Using Stochastic Oscillator to Trade in Bristol Stock Exchange

Abstract. The main purpose of this report is to examine whether incorporating a Stochastic Oscillator (KD) and stop-loss function into a trading model can increase stock profitability. In trading model TraderMMM02 by integrating KD to identify the best times for purchases and employing stop-loss function to avoid selling in adverse market conditions, this study seeks to control risks and reduce unnecessary financial losses effectively. The strategy was applied to four different stock data sets, with exhaustive simulated trading on the Bristol Stock Exchange. The study conducted rigorous statistical analysis and verification on TraderMMM02 and TraderMMM01 through basic statistical charts and using the Wilcoxon-Mann-Whitney U test and mean square error (MSE). The verification results show that this strategy is significantly better than the existing trading model TraderMMM01 in terms of profitability and stability, thus proving that this trading rule has the potential to maximize profits while also reducing risks and is an excellent trading model. Furthermore, the report contributes to the existing literature by demonstrating the effectiveness of combining technical indicators with prudent sales strategies. It also lays the foundation for future research, providing key recommendations for further enhancing algorithmic trading methods, thereby opening new avenues for quantitative trading strategies utilizing technical analysis and risk management tools.

Keywords: Stochastic Oscillator, Wilcoxon-Mann-Whitney U Test, Mean Squared Error.

1 Introduction

This report is divided into 6 parts. This chapter explains the experimental background and process for the first part. The second part is the Background is to introduce the methods and calculations used in detail. The third chapter is Results, which aims to analyze the experimental results using statistical methods. Section 4 is the Conclusion for the purpose of summarizing and discussing future developments. Section 5, Reference will list the documents used. Finally, Appendix lists the code of TraderMM002.

Technical analysis is a widely used trading strategy that mainly predicts the future price trend of financial assets by analyzing past prices or trading volumes. It is a strategy that opposes market efficiency (Fama,1970). However, applying the rules of technical analysis to high-frequency trading may provide higher returns under certain market conditions. As an important tool in technical analysis, the stochastic oscillator can effectively determine the overbought and oversold conditions of the market. This report imports this technical analysis tool to determine the timing of purchases but replaces the use of the KD indicator with a simple loss function for selling decisions. It also analyzes whether this approach performs better than using the average past transaction prices as a benchmark for decision-making.

The trading model using this technical trading rule is TraderMM002, which initially calculates the corresponding K and Q lines (Murphy & Murphy, 1999) from the past 14 purchase prices as a cycle to determine the timing for buying and selling. The buying and selling prices are thresholded by the average price within the cycle. Subsequently, a loss function is used to determine the timing for selling and compared the previous purchase price for deciding whether to sell. This model is applied to four stock datasets in the Bristol Stock Exchange for 35 simulations over a period of 10 days to calculate profits. It is then compared with TraderMM001, and the Wilcoxon-Mann-Whitney U Test (Wilcoxon, 1945) and Mean Squared Error (MSE) (Dekking et al., 2005) are used for analysis and discussion.

2 Background

2.1 Data

This report uses 4 csv files as input files, which are "offset-coppoer-10", "offset-ibm-1m", "offset-nasdaq-1m", "offset-tnote10yr-1m".

2.2 Methodology

Raw Stochastic Value (RSV):

RSV is the core of Raw Stochastic Value, which is used to compare the current closing price with the highest and lowest prices within a period. When the value is close to 100%, it indicates that the market may be overbought, and conversely, if it reaches 0%, it means oversold. The traditional RSV Taking 14 days as the main one, here we set 14 prices as one cycle instead. The following is the formula of RSV.

$$RSV = \frac{C_n - L_n}{H_n - L_n} \times 100\%$$

n: *set* 14 *prices as* 1 *period*, C_n: *recent price*,
H_n: *highest price in* 1 *period*, L_n: *lowest price in* 1 *period*.

