

CS7637: Project 6: Indicator Evaluation

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Abstract—In this report, there are two main objectives. One is to create a theoretically optimal set of trades to maximize returns of a particular stock, with foresight of future price changes. The second is to describe several indicators which will give trade signals.

1 INTRODUCTION

This report aims to create the basis for stock trading by first describing several stock indicators, their implementations, as well as how they could be used to create trading signals. The next section will describe a theoretically optimal trading strategy. This strategy will have the foresight of future stock price, and will come up with optimal trades for a specific period. These trades will be compared to a benchmark portfolio which simply holds a set number of shares for the time period observed.

2 INDICATOR DESCRIPTIONS

There are five indicators which will be described in this section, which includes the Relative Strength Index (RSI), Bollinger Bands, Stochastic Indicator, Money Flow Index (MFI), and Commodity Channel Index (CCI).

2.1 Relative Strength Index (RSI)

The RSI is a type of momentum indicator which measures both positive and negative price movements over a moving window. The calculation of the RSI is shown below. Values above 70 are considered to be overbought, whereas values below 30 are considered to be over sold. Traders would use this indicator to buy when the RSI is below 30, and sell when RSI is above 70.

$$RSI = 100 - \frac{100}{1 + \frac{avg\ gain}{avg\ loss}}$$

This indicator was implemented in python, with two inputs – a dataframe of stock price over a certain period, as well as a window period. The average gain of the stock over the previous window period is calculated by finding the sum of all positive daily returns over the window period, divided by the size of the window period. The same is done for the average loss, and both values are used in the formula above. Below is a graph of the RSI values for the JPM stock over the period of 2008 to the end of 2009. The graph shows several buying and selling opportunities when the RSI passes the red bounds. For example, there was a selling opportunity at around May, 2008, as indicated by the RSI. Likewise, the stock fell shortly after. However, there are some false signals, as was the case in August, 2009, where the RSI indicated a selling opportunity, but the stock price remained relatively stable.

