FRE 7801 HW2 Report

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1. Methodology

In my baseline strategy, I implemented the Bollinger Band reversal strategy without considering the general trend by fully exploiting the mean reversion attribute of foreign exchanges. Specifically, I would enter into a short position if the price crossed over the upper Bollinger Band from above and a long position if the price cross over the lower Bollinger Band from below, because I was betting that the price would revert back to the mean price. For simplicity and consistency, the number of short positions I made was equal to the number of positions I would hold if I was to make a long position. For example, if my capitalization is $10000 and the asset price is $100, I will short 100 shares when the sell signal appears.

However, this trading algorithm did not take the trend into consideration, and it becomes likely to enter into a long position in a bullish market. Therefore, in my second strategy, I would only enter into a long position if the previous mentioned situation has been met and the short-term moving average was above the long-term moving average, indicating an upward trend of the price. Similarly, a short position would be entered if the previous mentioned situation has been met and the long-term moving average was above the short-term moving average.

In the backtesting, I traded when the market was just open (i.e. trading price was based on open price), and Bollinger Bands and other moving average values were determined on previous closes. The foreign exchanges I used in this project were EURUSD, GBPUSD, USDCHF, and USDJPY. The market data was hourly data from 2010/11/01 to 2011/01/31, so the backtesting was based on hourly trading. All the data before 2011/01/01 was used as a train/validation dataset, and the remaining data was used for out-of-sample testing. In the train/validation process, I implemented the backtesting with different combinations of important parameters in this model, which were the number of periods used for determining the Bollinger Bands (10, 15, 20, 25, 30), the number of standard deviations used for determining the Bollinger Bands (1.5, 2, 2.5), and the number of periods used for determining short (75, 100, 125) and long-term moving averages (175, 200, 225) for the advanced model. The parameters used in the strategy with highest Sharpe Ratio were picked for the out-of-sample testing of that particular asset.

In the plots below, you may identify some intervals where no intense price/value/drawdown fluctuation, no holding position indicators, and no returns, because these were weekends times when no foreign exchange trading happened.

2. Result and Interpretations

a. EURUSD

For the baseline strategy, the number of periods used for Bollinger Bands was 10, and the standard deviations was 2.5. On the other hands, the number of periods and the standard deviation used in the advanced strategy were 20 and 2 respectively, and the number of periods used for calculating short and long-term moving averages were 75 and 175. The

baseline strategy plot in *Figure 1* demonstrates the need for the trend filter, especially between 2011/01/14 and 2011/01/25 when I entered into a short position in the bullish market, but other holding positions were correct except during this period. After incorporating the trend filter, I still noticed a period when I made the wrong decision, which was between 2011/01/13 and 2011/01/18 when I entered into a short position at the price rebound point, but this mistake was quickly addressed when the short-term moving average went above the long-term moving average and the price was at a short-term low. Because of the difference in the parameters, I cannot do the apple-to-apple comparison, but simply as *Table 1* has shown the baseline strategy could outperform the buy-hold strategy while the advanced strategy could not. Despite of the lower Sharpe Ratio, the advanced strategy indeed brought me a slightly lower max drawdown by quickly adjusting the mistake in its trend identification process. We also need to notice the advanced strategy started its trading at the price valley, making it to incur some losses when the price rebounded at the beginning of the trading, as *Figure 2* has suggested its max drawdown happened at the very beginning of the trading. Therefore, it is likely the advanced strategy could potentially lead to better results if its trading happened to start at different time point.

	Bollinger Strat w/o Trend Filter	Buy-hold Strat
Annualized Return	0.891883	0.428567
Annualized Volatility	0.110595	0.114929
Max Drawdown	-0.030452	-0.039421
Sharpe Ratio	8.064418	3.728956

	Bollinger Strat with Trend Filter	Buy-hold Strat
Annualized Return	0.399911	1.643456
Annualized Volatility	0.113331	0.116551
Max Drawdown	-0.024574	-0.012268
Sharpe Ratio	3.528706	14.100724

Table 1: Performance Summary of Baseline Strategy (left) and Advanced Strategy (right)

