Report 6: Indicator Evaluation

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Abstract—In this report, I'm touching the base of trading strategies by introducing 5 indicators and build a Theoretically Optimal Strategy.

1 INTRODUCTION

The indicators I'm introducing are Simple Moving Average (SMA), Bollinger Bands, Momentum, Exponential Moving Average (EMA), and Moving Average Convergence Divergence (MACD). They all have different strength and weakness, we would want to use them together to make trading decisions in real life.

I'm also building a theoretically optimal trading strategy, which assume we know the future and could make the most profit per tomorrow price. There are no commission fees and no impact, so there is no fee to make an order. I can solely trade based on tomorrow price: if price goes up tomorrow, buy today; if price goes down tomorrow, sell/short today.

2 INDICATORS

I will introduce each of the 5 indicators in this section: Simple Moving Average (SMA), Bollinger Bands, Momentum, Exponential Moving Average (EMA), and Moving Average Convergence Divergence (MACD).

2.1 Simple Moving Average - SMA

Simple Moving Average (SMA) is a rolling average over a period of time (20 days in this report). The formula is:

$$SMA = \frac{A_1 + A_2 + ... + A_n}{n}$$

To use SMA as an action indicator, we will need to compute a Price/SMA ratio. When the ratio > 1.05, it gives a signal of sell/short the stock; when the ratio < 0.95, it tells we should consider buy the stock. In plot below, we can see that there are 3 buying opportunities between 2008-10 and 2009-04.
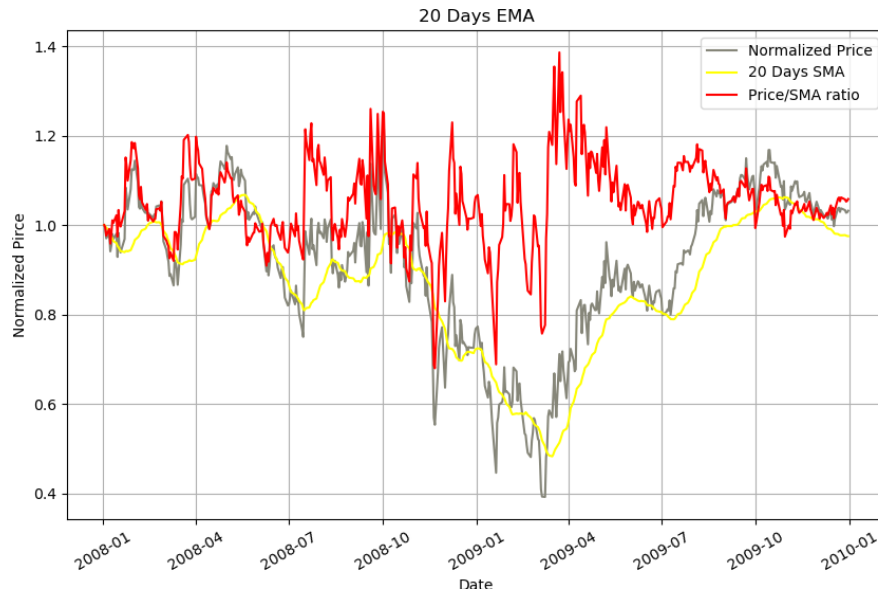
2.2 Bollinger Bands

Bollinger Bands are bands that are 2 standard deviations away from the SMA (also using 20 days). Basically, when the price went up high enough (say 2 standard deviations from the average price), it tells that it's good time to sell since price is more likely to drop in the future. Similarly, when price dropped low enough (say 2 standard deviations from the average price), it's a buying opportunity since price is more likely to go up in the future. When price crosses above the upper band, we should sell/short; when price crosses below the lower band, we should buy.