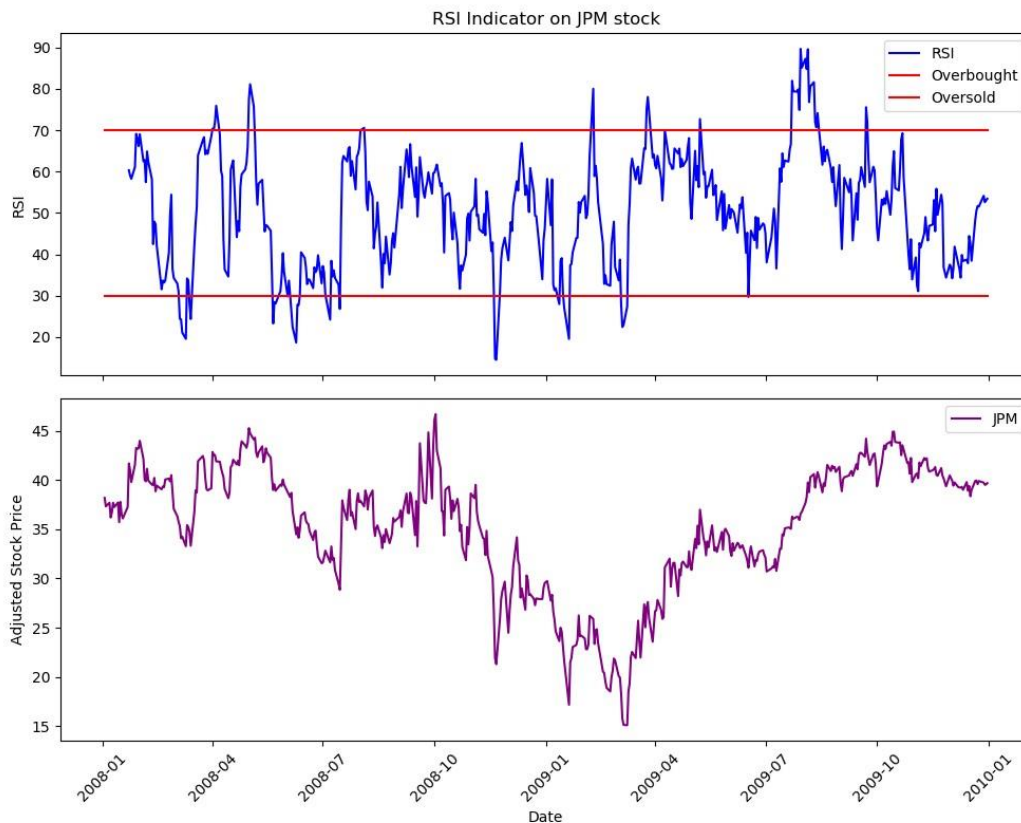


Figure 1—RSI Indicator on JPM stock

2.2 Bollinger Bands

Bollinger bands are a type of moving average indicator, like the RSI, which constructs two bands which indicate whether the stock is oversold or overbought. The implementation starts by first creating a simple moving average of the stock price, then finding the standard deviation using the points at each window. The bands are constructed to be two standard deviations from the simple moving average line. When the stock price crosses the Bollinger band, and re-enters the band, it indicates either a buying or selling signal. If the price re-enters from the bottom line, it is a buying signal, and vice versa. In addition to the bands, there are also two statistics which can be used alone to identify trading signals – the Bollinger value as well as the BBP. The formulas for both are given below.

$$B = \frac{\text{price} - \text{SMA}}{2 * SD} ; \text{BBP} = \frac{\text{price} - \text{lower band}}{\text{upper band} - \text{lower band}}$$

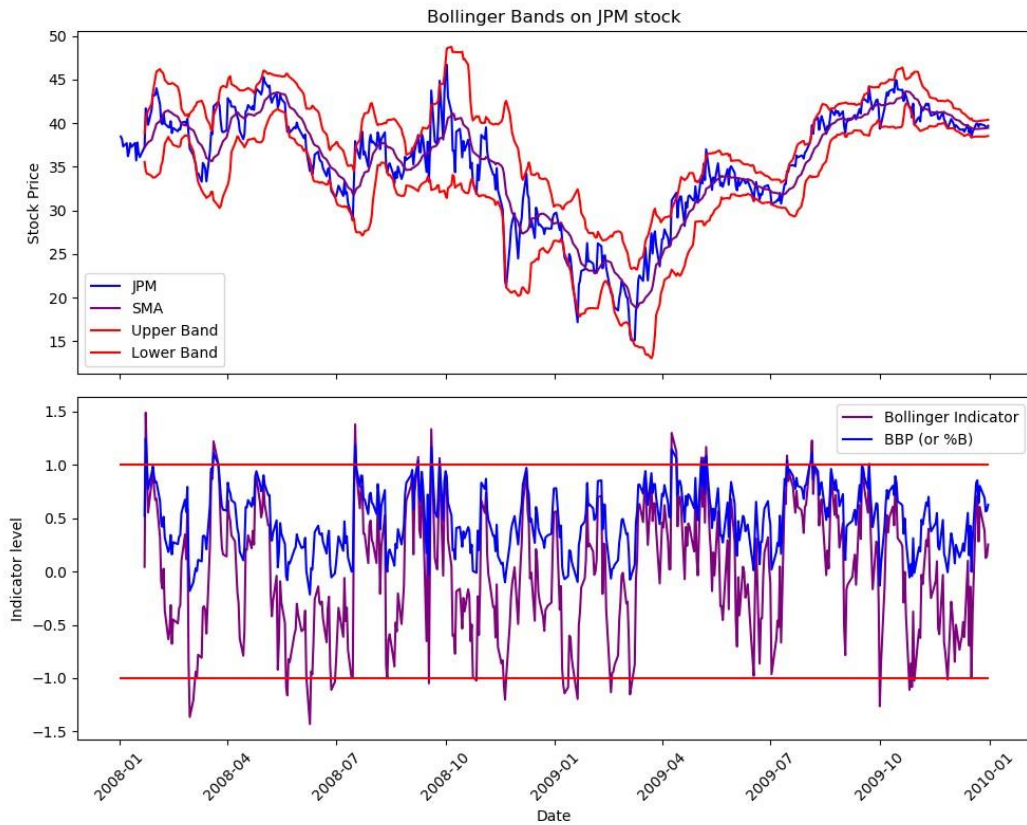


Figure 2 — Bollinger Bands on JPM stock

2.3 Stochastic Indicator/Oscillator

The Stochastic Indicator is another momentum based indicator which compares the current stock price to the highest and lowest price traded in the moving window. It includes two different curves - %K and %D. The formula for %K is given below.

