Give me a sign
Project 6: Indicators/TOS

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***Abstract*—This paper is a practical review of some technical indicators, mainly Golden/Death Cross, Bollinger Bands %, Rate of Change, Moving Average Convergence/Divergence, and Stochastic Oscillators. There will also be a small section on what is the Theoretically Optimal Strategy if the future was a known thing.**

1 THEORETICALLY OPTIMAL STRATEGY

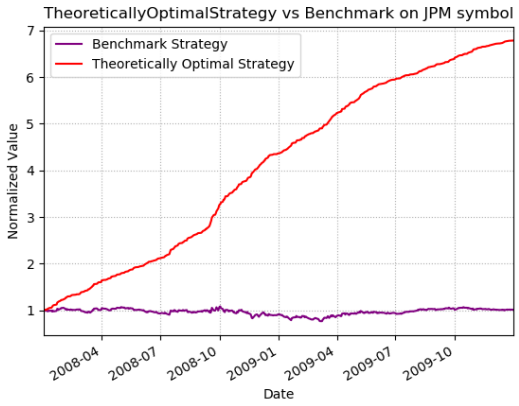

***Figure 1*—Theoretically Optimal Strategy**

In the Theoretically Optimal Strategy, the main assumption is precognition of next day events. The main constraints are that on any given day, the maximum amount of shares held or shorted should not exceed 1000. Trades can only be done in increments of 1000.
With these guidelines, the Theoretically Optimal Strategy is as follows:

- If tomorrow's price is more than today's price, proceed to buy stocks until the maximum holdings are met
- If tomorrow's price is less than today's price, proceed to sell (and short if possible) stocks until the maximum holdings are met

This effectively ends up being on the first day either a buy or sell of 1000, and every subsequent day a buy or sell of 2000 to maximize profit.

To test this strategy, it was evaluated against a benchmark. A portfolio starting with $100,000 cash, investing in 1,000 shares of JPM, and holding that position. No commission or impact is considered in this experiment.
Below is a comparative table with performance metrics. The comparison is done against the benchmark which

	Portfolio	Benchmark
Cum Return	5.786100	0.012300
Avg. Daily Ret	0.003817	0.000168
Std. Daily Ret	0.004548	0.017004
Sharpe Ratio	13.322770	0.156918

Table 1—Portfolio vs Benchmark Performance Metrics

2 TECHNICAL INDICATOR

2.1 Golden/Death Cross

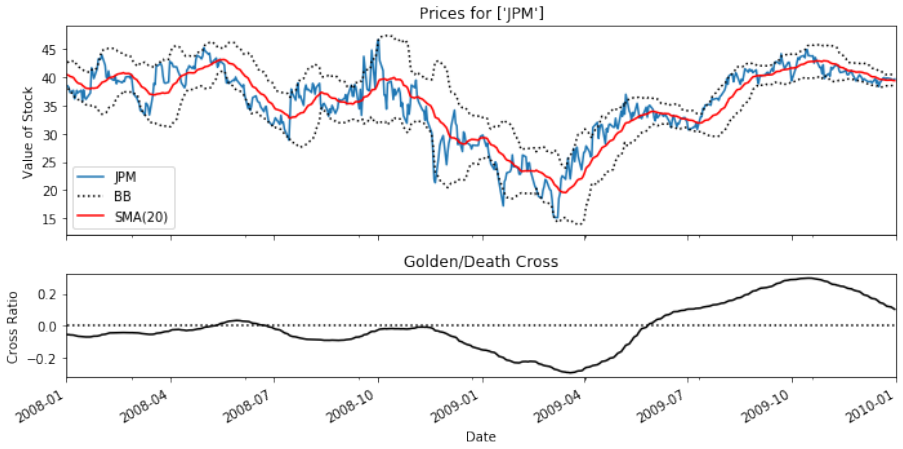

Figure 2—Cross Indicator

In order to discuss the cross indicator, a discussion on Moving Averages must first be had.
Moving averages are trend-following/lagging indicators, returning the average over a specific window in time, most commonly 50-days and 200-days windows. (Fernando, 2023) The simplest moving average is called Simple Moving Average, which just takes the arithmetic mean of the window. $SMA = \frac{A_1+A_2+A_3+...+A_n}{n}$
Golden/Death crosses are effectively the crossing of short (50-days) and long (200-days) moving averages. (Hayes, 2023) Golden crosses are when the short-