We will use Bollinger Band Percent (BB %B) to indicate buy/sell signal. BB %B shows price relative to Bollinger Bands. The way to compute BB %B is (price - lower band) / (upper band - lower band). When BB %B > 1, it means the price is above the upper band, we should sell/short; when BB %B < 0, the price is below the lower band, we should buy.
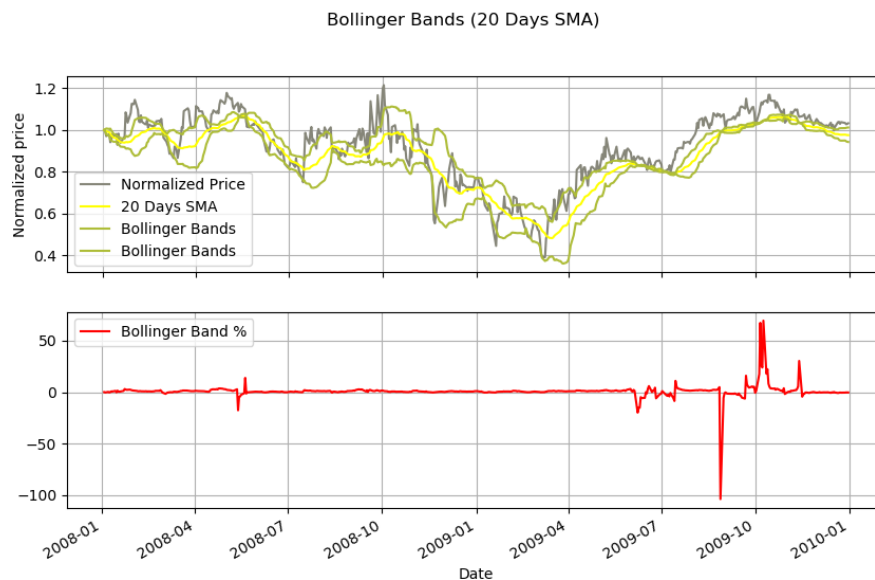
2.3 Momentum

Momentum is the trend of a stock's price. A common knowledge is that if a stock price went up in the past, it tends to keep going up, the same applies to downward trend (momentum). There are 2 ways to calculate momentum, I'm using the price at end of period minus the price at beginning of period to compute momentum in this report. I'm also using 20 days period to find the momentum of the stocks. Positive Momentum gives a signal to buy, and negative Momentum gives a signal to sell. In plot below, it tells that there are good buying opportunities between 2008-10 - 2009-04 which matches with our conclusion using SMA.
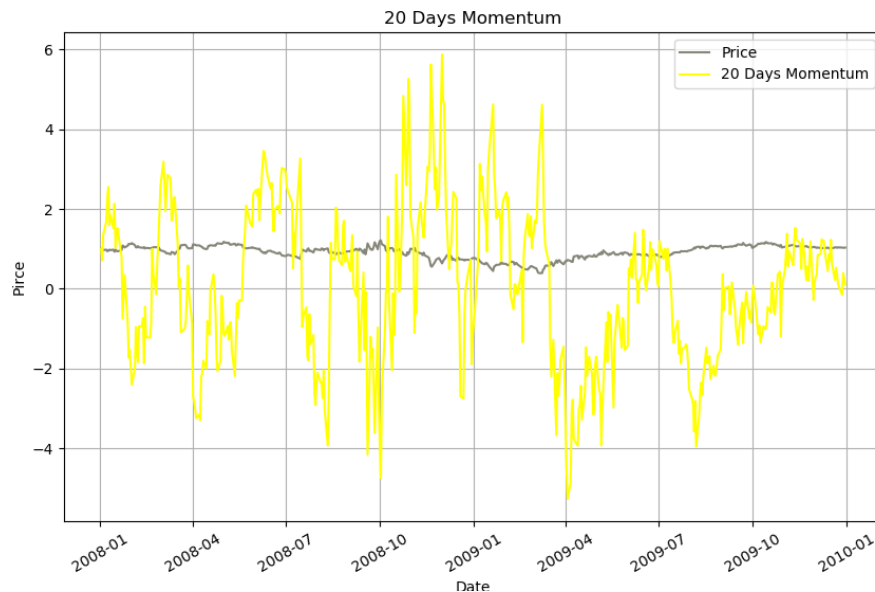
2.4 Exponential Moving Average - EMA

