PROJECT 6 – Indicators

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1 INTRODUCTION

This report contains two parts. First part compares a benchmark portfolio with a theoretically optimal portfolio. Second part of the report explains six different technical indicators and show the plots for them. I did six instead of five in case one of them is not accepted. The used indicators are Momentum, SMA, Bollinger, MACD, Stochastic Oscillator and Aroon Oscillator.

2 THEORETICALLY OPTIMAL STRATEGY

At this section, we create a theoretically optimal strategy as though we can see the future for JPM (JP Morgan) between 2008.01.01 and 2009.12.31. The assumptions are zero impact and zero commission. Also, we only study based on adjusted close per day. The strategy is to buy the maximum available if the next day is increasing and short the maximum possible if the next day is decreasing. We don't have to think about the remainder days as any further increase is a gain if we are long and vice versa. Initially, holding is 0 and cash is 100000 dollars. We can go negative with the cash as well. Holding can only vary in between [-1000,1000] where negative indicates a short position and positive indicates a long position. If we, are at 0 holdings, we can either buy 1000 shares or sell 1000 shares depending on the next day's adjusted close. If we are at 1000 holdings, we can either hold the position if the stock is higher the next day. Otherwise, we short 2000 stocks and the holdings drop to -1000. If we are at -1000 holdings, we either hold the position if the next day is lower, or we buy 2000 shares and holdings increase to 1000. The plot is shown in Figure 1. To normalize the benchmark and the theoretically optimal strategy, we divide all the values by 100000 as this is the initial value.

The paragraph above was mostly for optimal strategy. The difference for the Benchmark is we buy 1000 shares of JPM the first day and hold it until the end. As the stock price for JPM doesn't change much during this period (financial crisis), the holdings are pretty stable for the benchmark. However, theoretically optimal strategy frows six-folds unsurprisingly.

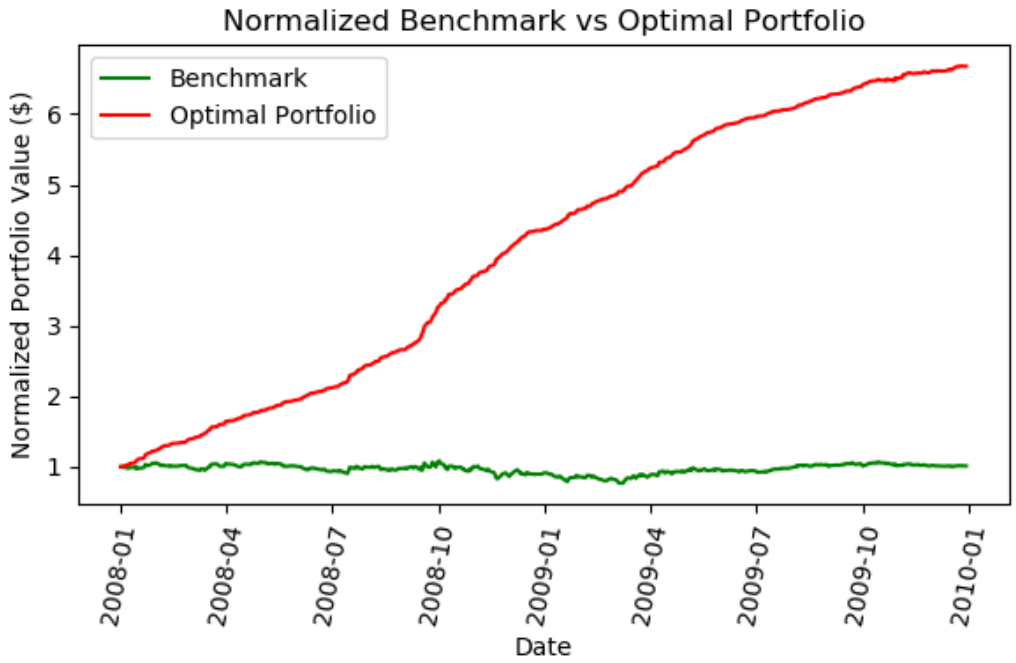

Figure 1 — Comparison of the normalized holding values for the Benchmark and the Theoretically Optimal Strategy.

Table 1 shows the average daily return, standard deviation of daily return and cumulative return values for benchmark and tos. Please multiply by 100 to convert to percentage values.

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	Average Daily Return	**STD Daily Return**	**Cumulative Return**
Benchmark	0.000165	0.017038	0.0106
TOS	0.003799	0.004624	5.6764

3 INDICATORS

3.1 Momentum

Momentum is calculated as $momentum[t] = price[t]/price[t-20] - 1$ where price is the adjusted close, t is time i.e. the day at which momentum is evaluated, 20 is days. Therefore, price[t-20] is the adjusted close price 20 days ago. Momentum is not defined for the first 20 days.