Stochastic Oscillator:

The K line is also called the fast average. It is a simple smoothing process based on RSV to generate a smoother indicator that is more suitable for observing market trends. We set K <25 as buying time. Its formula is as follows:

$$K_n = \frac{2}{3}K_{n-1} + \frac{1}{3}RSV$$

The D line is also called the slow average and is less responsive. It is the 3-day simple moving average of the K line. In addition, the higher the smoothness of the D line, the better it can provide a mid- to long-term perspective on the market trend. The formula is as follows:

$$Q_n = \frac{\sum K_n}{n}$$

n: *three* k *as one period*.

Loss function:

The purpose of setting loss function is to avoid it sells at wrong timing and loss the profits. The sell logic is as follows:

$$if\ ask\ price \geq Loss\ price.$$

The stop logic is as follows:

$$if\ ask\ price < Loss\ price.$$

Wilcoxon-Mann-Whitney U Test:

The Wilcoxon-Mann-Whitney U test is a non-parametric statistical method used to compare whether two independent samples come from populations with the same distribution. This test does not strongly require that the data adhere to a normal distribution. The steps are as follows:

1. Combine the comparison samples into a population sample.

2. Rank the combined sample and calculate the sum of the rankings of odd observations in the overall sample.

3. Calculate the U statistic for each group, the formula is as follows:

$$U_i = R_i - \frac{n(n+1)}{2}$$

n: *Sample size*, R_i: *sum of sample rankings.*

4. Select a smaller U value, calculate its mean and standard deviation, standardize the U value, and then judge significance based on its standardized value.

Mean Square Error (MSE):

This study uses this function to evaluate how well the model is profitable. Its formula is as follows:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Y'_i - Y_i)^2$$

Y'_i: *the profit from* TraderMMM01,
Y_i: *the profit from* TraderMMM02.

3 Results

After simulated trading on Bristol Stock Exchange, we obtained the profit performance of TraderMMM02 in 4 different environments. According to TABLE 1, we can observe that it has a large standard deviation in the TNOTE environment, indicating that there may be high Risk, and in the IBM environment, its average profit and median are relatively close, showing superior profitability. In the NAQSQ environment, its average profit and median have the weakest profitability. The performance in the COPPER environment is relatively ordinary.

	MAX	MIN	STD	MEAN	MEDIAN
TNONTE	36358	9061	4270.7	28529.8	29374
NADSQ	33239	20114	2577.97	27041.6	26940
IBM	34374	26062	2127.54	29393.46	29261
COPPER	33227	23033	2396.74	28455.43	28721

Table 1. MMM02 balance profits statical data in 10days from 35 trails.

3.1 Wilcoxon-Mann-Whitney U Test

We employed the Wilcoxon-Mann-Whitney U Test to evaluate the performance differences between TraderMMM02 and TraderMMM01 across four trading environments. According to Table 2, the R value for TraderMMM02 was consistently higher than that for TraderMMM01, indicating better performance. Moreover, the P value shows significantly and providing strong statistical evidence to reject the null hypothesis. This suggests that the profit-making capabilities of the two traders are statistically different, with TraderMMM02 outperforming TraderMMM01.

	R_M01	R_M02	U	P
TNONTE	659	1826	29	7.49E-12
NADSQ	906	1579	276	7.92E-05
IBM	736	1746	109	3.46E-09
COPPER	758	1727	128	1.31E-08

Table 2. The Wilcoxon-Mann-Whitney U Test results of MMM02 and MMM01.