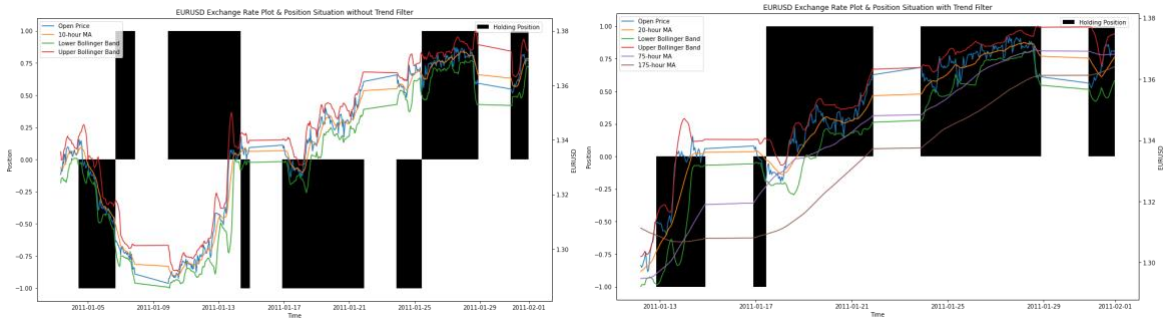

Figure 1: Exchange Rate Plots of Baseline Strategy (left) and Advanced Strategy (right)

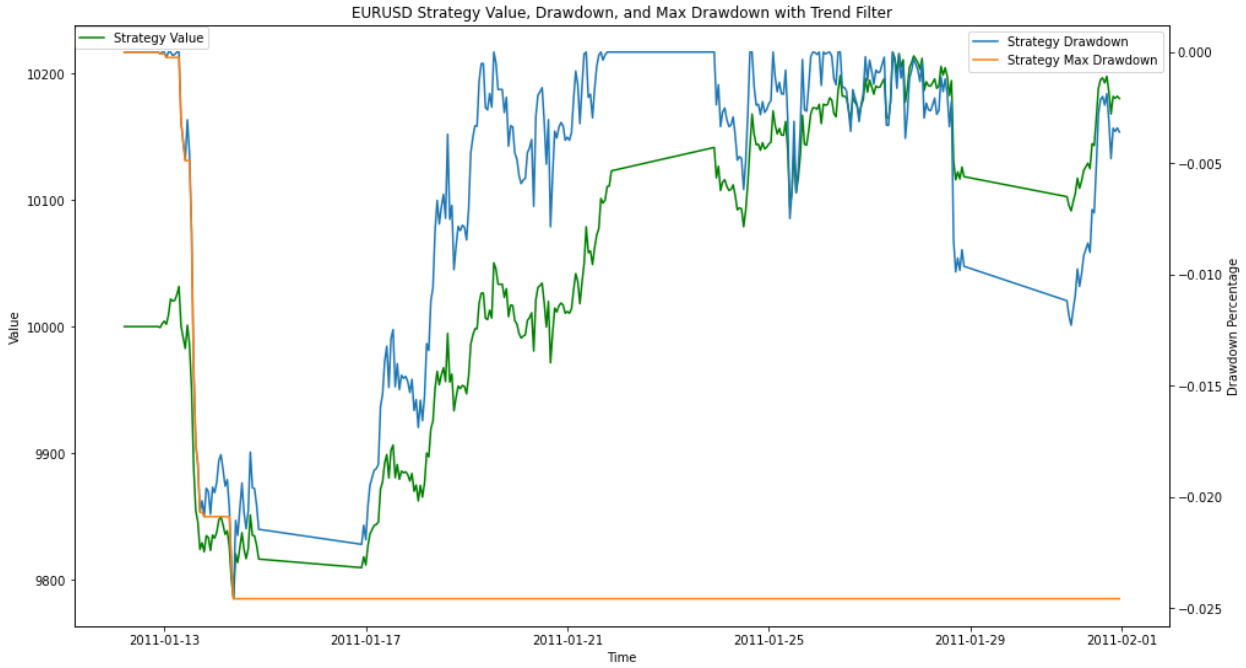

Figure 2: Value, Drawdown, and Max Drawdown of Advanced Strategy

The Excel prototype can give us a better illustration of the trend filter's importance by making the Bollinger Bands parameters the same. In the prototype, the number of periods and the standard deviation used in both strategies were 20 and 2 respectively, and the number of periods used for calculating short and long-term moving averages in the advanced strategy were 100 and 200. In *Figure 3*, you can clearly see that almost every holding position of mine was in adversity against the market. Even though some misidentification still existed in the fluctuating market, the addition of the trend filter indeed added values to the strategy, especially at the beginning and the end of the trading period. Furthermore, the stricter buy and sell rules make the trading less frequent, so the trading cost would be much lower in the real life. As *Table 2* has shown, much higher Sharpe Ratio and similar max drawdown of the advanced strategy make it a more favorable strategy in EURUSD trading under the same parameter settings.