term moving average rises above the long-term moving average. Death crosses are the opposite of Golden crosses.
Since short term averages are faster in their "response", when they cross the slower average, it may suggest that the stock is on the rise (for golden crosses) suggesting a buy, or a decline (for death crosses) suggesting a sell.(Hill, 2021)
This indicator is not fool proof (none are[1]), and as such, it is worth using it in conjunction with other indicators or strategies, such as the ones listed by Al Hill in his article in tradingsim.com. In the graph[2] presented, around May '08, there is a potential crossing, but is quickly reversed one month later. It's not until May '09 does the cross show a longer period of profit.

2.2 Bollinger Bands

Building off of Moving Averages, Bollinger Bands envelope the moving average by an upper (+) and lower (-) "band" of n times the standard deviation (to measure volitility) of prices over the same window as the moving average. Normally this window is 20-days and n is 2. Bollinger bands help determine whether prices are high or low on a relative basis (, n.d.).

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moving_average(prices,20) +/- (2 x moving_std(prices,20))
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These bands are used in two ways:

- The Squeeze: "When the bands come close together, constricting the moving average. This signals a period of low volatility and is considered by traders to be a potential sign of future increased volatility and possible trading opportunities."(Hayes, 2023)
- The Breakout: When a price goes above or below these bands, it's usually a significant event. When the price recrosses back into the envelope, it is a signal to buy (when crossing from underneath) or sell (when crossing from up top).

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1 This sentiment of not using indicators stand alone will be echoed among any indicator looked at, whether in this paper or not. Since this topic deals with the uncertain future using certain mathematical principles, certain indicators may be sensitive to swings or may not provide enough information on their own.

2 Note, the plot shows the cross ratio, which is $= \frac{MA_{short}}{MA_{long}} - 1$, where 0 means both are equal, greater than 0 means short is more than long, and less than 0 means long is more than short

3 Note, the plot shows the Bollinger Band %, which is $= \frac{Price - BB_{Lower}}{BB_{Upper} - BB_{Lower}}$, where 0 price = lower band and 1 is price = upper band. The upper and lower bands are represented by dashed lines moving horizontally from both 0 and 1.

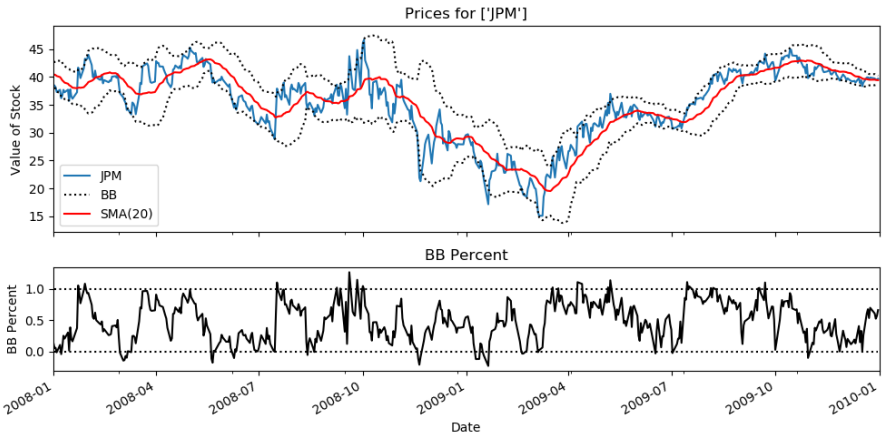

Figure 3—Bollinger Band Indicator[3]

Now, Bollinger Bands are not a standalone indicator. It is designed to give a sense of a prices volatility. "John Bollinger suggests using them with two or three other non-correlated indicators that provide more direct market signals and indicators based on different types of data. Some of his favored technical techniques are moving average divergence/convergence (MACD) and relative strength index (RSI)."(Hayes, 2023)

It is worth mentioning that depending on the frequency of the data and the windows set, several signals maybe indicated over a short time. In the graph above, there are 5 different buy signals Sept '08 alone. Depending on other indicators, this can be a great time to buy or a sign of unstability in price.