Exponential moving average (EMA), also called Exponentially Weighted Moving Average, is a type of moving average that places a greater weight on the most recent price. EMA reacts more on most recent price changes than SMA which reacts equally on all historic price within the time period (20 days in this report). This means that EMA reflects more quickly to trend than SMA. EMA is easy to compute and easy to read. The current EMA = price x multiplier + previous day EMA x (1 - multiplier). The Multiplier represents the weight of the price, it uses a Smoothing factor to achieve the goal:

$$\frac{\text{Smoothing}}{1 + \text{Days}}$$

The Smoothing factor normally is 2, and Days is the number of days in the time period. In this report, I'm using a 20 days period. Like SMA, the buying signal for EMA is when price is lower than EMA and selling signal is when price is greater than EMA.
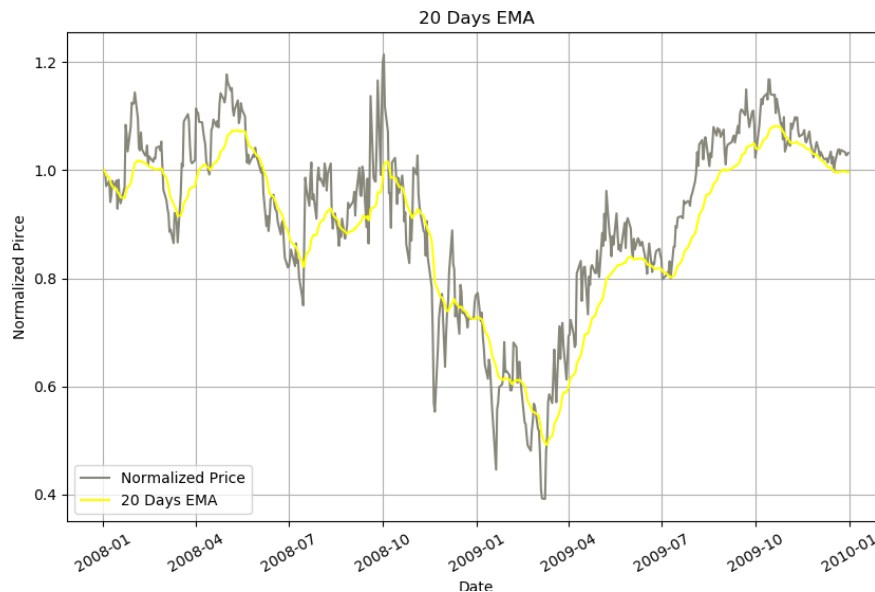
2.5 Moving Average Convergence Divergence - MACD

"Moving average convergence divergence (MACD) is a trend-following momentum indicator that shows the relationship between two moving averages of a security's price."[1] The calculation for MACD is 12-period EMA - 26-period EMA. And use a 9-period EMA line of the MACD as a signal line, MACD crosses above the signal line gives a buy signal, and sell/short when it's below the signal line.
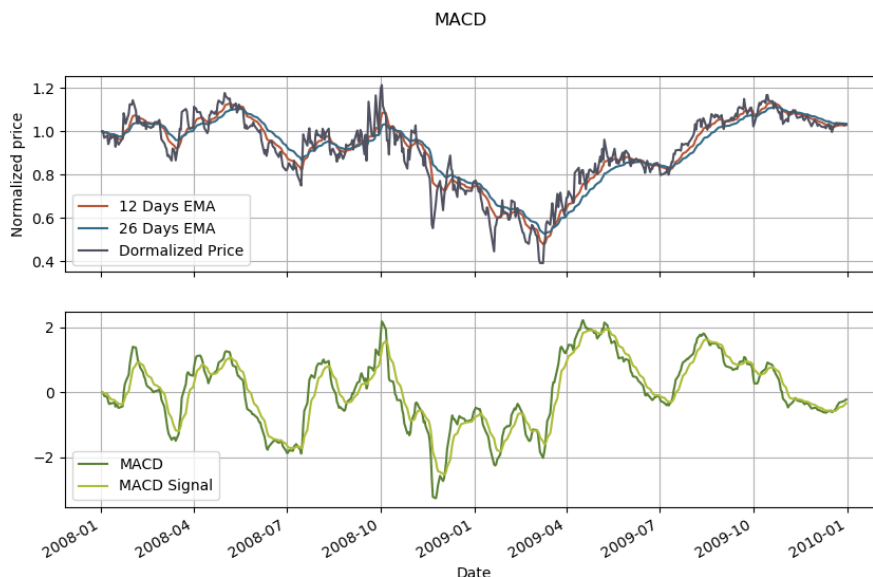
3 THEORETICALLY OPTIMAL STRATEGY