	Bollinger Band Strategy	Buy-hold Strategy
Annualized Return	0.0191193	-0.057023946
Annualized Volatility	0.116110965	0.118679905
Max Drawdown	-0.073531406	-0.098011573
Sharpe Ratio	0.164664039	-0.480485266

	Bollinger Band Strategy	Buy-hold Strategy
Annualized Return	0.080593012	-0.030335483
Annualized Volatility	0.10974416	0.118166651
Max Drawdown	-0.079803632	-0.066231038
Sharpe Ratio	0.734371763	-0.256717805

Table 2: Excel Performance Summary of Baseline Strategy (left) and Advanced Strategy (right)

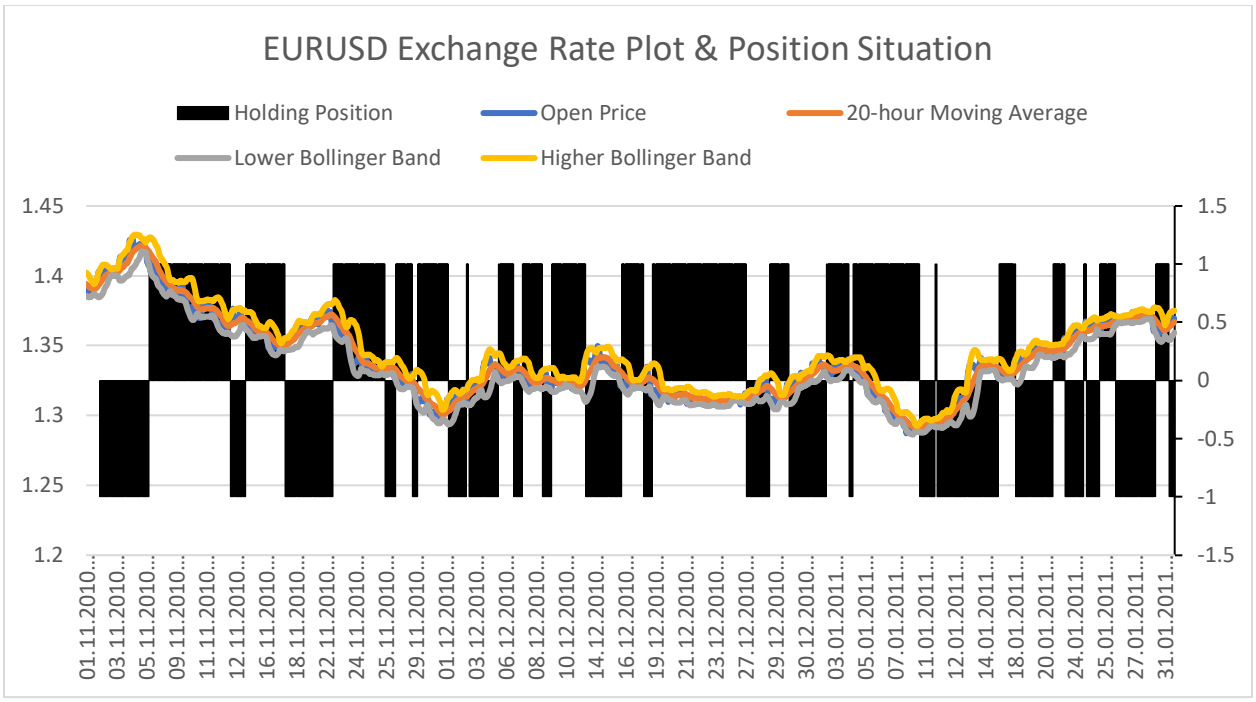

Figure 3: Exchange Rate Plots of Baseline Strategy (Excel)