2.3 Rate of Change

The rate of change (ROC) is the speed at which a variable, or in this case, price, changes over a specific period of time. It's effectively the percent change of a price.

$$ROC = \frac{Price_t - Price_{t-n}}{Price_{t-n}}$$

It is considered as an important basic momentum indicator, because "a security with high momentum, or one that has a positive ROC, normally outperforms the market in the short term. Conversely, a security that has a ROC that falls below its moving average, or one that has a low or negative ROC is likely to decline in value and can be seen as a sell signal to investors" (Chen, 2022). It's a solid metric that demonstrates the prices speed and strength of a stocks movement.

It is worth mentioning that too sharp (50%+) of an increase may suggest short-

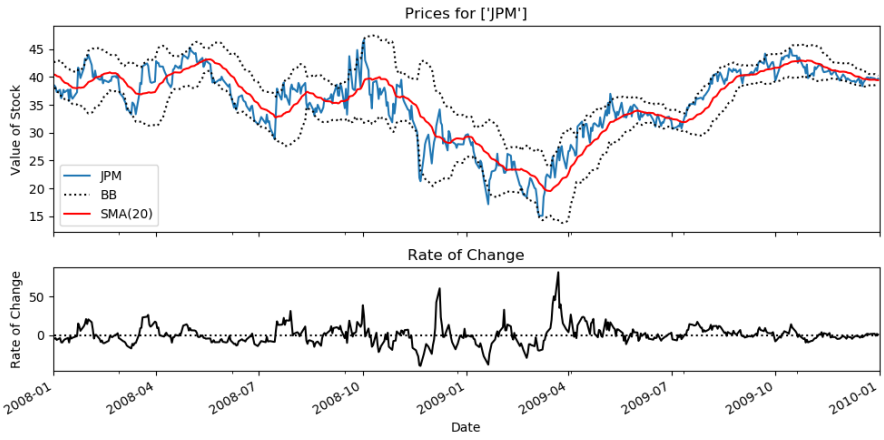

Figure 4—Rate of Change Indicator

term unsustainability/bubble.
However, like other oscillators, it is prone to false reads due to sudden changes in price from one window to the next. This is maybe why ROC may not be good as a stand alone indicator, and is often used alongside other indicators like overbought/oversold markers, moving averages of price, and moving average of ROC (, n.d.).

2.4 Moving Average Convergence Divergence (MACD)

This indicator takes two Exponential Moving Average (normally 12-day and 26-day windows), converting them into a momentum oscillator (, n.d.) and demonstrating the relationship between them (Dolan, 2024). There is the signal[4] line, which is the EMA of the MACD. Finally, the histogram, which is MACD - Signal, is used to represent current selling pressures in the marketplace.(West, 2023)

- Calculate the price EMA for 12-day (fast) and 26-day (slow) window
- MACD = Price_EMA_12 - Price_EMA_26. MACD is considered as the slow line.
- Signal = MACD_EMA_9. Signal is considered the fast line
- Histogram = MACD - Signal

"The MACD can be interpreted in many different ways, each using the MACD line, the signal line, and the histogram values differently,"(West, 2023) which

4 Sometimes called the trigger to reduce confusion since both the MACD and Signal/Trigger lines can both be referred to as singals.

gives the MACD it's versatility. When talking about crossovers, the MACD on it's own is a lagging indicator. It's position against the center can indicate a uptrend or downtrend, and it's position with the signal line can be seen as a buy (when above) or sell (when below). When looking at the histogram, it's considered as a lead indicator and are considered as a representation of momentum. As a lead indicator, it can often give an early warning that the uptrend/downtrend is on a reversal path (, n.d.).