Momentum can signal a buy if it goes above 0 and a sell if it goes below 0.

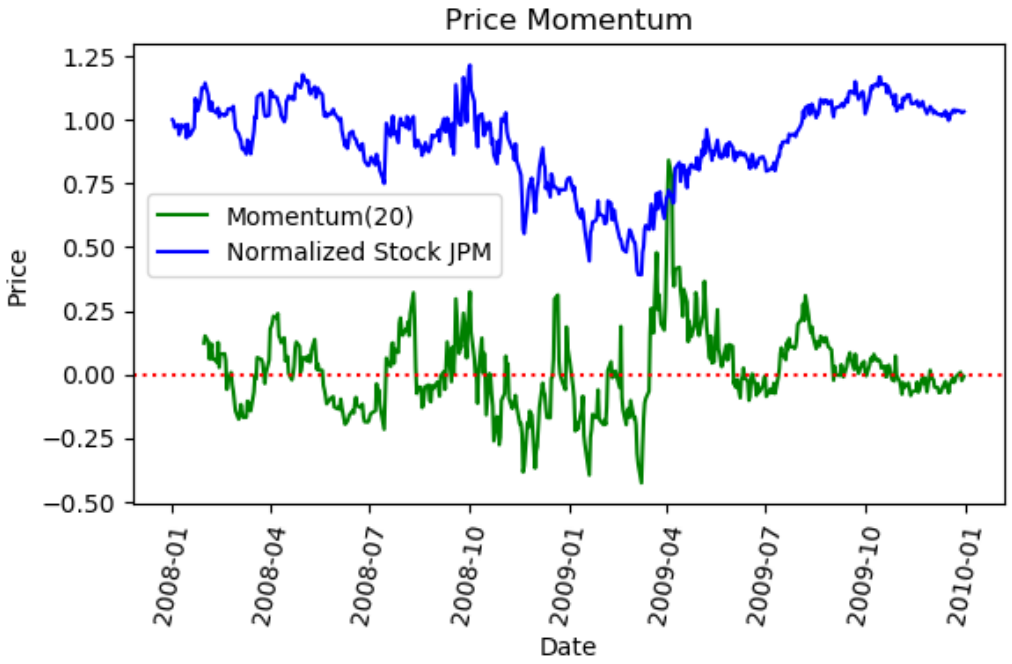

Figure 2 — Momentum(20) and JPM adjusted close value.

3.2 Simple Moving Average (SMA)

Simple moving average (20 days) plots the average of the adjusted close values of the 20 preceeding days of JPM. First 20 days are not defined. When SMA and the stock values cross, if SMA is higher then it is a buy signal, if SMA is lower then it is a sell signal. The idea is that the stock value should converge to the SMA value. We also plot price / sma. If this values foes above 1, then it is a sell signal, if it goes below 1, then it is a buy signal.