$$\%K = \frac{\text{price} - LOW_{14}}{HIGH_{14} - LOW_{14}}$$

LOW_{14} = Lowest price traded in the moving window

$HIGH_{14}$ = Highest price traded in the moving window

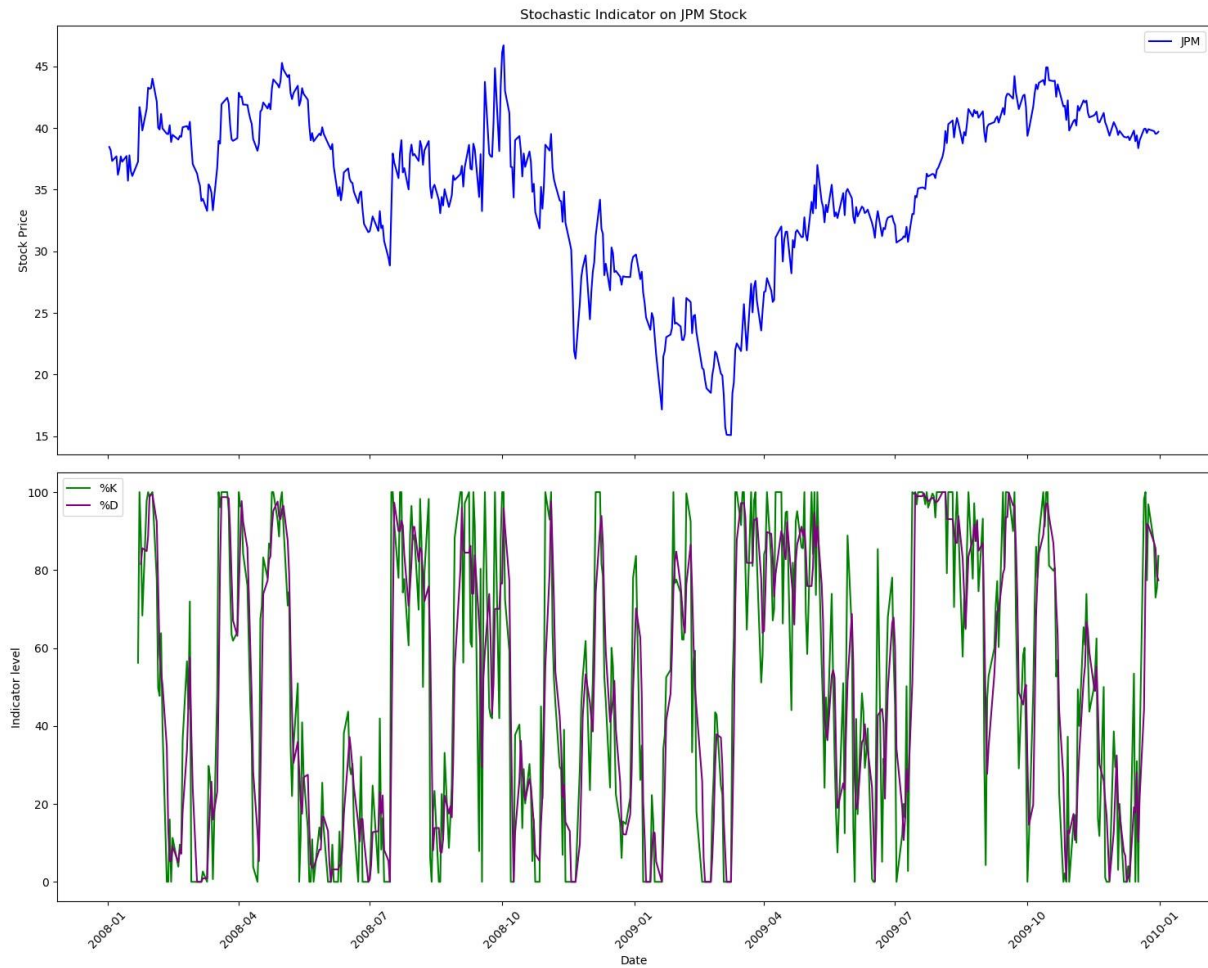


Figure 3— Stochastic Indicator on JPM stock

The %D value is found by applying the SMA to %K. For this function, there are two window sizes, one for %K and one for %D, with the window for %D usually smaller. Trading opportunities usually arise when the indicators go above 80 (which presents a selling opportunity) or go below 20 (which presents a buying opportunity). When the %K indicator passes through the %D indicator, it usually indicates a reversal of the current trend. The graph above shows the indicator over the same period for JPM stock. This is case, the windows for %K and %D would need to be adjusted to match the trading horizon. This indicator would be more interpretable over shorter periods of time.

