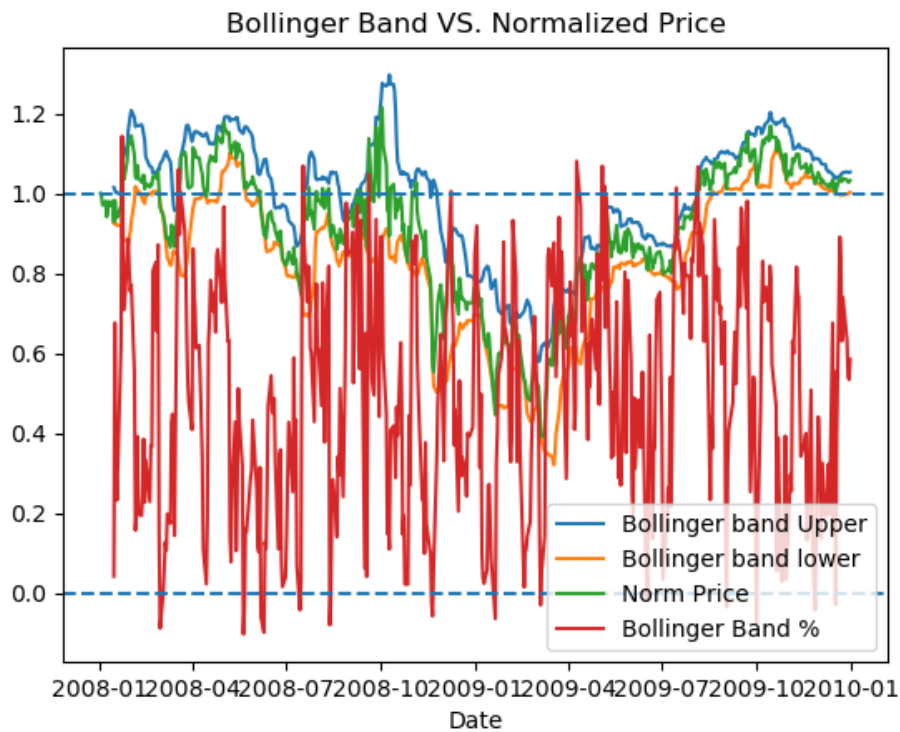
Lower Bollinger band(n) = $SMA(n) - 2 * std(n \text{ day's price})$

The Bollinger Band percentage is a useful signal to see if the stock is overbought or over sold:

Bollinger Band Percentage = $(\text{stock price} - \text{lower Bollinger Band}) / (\text{Upper Bollinger Band} - \text{Lower Bollinger band})$

If the Bollinger Band % > 1, it indicates overbought, and we should signal a sell. If Bollinger Band % < 0, it indicates oversold and we should signal a buy.

Below chart shows Bollinger Band ratio. I choose 10 day's SMA to calculate. The upper/lower Bollinger Band and the Bollinger Band % is shown below:

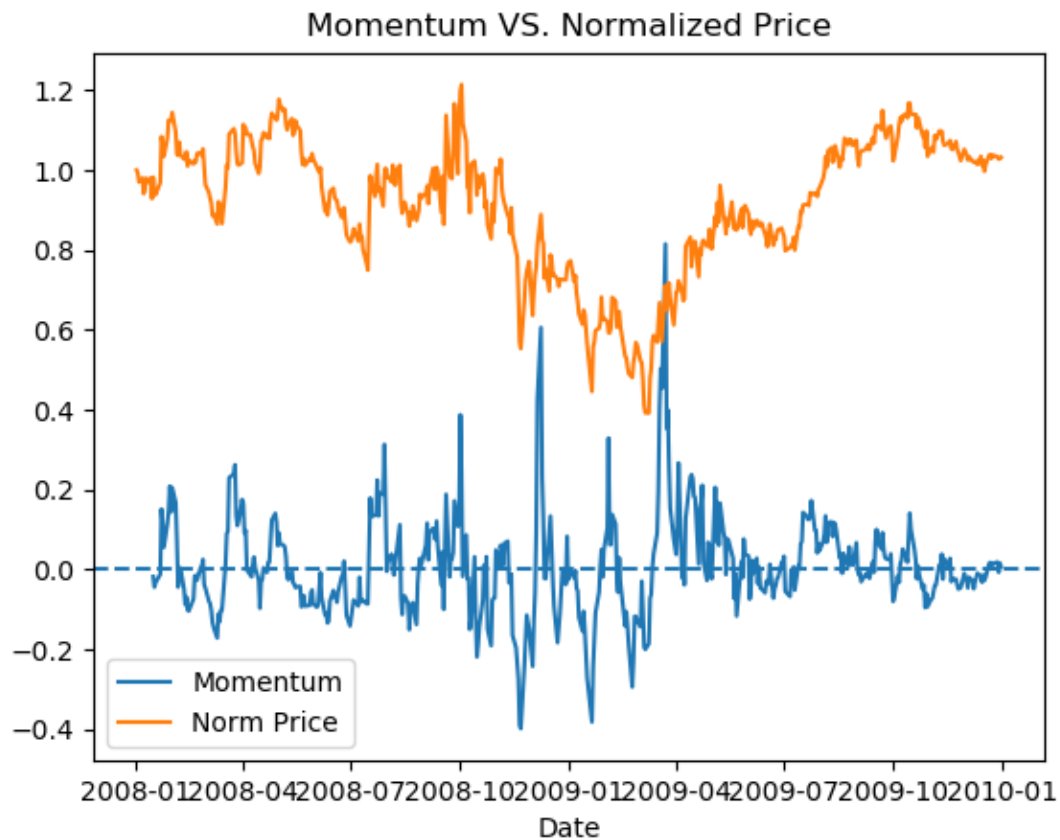


1.3 Momentum

The formular of Momentum is below:

$$\text{Momentum}[t] = (\text{price}[t] / \text{price}[t - n]) - 1$$

Momentum neglect the volatility of the stock price changes, but shows an overall trend in the past n day's period. If momentum > 0 , it means stock prices has been going higher, and we assume the trend will continue, and vise versa. If momentum > 0 , we can signal a buy. Below figure shows the normalized stock price and momentum of 10 days:



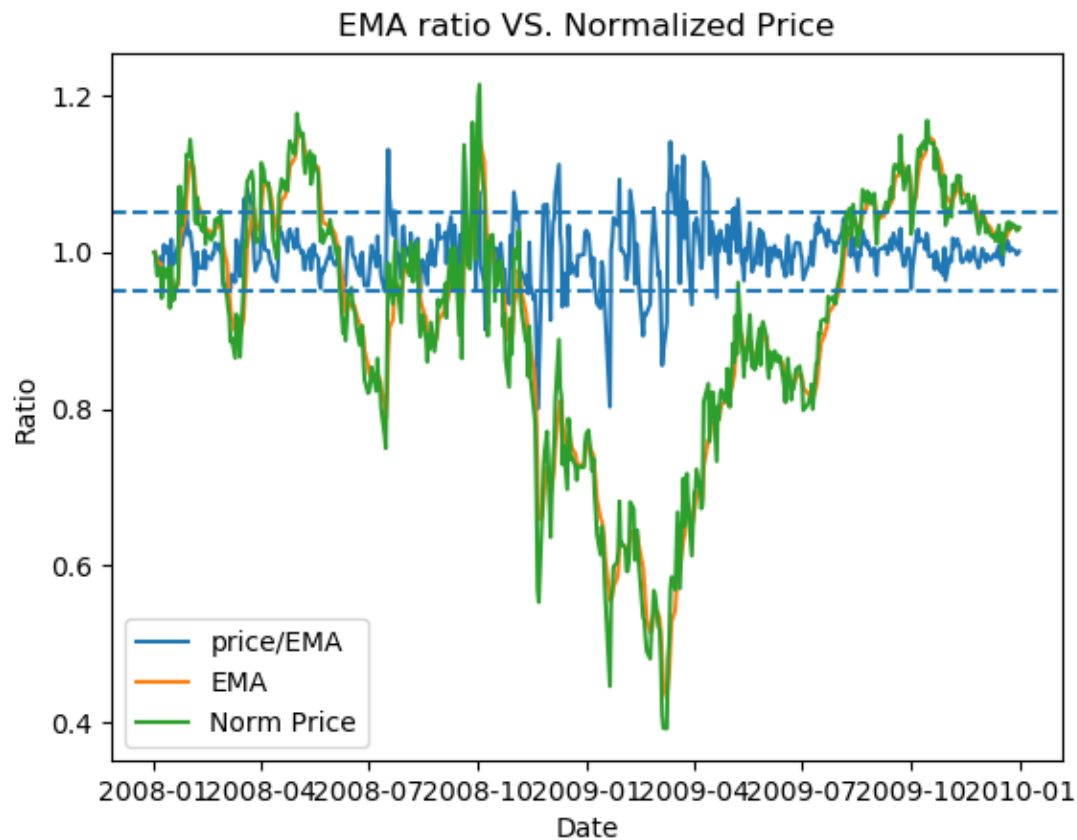
1.4 EMA

EMA means Exponential Moving Average. EMA is similar to the SMA that we introduced before, but gives more weight to the price of today. The EMA formular of n day's period is:

$$\text{EMA} = \text{price} * \text{multiplier} + \text{EMA}(\text{precious day}) * (1 - \text{multiplier})$$

$$\text{Multiplier} = 2/(1 + n)$$

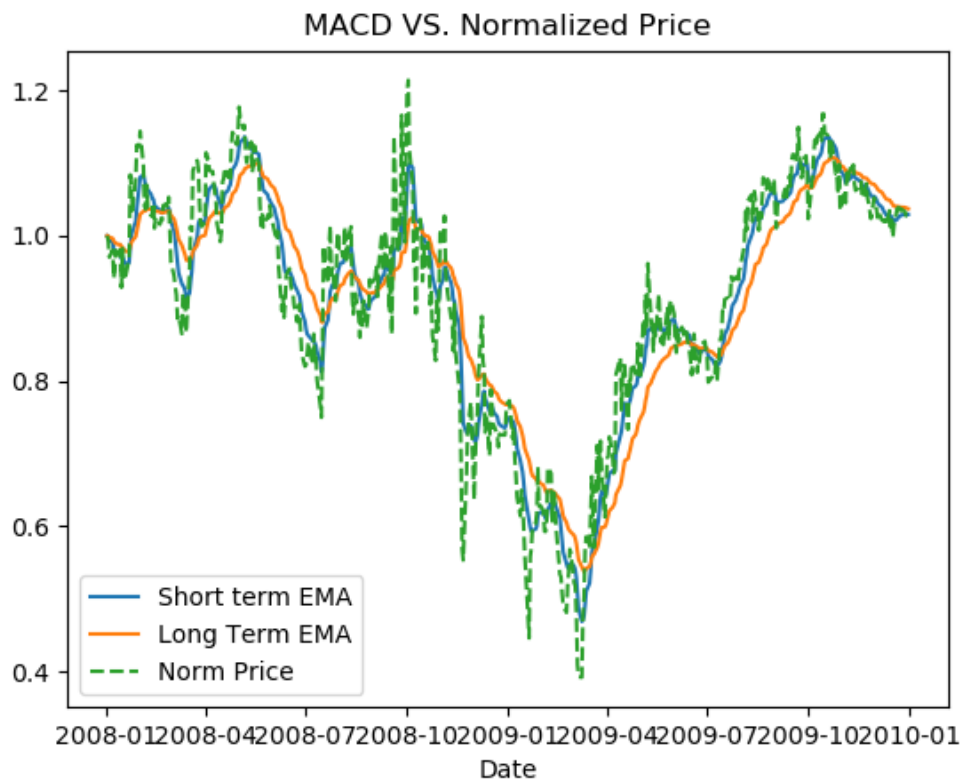
To use EMA as an indicator, we can introduce the Price/ EMA ratio, and when price/EMA ratio is higher than 1.05, we can signal a sold/short. When the price/EMA ratio is lower than 1.05, we can signal a buy/long. Below chart shows 5 day's EMA and price/EMA ratio:



1.4 MACD

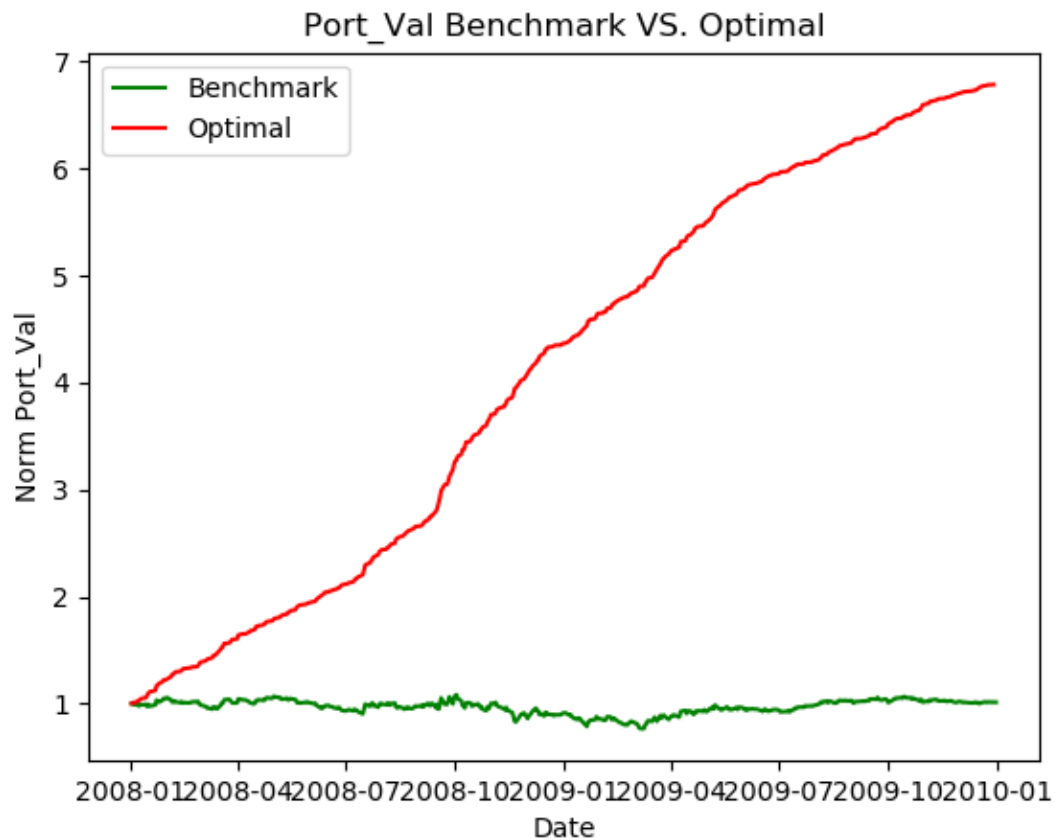
MACD is implemented with EMA in different time period. We introduce a short-term EMA and a long-term EMA. Short term EMA can refer to a stock's trend in a short-term time period, while long term EMA refers to a stock's trend in a long time period. If the short term EMA goes from higher than long term, and cross to lower than long term, it normally means the short term trend of the stock has changed, and we need to sell the stock. When short term EMA starts from lower than long term, but cross to higher, it means we can signal a buy.

Below chart shows 10 days' EMA VS. 30 day's EMA:



THEORETICALLY OPTIMAL STRATEGY:

The Theoretically optimal trading strategy was developed following below logic: comparing today's and tomorrow's stock price, and if today's price > tomorrow's stock price, the strategy will short the stock. This strategy assumes we can see the future. If today's price < tomorrow's price, the strategy longs the stock. If the price does not change, then there's no change to holdings. In this project the net holdings are constrained to 1000 shares and -1000 shares. The strategy also ensures the holdings are legal. The trading amount will not exceed 2000 shares. There would only be 3 legal holding status, +1000, -1000, and 0. The benchmark trading strategy starts with \$100,000 cash, investing in 1000 shares of JPM, and holding the position through the time interval.



The chart above shows the normalized portfolio value Benchmark trading strategy (shown as green) VS. Optimal trading strategy. The Optimal strategy performs much better than just holding the position. Of course the TOS is not practical as one cannot foresee the future.

Below are the necessary statistics comparing TOS with the benchmark:

	TOS	Benchmark
Cumulative Returns	0.0123	5.7844
Std of Daily Return	0.0046	0.0170
Mean of Daily Return	0.0038	0.0002