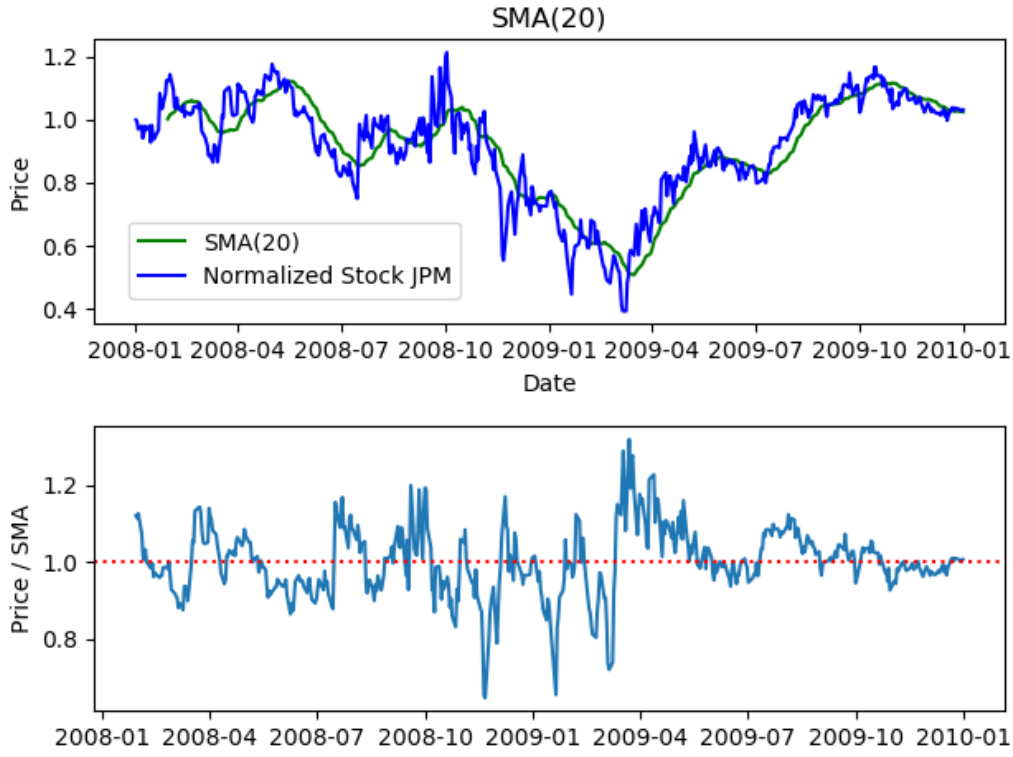

Figure 3 — Top: SMA(20) and adjusted close value of JPM. Bottom: Price/SMA.

3.3 Bollinger Bands

There are two Bollinger bands: upper and lower. They are calculated as follows:

> Calculate SMA(20) as shown above.
> Calculate the standard deviation of the trailing 20 days' adjusted close values and assign as STD.
> Bollinger Upper = SMA(20) + 2 * STD
> Bollinger Lower = SMA(20) – 2 * STD

When the stock value gets inside the Bollinger Band zone, it is a sell signal if the stock value crosses the upper band, it is a buy signal if the stock value crosses the lower band.

We also calculate boiler bands percentage: BBP = (Stock price – SMA(20))/(2*STD). If this value goes above 1, it is a sell signal. If it goes below -1, it is a buy signal.

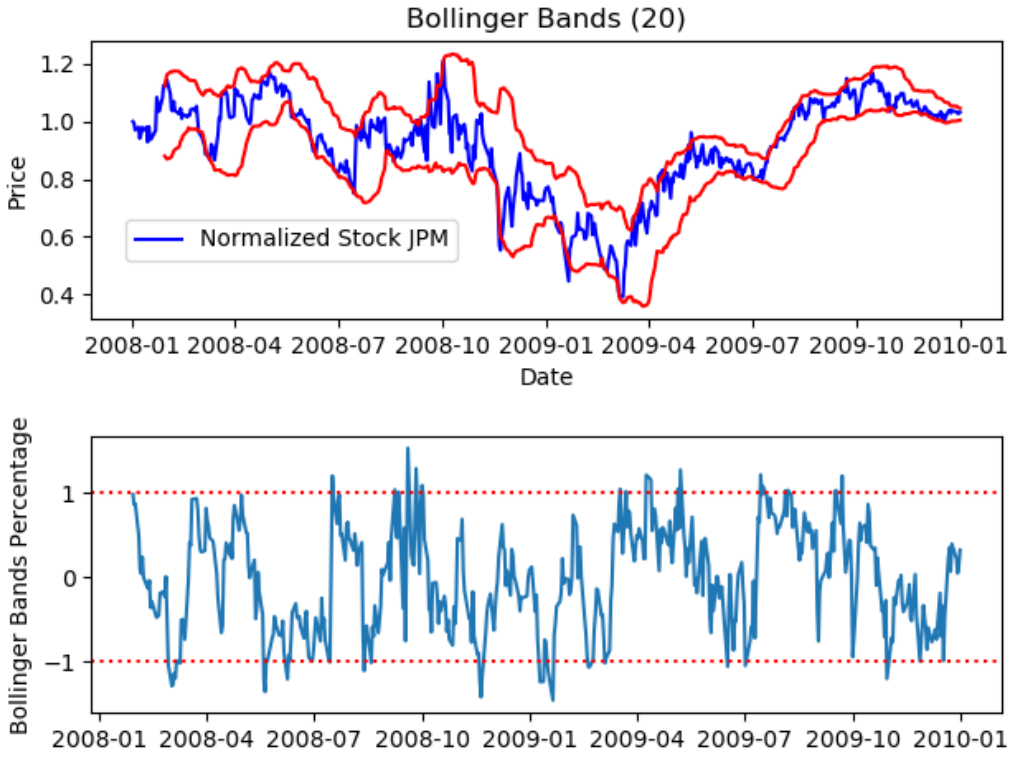

Figure 4 — Top: Normalized stock price for JPM and its Bollinger Bands (20). Bottom: Bollinger bands percentage.