Our assumption is no commission fees and no impact (means we can trade as many times as wanted), caps are 1000 or -1000 shares. My strategy is just look at tomorrow price and if price goes up tomorrow, go long 1000 shares today; if price drop tomorrow, go short -1000 shares today. This makes the maximum profit since we are making profit from each price change.

3.1 Stats

As the stats shown below, theoretically, we could have much higher return and much lower risk than the benchmark(go long 1000 share of JMP on day one and hold it for the entire time period).

```
[Benchmark]
Cumulative return: 0.0123
Stdev of daily returns: 0.0170
Mean of daily returns: 0.0002


[TheoreticallyOptimalStrategy]
Cumulative return: 5.7861
Stdev of daily returns: 0.0045
Mean of daily returns: 0.0038
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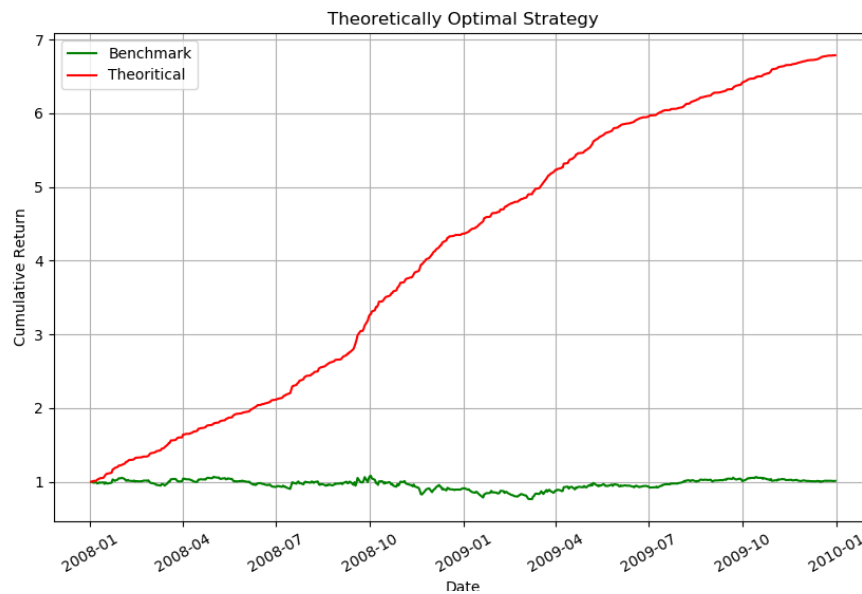
3.2 Plot

In plot below, I have the cumulative return plot for theoretically optimal strategy vs. the benchmark. We can see in the plot that theoretically we can make much more profit than just holding 1000 shares of stock.

4 SUMMARY

The indicators all work differently, some are easy to read even for just eye bowling, some requires more math and need other tools to take a closer look.

REFERENCES

[1] J. Fernando, "Moving Average Convergence Divergence (MACD)," *investopedia*, Apr. 2021. [Online]. Available: https://www.investopedia.com/terms/m/macd.asp.