2.4 Money Flow Index (MFI)

The money flow index is a technical indicator which uses price and volume changes to identify overbought and oversold stocks. Values range from 0 to 100, with values above 80 indicating overbuying and values below 20 indicating over-selling. The formulas for the index are shown below.

$$MFI = 100 - \frac{100}{1 + MFR}$$

$$MFR = \frac{\text{positive RMF over window}}{\text{negative RMF over window}}$$

$$RMF = \text{Typical Price} * \text{Volume}$$

$$\text{Typical Price} = \frac{\text{High} + \text{Low} + \text{Close}}{3}$$

The first step is to obtain the typical price. This required obtaining the close, high and low price for each trading day using the `get_data()` function from `util.py`. To obtain the positive and negative raw money flows (RMF), use of the `np.sign()` and `.diff()` functions are necessary to create a Boolean mask of stock prices that increase from the previous trading day. The positive and negative RMF values can then be found over the window, and the MFR and MFI can be calculated using the formulas above. The MFI indicates whether a divergence is about to occur. For example, if the stock price is rising, but at the same time the MFI begins to decrease below 80, it may be a signal that the price is about to fall, and that a selling opportunity is about to rise. The plot below shows this. For example, at around May, 2008, the MFI dipped below 80, and so did the stock. The same is true for the second MFI excursion below 20, where the increasing price resulted in a buying opportunity.