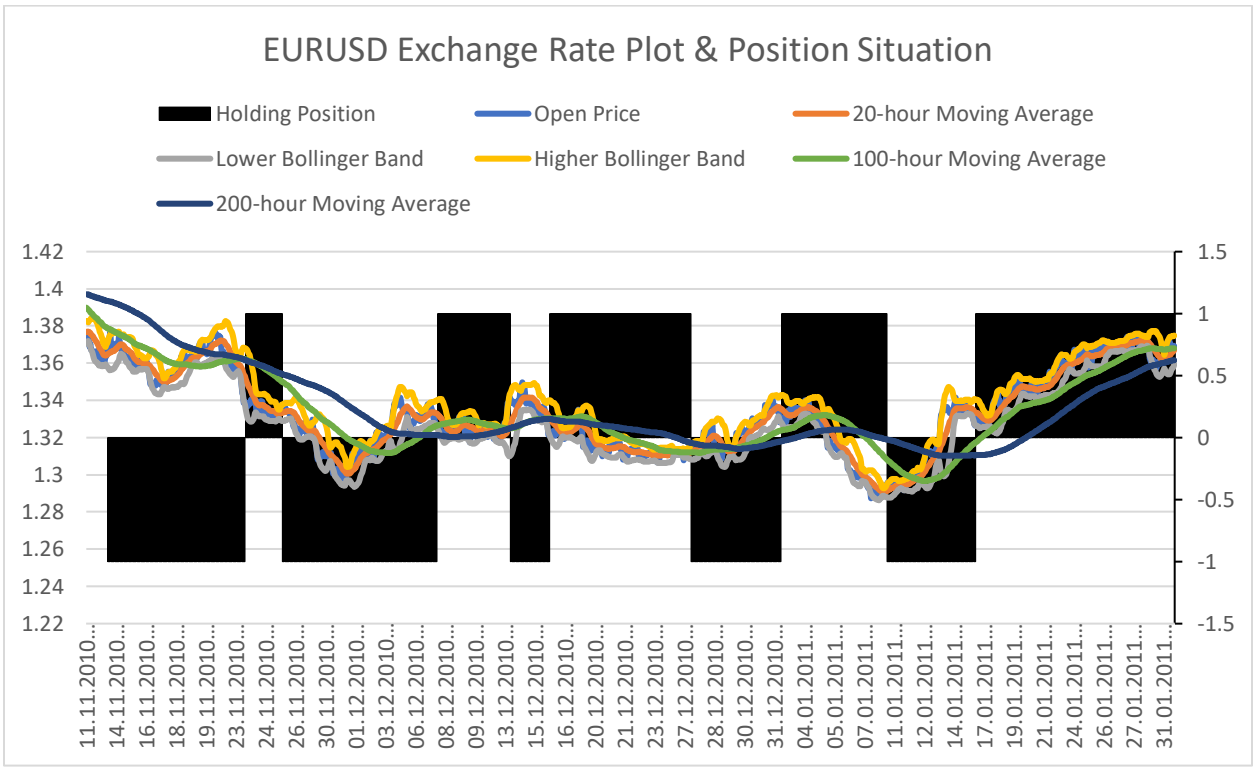

Figure 4: Exchange Rate Plots of Advanced Strategy (Excel)

b. GBPUSD

The number of periods and the standard deviation used for both strategies' Bollinger Bands were 15 and 2 respectively, and the numbers of periods used for short and long-term moving average of advanced strategy were 75 and 175. According to the left plot of *Figure 5*, we again can realize the importance of utilizing trend filter in the Bollinger Band trading strategy. Approximately between 2011/01/12 and 2011/01/17, my short position in GBPUSD incurred a significant loss when the market price rallied, as *Figure 6* showed. On the other hand, the backtesting of GBPUSD also addressed the importance of choosing the correct parameters in the trading strategy. Even though we chose the best combinations of parameters from training data for my advanced trading strategy, there is no guarantee that the future out-of-sample market pattern would be the same as before. As shown in the right plot of *Figure 5*, the short-term moving average had been lower than the long-term moving average from 2011/01/25 to the end of my trading period, and my short position based on my view of current price level and price trend brought me huge loss when the price eventually ended up higher. The drastic change of market pattern from training data to testing data hurt the performance of the advanced strategy, and the baseline strategy became a more favorable one in this experiment of GBPUSD trading, as *Table 3* showed.

The lengths of training and testing periods affect the effectiveness of parameter choices in a trading strategy, thus, furthermore making the trading performance less controlled. One of the solutions to mitigate this bias is to prolong the training and testing periods so that more variations of the historical price pattern can be recorded and less extreme uncertainty exists in the out-of-sample data. Clearly, 2-month validation data and 1-month out-of-sample testing data will not be sufficient to come up with a consistently profitable trading strategy.