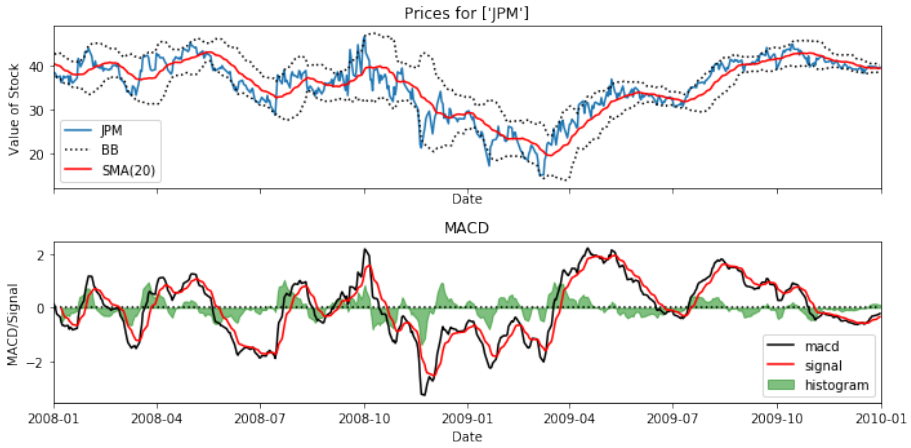

Figure 5—Moving Average Convergence Divergence Indicator

In the chart above, the histogram has sometimes shown early signs that the stock will be on the rise/fall (eg. May '08 or March '09). Usually these early warnings are followed by a crossing of the MACD and Signal lines, which indicate good times to buy.

Another use case is comparing the MACD with the Price action. If the price action and MACD are not moving together, this may suggest a possible reversal and something to monitor closely.

As discussed prior, it's usually better to use this indicator alongside other indicators to have more data in hand to make better decisions, such as RSI and SMA (Theophanopoulos, 2023).

2.5 Stochastic Oscillators

The Stochastic Oscillators is a momentum indicator comparing the closing price to the range of the prices over a window. It utilizes that bound oscillator (a fast line bound between 0-100) and averages it out over a slower window (Hayes, 2023). These values would be compared to thresholds (20-80 or 30-70) marked as

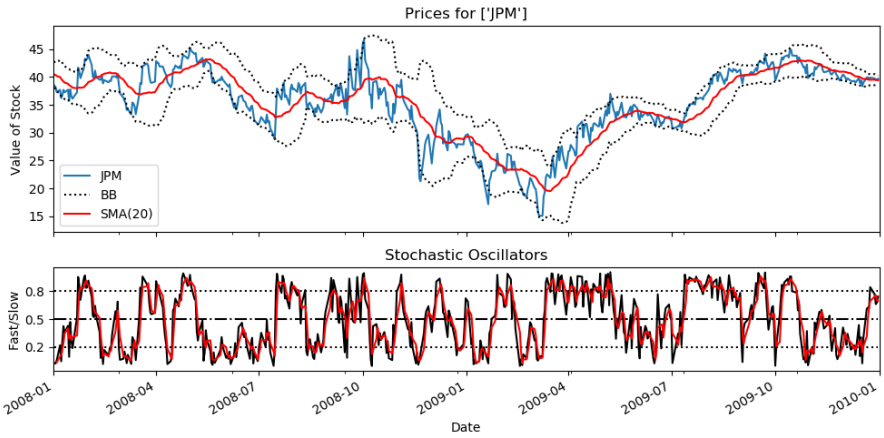

Figure 6—Stochastic Oscillators Indicator

the oversold/overbought lines (West, 2023).

$SO_{Fast} = \frac{Close - Low_{window}}{High_{window} - Low_{window}}$

$SO_{Slow} = SO_{Fast}.MovingAverage$

Using these four lines, the algorithm for using Stochastic Oscillators is (West, 2023):

```
if fast and slow above overbought line and fast < slow:
    sell
else if fast and slow below oversold line and fast > slow:
    buy
else:
    do nothing
```

As before, best to use this indicator with others to maximize information and potential gains. Some good indicators to use along side Stochastic Oscillators are moving average crossovers, moving average convergence divergence (MACD), and relative strength index (RSI).(Maverick, 2024)

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