3.4 Moving Average Convergence Divergence (MACD)

MACD is calculated as EMA(12)-EMA(26) where EMA is exponential moving average. EMA is calculated as

$$\text{EMA(Today)} = \text{Value(Today)}*\text{factor} + \text{EMA(Yesterday)}*(1\text{-factor})$$

where factor is 2/(1+Days). EMA(12) is EMA for 12 days, for example. EMA is like SMA but puts more emphasis on the later days rather than the earlier ones.

The signal for MACD is its own EMA for 9 days span which is calculated the same way as above function except Value is switched with MACD. Figure 5

shows MACD and its signal. When both lines cross each other, if the MACD line is below the Signal line, it is a sell signal. If the MACD line is above the Signal line, it is a buy signal.

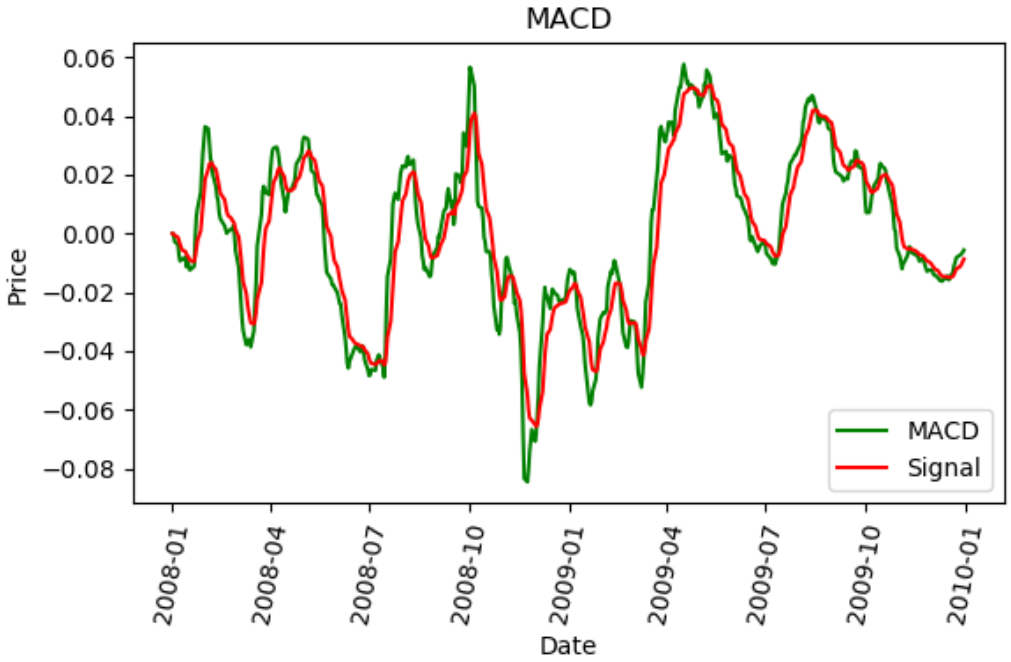

Figure 5 — MACD and its signal.

3.5 Stochastic Oscillator

For this indicator, I imported the Close, High and Low values for the JPM ticker. The calculation is:

%K = (Close - Low_Min(14))*100 / (High_Max(14)- Low_Min(14))

%D = SMA(%K,3)

where Close is the close value, Low_Min is the minimum of the 14 trailing Low values, High_Max(14) is the maximum is the 14 trailing max values, SMA(%K,3) is the simple moving average of %K for the trailing 3 days. %K is the indicator and %D is the signal. Comparison of %K and %D is done only in the overbought region (above 80%) and oversold region (below 20%). In the overbought region, if %K goes below %D, it is a sell signal. In the oversold region, if %K goes above %D, the it is a buy signal. Figure 6 shows the plot for %K and %D.