	Bollinger Strat w/o Trend Filter	Buy-hold Strat
Annualized Return	0.465260	0.553746
Annualized Volatility	0.098082	0.101817
Max Drawdown	-0.021871	-0.018048
Sharpe Ratio	4.743602	5.438645

	Bollinger Strat with Trend Filter	Buy-hold Strat
Annualized Return	-0.157880	0.557585
Annualized Volatility	0.092110	0.097960
Max Drawdown	-0.022954	-0.018105
Sharpe Ratio	-1.714052	5.691934

Table 3: Performance Summary of Baseline Strategy (left) and Advanced Strategy (right)

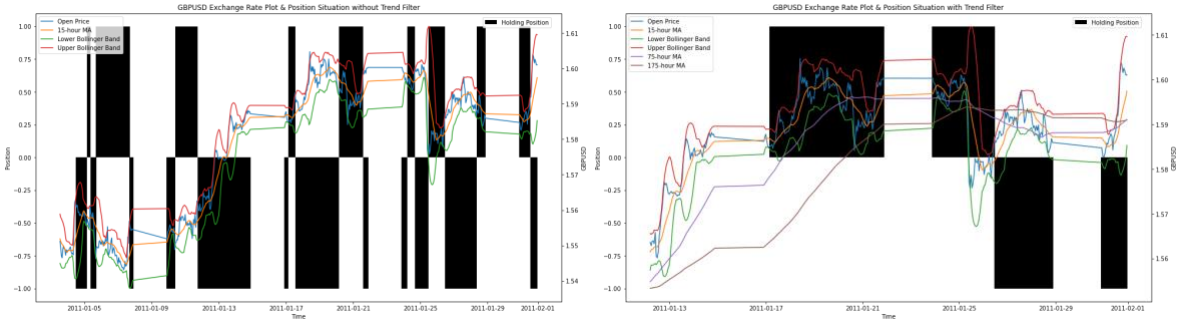

Figure 5: Exchange Rate Plots of Baseline Strategy (left) and Advanced Strategy (right)