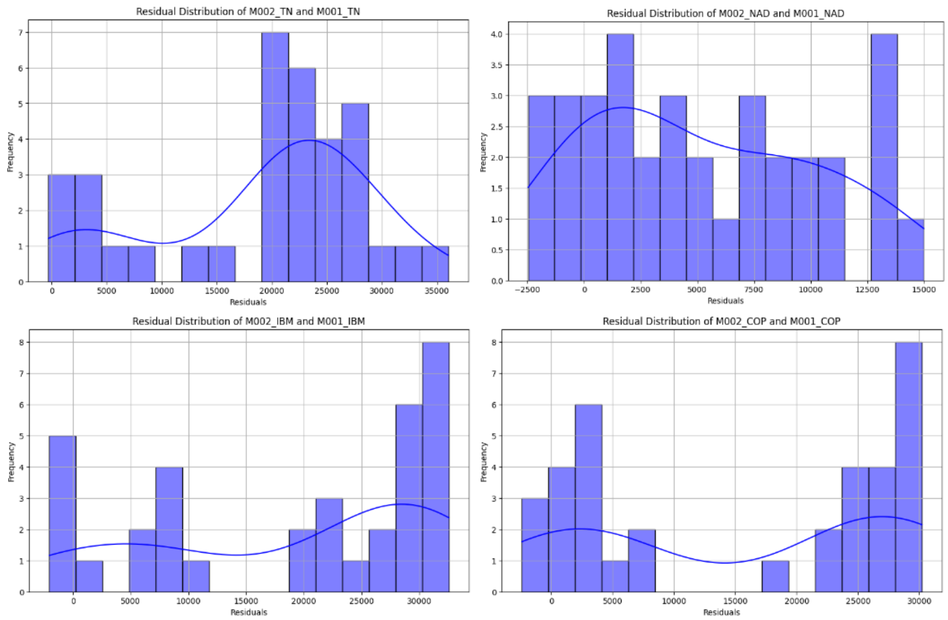
3.2 MSE

Table 3 shows the MSE performance of MMM02 and MMM01 in four environments. We use MSE to observe the profit performance of MMM02 and MMM01 more deeply. We can find that the values are much larger, which means that the difference between the two models is significant.

	TNONTE	NADSQ	IBM	COPPER
MSE	5E+08	5E+07	5E+08	3.98E+08

Table 3. The MSE results shows that MM02 and MM01 has significant difference.

3.3 Profits Residual Distribution MM02 and MM01



Grap 1. Residual Distribution of MM02 and MM01 in 4 environments. The profit residual here is the profit of MM02 minus the profit of MM01. The Y-axis is the number of statistics, and the X-axis is the profit residual. Use a histogram to count the number of times, the wavy line represents the trend.

From Graph 1, we can observe the residual distribution of MM02 and MM01. In the TONTE environment, the peak value of the residual of MM02 is around 20000 and 25000, and the profit of MMO2 is higher than that of MM01 because there is no negative residual. As for the NADSQ environment, although the overall performance of MM02 is better than that of MM01, it has 6 losses time. However, the amount of loss was much less than the amount of the win. In addition, according to the peak value, it can be known that most of the performances will not be better than MM01. Next is the IBM environment. Obviously, MM01 lost 5 times, the amount was very small. We can also know from its peaks and wavy lines that most of the profits when winning will fall between 27,500 and 30,000. Finally, is the COPPER environment. Its trend line is somewhat similar to IBM, but it has fewer losses, only 3 losses times.

4 Discussions and Conclusions

In summary, our trading rules are effective. The setup of the KD Line ensures that the model places orders at the correct times and uses a loss function to avoid selling at unacceptable prices. Additionally, the Wilcoxon-Mann-Whitney U Test was applied to compare the differences between MM02 and MM01. Following this, from combining the R and P values results, we were able to reject the null hypothesis and obtain significant performance differences with MM02 outperforming MM01. Moreover, using the Mean Squared Error (MSE) to evaluate the average profit performance of MM02 and MM01 in various environments also confirmed noticeable performance disparities. Finally, the Profit Residual Distribution was used to supplement the actual profit performance of MM02 and MM01, showing that MM02 generally performs better than MM01 in various environments.

Future challenges should include exploring more loss functions. Although this report's analyses conclude that MM02 performs better than MM01, applying this loss function to real stock trading could potentially lead to short-term entrapments. This is because in real stock trading, significant events that cause price drops dramatically might require more than 10 days to return to previous prices. Additionally, it is important to note that if this strategy is implemented in real world might hard to earn profits. Since everyone might be using the KD Line to determine buy and sell points will make it difficult to meet purchase conditions.

References

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