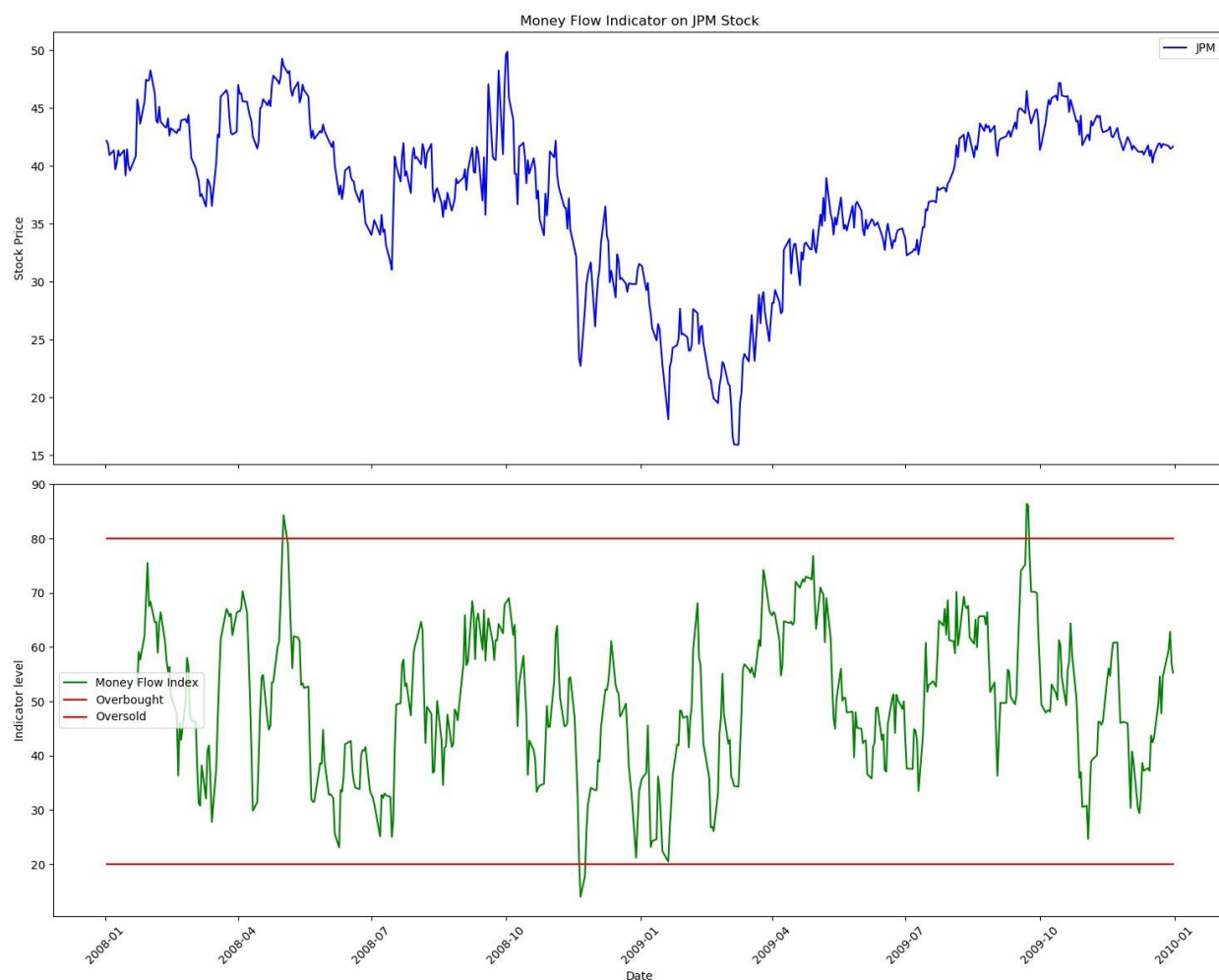


Figure 4— Money Flow Indicator on JPM stock

2.5 Commodity Channel Index (CCI)

The CCI is an indicator that is similar to the Bollinger bands, but has a slightly different calculation. Like the Bollinger bands, it measures the deviation from the SMA, however, instead of using two standard deviations, it uses 0.15 of the mean deviation. In addition, instead of the closing price, it uses the typical price. Usually, values above 100 signal an upward trend in price, and vice versa for values that go below -100. If the CCI then rises or falls into the 100 or -100 threshold, it signals a buying or selling opportunity similar to Bollinger bands. The formulas to calculate the CCI are given below.

$$CCI = \frac{Typical\ Price - SMA}{0.015 * Mean\ Deviation}$$

$$Mean\ Deviation = \sum_1^{window\ size} abs(Typical\ Price - SMA) \div window\ size$$

In the graph below, at around September, 2008, there was a large excursion of the CCI value (up to almost 300), and as expected, the price fell shortly after.