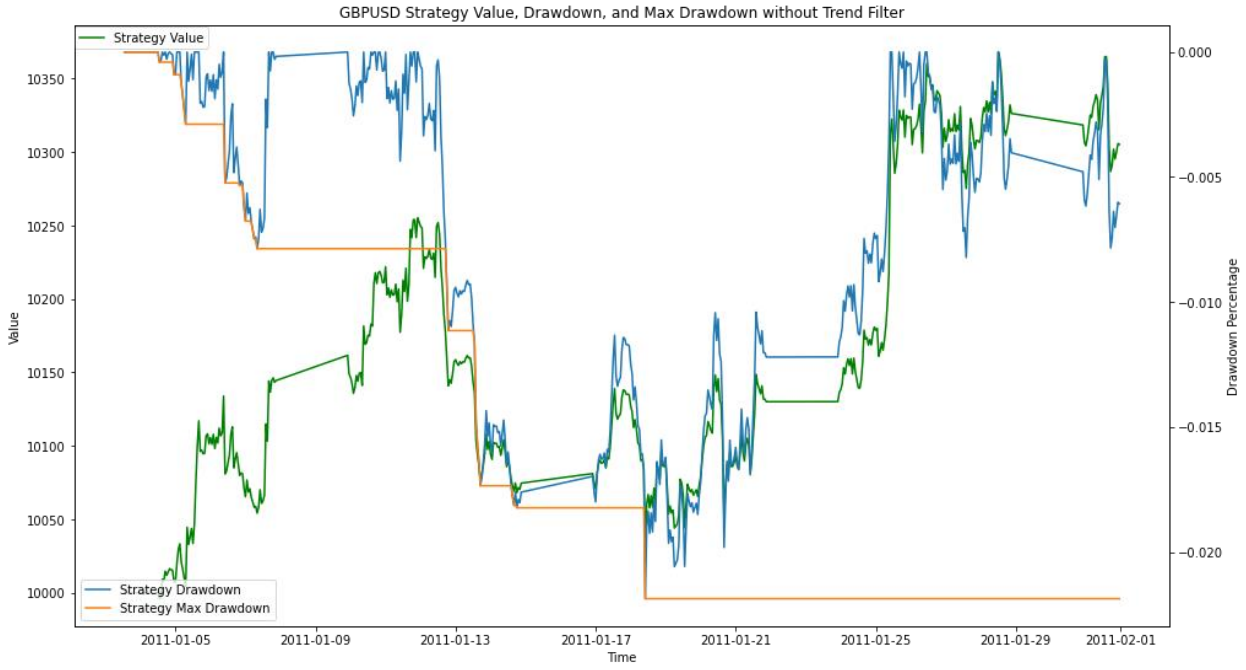

Figure 6: Value, Drawdown, and Max Drawdown of Baseline Strategy

c. USDCHF

The number of periods used for calculating the Bollinger Bands for both strategies was 10, but the standard deviation used for baseline one was 2 while for advanced one was 1.5. The short-term moving average number of periods was 75 and the long-term moving average number of periods was 200. Instead of assuming $10000 to be my initial capitalization, I changed the assumption to be 10000CHF to make the conversion and calculation easier. Even though the simple Bollinger Band Reversal strategy made buy/sell signal based on the positioning of current price against very short-term moving average, its ignorance of the general price trend made it a money-losing strategy from the beginning moment of the trading period. As people can see in the left plot in *Figure 7*, the strategy betted on the wrong direction of the price for every long-held position (from 2011/01/03 to 2011/01/10, from 2011/01/11 to 2011/01/13, and from 2011/01/18 to 2011/01/21). *Figure 8* also indicates how bad the strategy performed throughout the trading periods, so it is obvious that using simple Bollinger Bands Reversal strategy should not be enough to come up with a profitable strategy. In the contrary, the advanced trading strategy correctly identified the crash from 2011/01/19 to 2011/01/31, which helped it to beat the benchmark when the baseline strategy underperformed the benchmark in *Table 4*. Even if the difference between parameters makes these two strategies less comparable, we can still notice the potential improvement of incorporating trend filters into the baseline strategy.

	Bollinger Strat w/o Trend Filter	Buy-hold Strat
Annualized Return	-0.268941	0.129319
Annualized Volatility	0.117376	0.116635
Max Drawdown	-0.039764	-0.037787
Sharpe Ratio	-2.291273	1.108754

	Bollinger Strat with Trend Filter	Buy-hold Strat
Annualized Return	0.469381	-0.402980
Annualized Volatility	0.108955	0.115489
Max Drawdown	-0.016326	-0.036622
Sharpe Ratio	4.308018	-3.489334

Table 4: Performance Summary of Baseline Strategy (left) and Advanced Strategy (right)

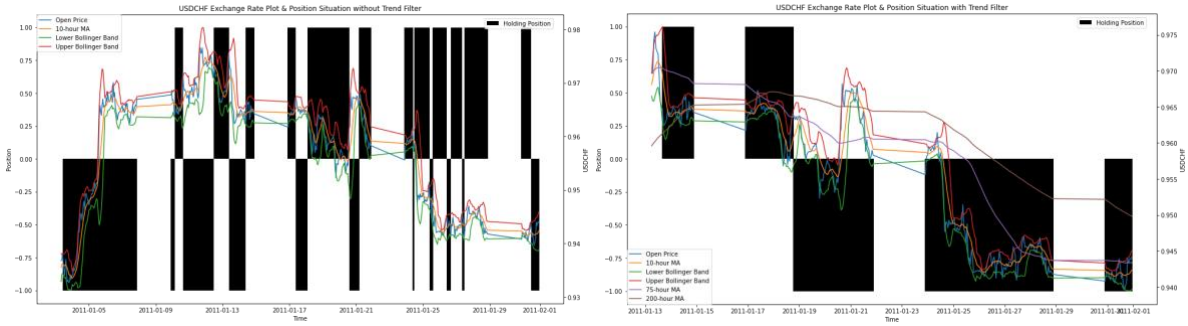

Figure 7: Exchange Rate Plots of Baseline Strategy (left) and Advanced Strategy (right)