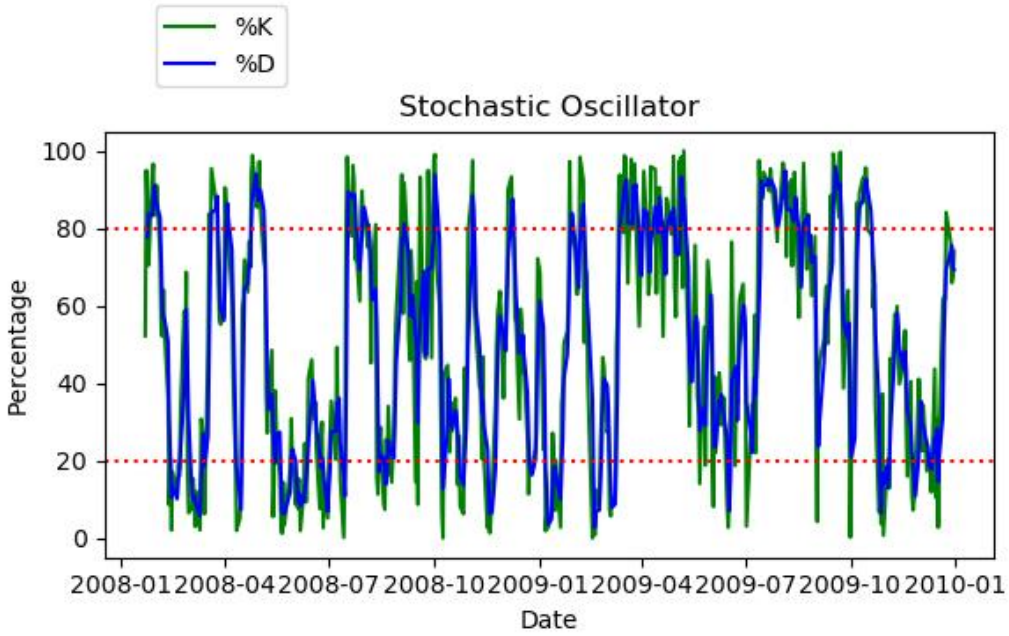

Figure 6 — %K, %D, oversold and overbought lines (shown as red dotted lines).

3.6 Aroon Oscillator

Aroon Oscilator gives a hint of short term trend. If you reaching new highs, most likely the stock will move up next day. If you are reaching new lows, most likely the stock will decrease the next day. The calculations are as follows:

Aroon Up = 100 * (25 – number of days since the highest value found in the 25 trailing values) / 25

Aroon Down = 100 * (25 – number of days since the lowest value found in the 25 trailing values) / 25

Aroon Oscillator = Aroon Up – Aroon Down

I use only the adjusted close value for this case. A positive Aroon Oscillator indicates an upward trend and a negative one indicates a downward trend. Figure 7 shows the Aroon up, Aroon down and Aroon Oscilator plots.

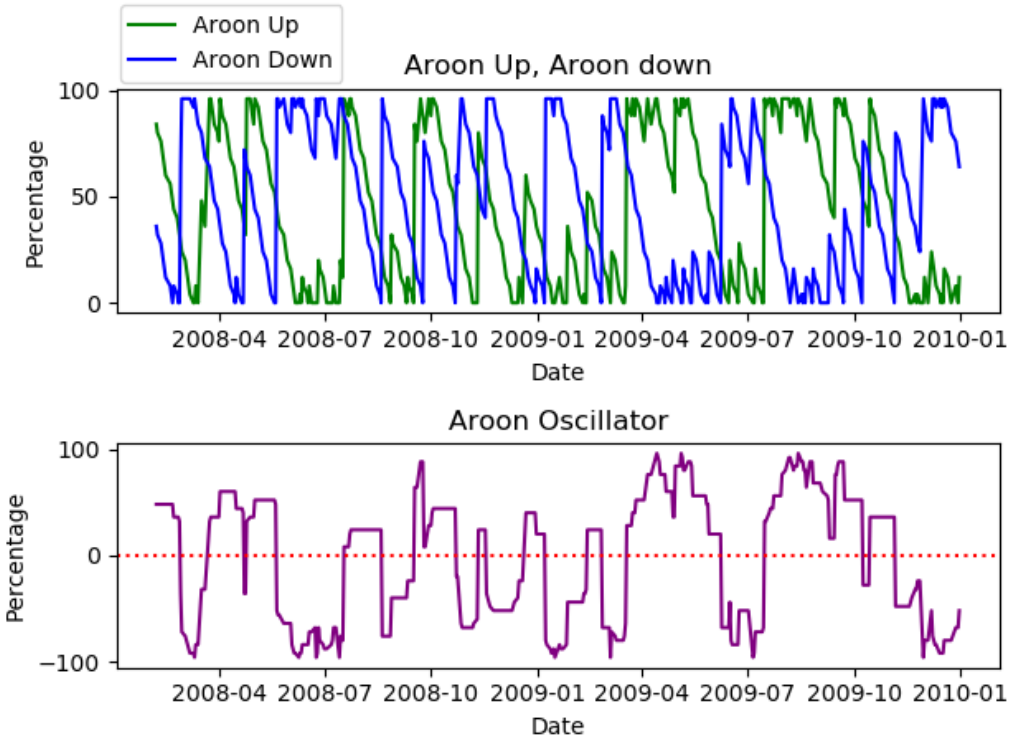

Figure 7 — Top: Aroon up and Aroon down. Bottom: Aroon Oscillator