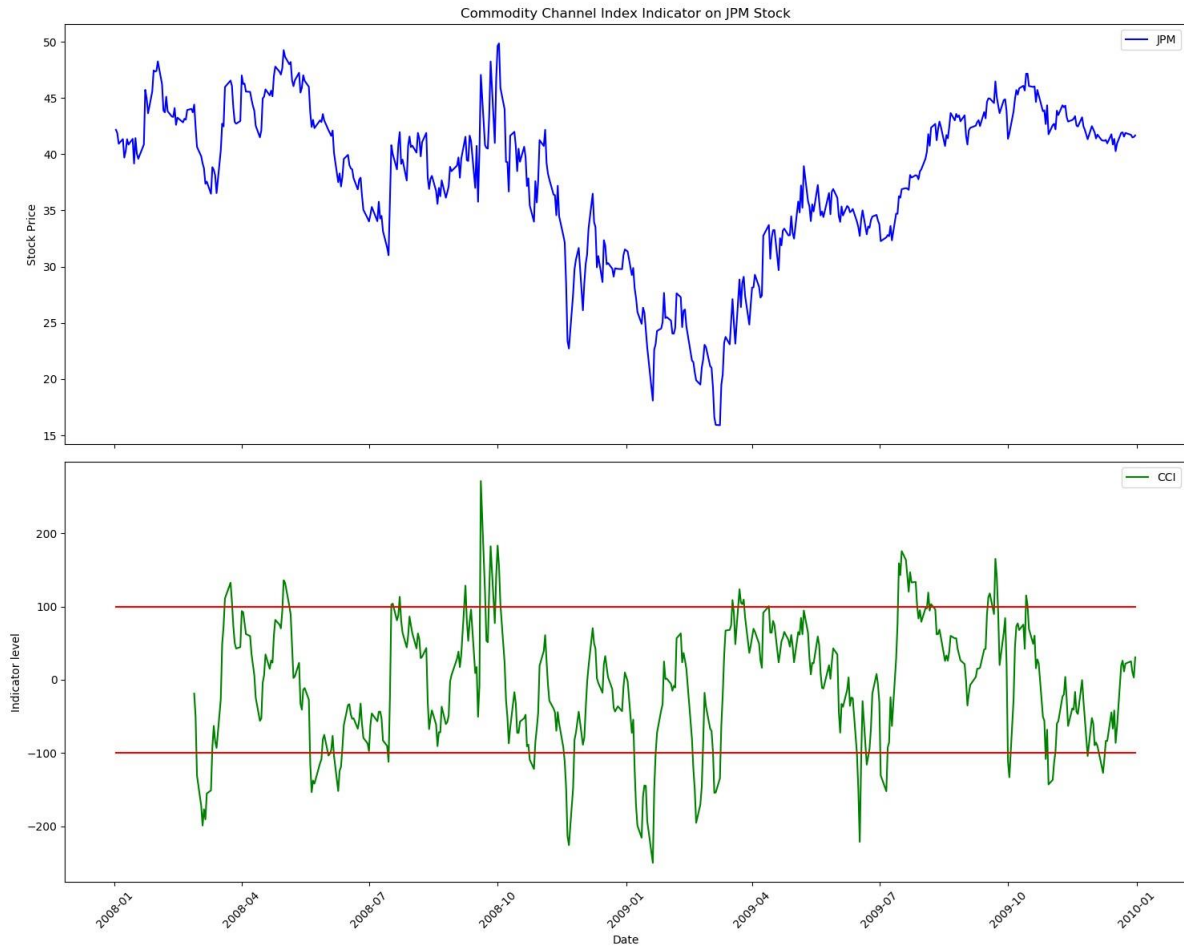


Figure 5— Commodity Channel Index on JPM Stock

3 THEORETICALLY OPTIMAL STRATEGY

Two portfolios are created, one which will be the theoretically optimal strategy (TOS), and the other will be the benchmark. The benchmark will be a portfolio with starting value of 100,000 in cash, which will purchase 1000 shares of JPM on the first trading day. The theoretically optimal strategy will have a limit of having either a long or short position of 1000 shares at any given time, as well as a starting value of 100,000 in cash. The strategy assumes that we have foresight of future prices, and so we can exploit future information. The trading frequency would be as frequent as possible to maximize profit. In this case, since we are considering only daily adjusted stock prices, trades will only occur daily, at the closing price. If the price falls the next day, the TOS will have a short position of 1000 shares the day prior, and vice versa if the stock price increases the next day. The stock performance comparison is shown in the graph below. It has a cumulative return of almost 600% on a stock whose price has not changed very much over the course of 2 years.

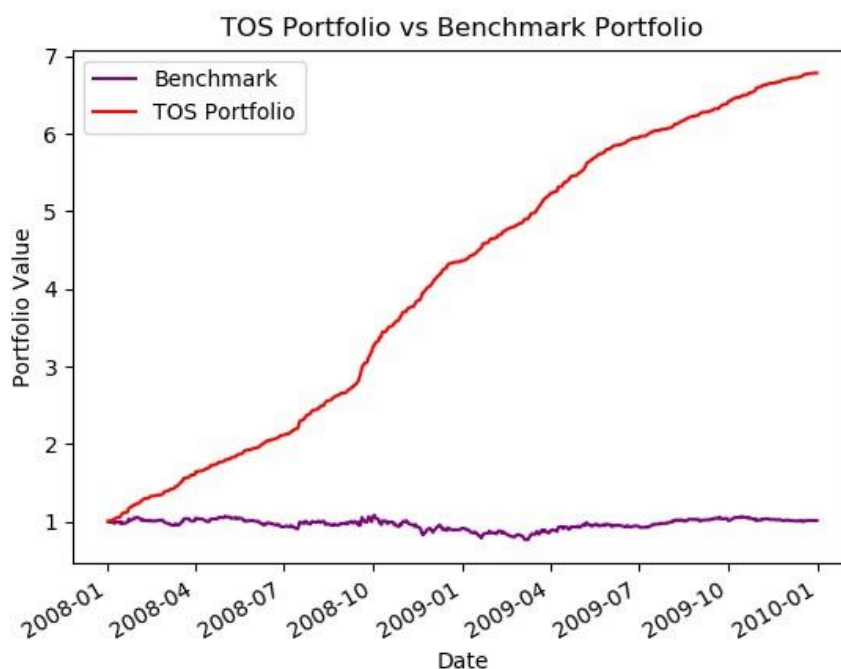


Figure 6— TOS vs Benchmark Portfolio

Table 1 — Performance Metrics TOS vs Benchmark

Performance Metric	TOS Portfolio	Benchmark Portfolio
Cumulative Returns	5.786099	0.0123000
Standard Deviation	0.00454782	0.017004366
Mean of Daily Returns	0.00381678	0.000168086

The table above shows that the risk of the TOS portfolio is actually lower than the risk of the benchmark (based on the standard deviation), and the returns are much higher. The power of foresight results in high returns and low risk.

4 REFERENCES

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