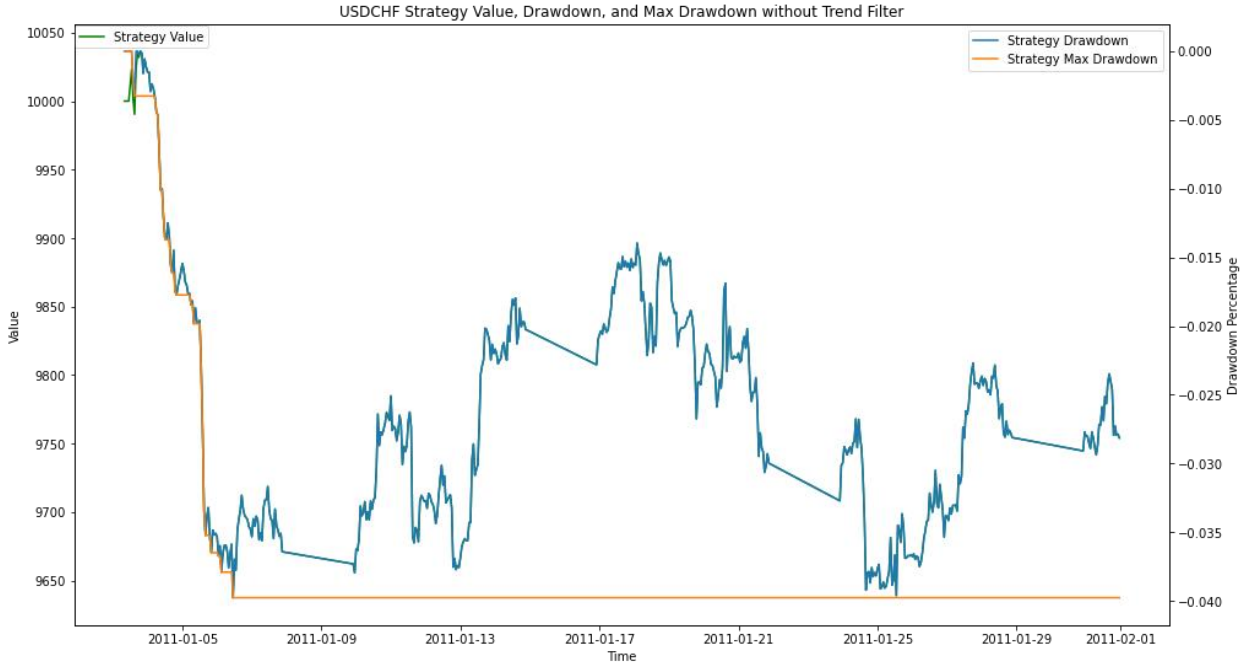

Figure 8: Value, Drawdown, and Max Drawdown of Baseline Strategy

d. USDJPY

For the baseline strategy, the number of periods used for Bollinger Bands was 20, and the standard deviations was 2. On the other hands, the number of periods and the standard deviation used in the advanced strategy were 25 and 1.5 respectively, and the number of periods used for calculating short and long-term moving averages were 75 and 175. Instead of assuming $10000 to be my initial capitalization, I changed the assumption to be 10000JPY to make the conversion and calculation easier. Like what has been found in previous foreign exchanges, the numerous wrong bets in market directions harmed the strategy performance, especially from 2011/01/04 to 2011/01/07 when the strategy's max drawdown was achieved, shown in *Figure 10*. The strategy with trend filter correctly made every buy/sell decision except for the first holding period, when the strategy ended up with slight loss. As the result shown in *Table 5*, the baseline strategy underperformed the benchmark while the advanced strategy outperformed the market. Again, the necessity of using trend filter in Bollinger Band reversal strategy was implied in the USDJPY backtesting.

	Bollinger Strat w/o Trend Filter	Buy-hold Strat		Bollinger Strat with Trend Filter	Buy-hold Strat
Annualized Return	-0.060605	0.080636	**Annualized Return**	0.104980	-0.217409
Annualized Volatility	0.098575	0.099005	**Annualized Volatility**	0.095882	0.098280
Max Drawdown	-0.019186	-0.020243	**Max Drawdown**	-0.016476	-0.018123
Sharpe Ratio	-0.614816	0.814469	**Sharpe Ratio**	1.094885	-2.212146

Table 5: Performance Summary of Baseline Strategy (left) and Advanced Strategy (right)

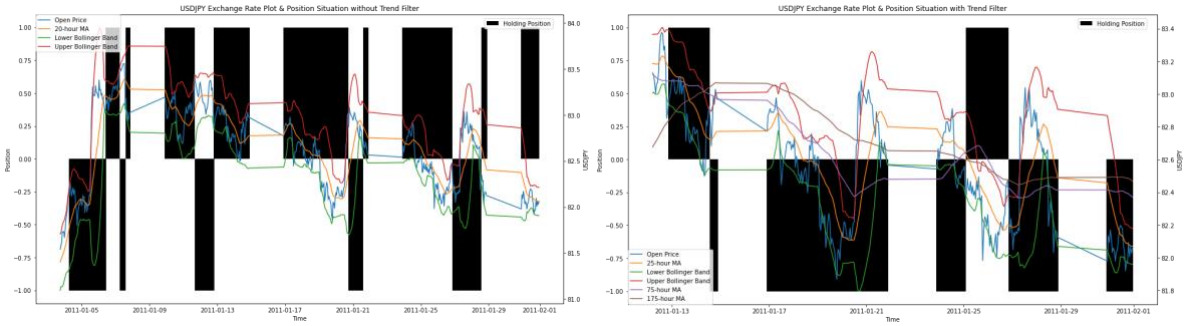

Figure 9: Exchange Rate Plots of Baseline Strategy (left) and Advanced Strategy (right)

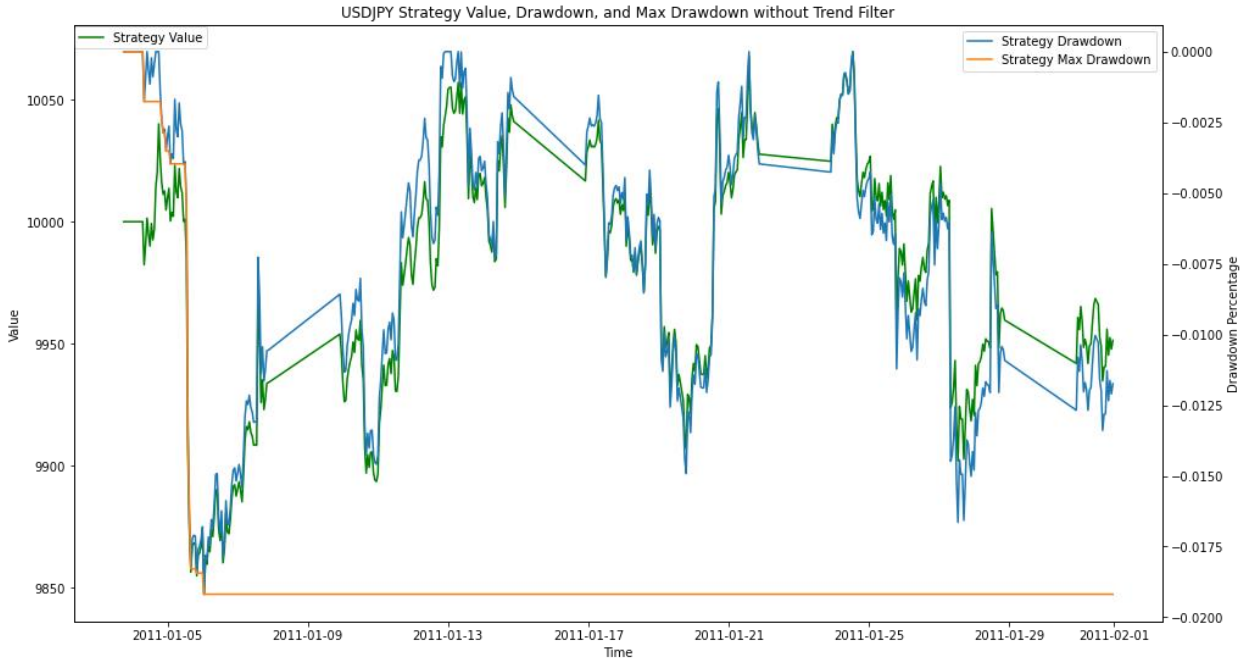

Figure 10: Value, Drawdown, and Max Drawdown of Baseline Strategy

e. Conclusion

After backtesting strategies on these four foreign exchanges, I have seen the need for using trend indicators in Bollinger Bands reversal strategy. Intuitively, the overall trend is one of the most important factors in determining if you can profit from investing. Even if you buy at a short-term low point, you will still lose money if price trend is downward sloping in the future. Despite of the different parameter settings and trading periods of two competing strategies, the Excel prototype offered us the closest apple-to-apple comparison, and the advanced trading strategy eventually won in that battle. In addition, we can also draw the

same conclusion by critically analyzing the plots generated from Python. However, more rigorous experiments with controlled parameters and trading periods are needed to come up with more systematic results. Longer validation and testing periods are also preferred if it is possible.