Developing a Stock Trading Simulator Using Candlestick Chart Patterns for Estimating Profitability of Global Markets

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***Abstract*— This paper deals with the development of a stock trading simulator. It uses candlestick chart patterns and the 5-day moving average for deciding trade opportunities, and tries to make profits on both trades that start with buying stocks and those that start with selling stocks, i.e., long and short trades. Experiments are performed using the seven world markets consisting of Euro Stoxx 50 (the European Union), DJI and NASDAQ (the United Sates), Bovespa (Brazil), Sensex (India), SSEC (China), and Nikkei 225 (Japan). Profits are simulated using ten-year daily stock data of the seven global stock markets with and without a trading fee. The results of experiments are generally consistent in the seven markets, showing the wide range of applicability of the simulator. The average success rates for trades that are started with buying stocks with a trading fee remains in the middle of 60%, while it is at the beginning of 20% for the trades that start with selling stocks because margin interest to loan stocks squeezes profits. Although the developed simulator has some limitations, it provides a benchmark for measuring profitability of trading techniques and helps to analyze stock trade timings that lead to significant profits or losses.**

Keywords*— *Stock trading simulator; Global market comparison; Technical analysis; Candlestick chart; Moving average.

I. INTRODUCTION

The stock market has fascinated people for extra income. Many make profits, others losses thorough trading on a stock market. Stock price forecasts play an important role to mitigate the risks associated with investment.

Generally, there are two main types of methods that allow investors to make an investment decision, namely fundamental analysis and technical analysis [1].

Fundamental analysis is an investing strategy that attempts to determine a security's intrinsic value by focusing on microeconomic indicators and macroeconomic factors. Examples of the former are a company's historical earnings and profit margins as well as future growth prospects. Examples of the latter include the state of industry conditions and market sentiments. The primary assumption of the fundamental analysis is that the stock price of a company reflects the intrinsic value in the long run. Because of this nature, the fundamental analysis is considered to be effective for a long-term trade.

In contrast, technical analysis is an investing strategy that tries to identify trading signals by analyzing the statistics of preceding stock price data and volume. Typically, the technical analysis uses charts and indicators to forecast price trends and patterns in the near future.

This study focuses on candlestick patterns to spot the timing of a trade [2][3]. Because candlestick patterns are typically formed by one to three candlesticks, they are believed to be suitable for a short-term prediction. While the candlestick charting technique was probably established sometime after 1850, the candlestick technique became popular worldwide in the 1990s. Despite its long history and popularity, mixed results are obtained in the studies on the technique. Negative conclusions to the predictability of candlestick charts are reported [4]-[6], while positive evidences are provided for several candlestick patterns by experiments using the U.S. and Asian stock markets' historical data [7]-[11]. Most of the papers on stock price prediction focus on discussions about the accuracy of predictions concerning stock price increases using specific chart patterns and/or indicators. Since stock trading fundamentally consists of buying and selling stocks, the criteria for deciding when to buy and sell stocks, and the resulting profits must be estimated before they can be applied to actual trading.

The purpose of this study is to develop a simulator for stock trading and to compare the performances of global markets in terms of profits. The developed simulator uses candlestick patterns and the 5-day moving average to find the opportunities to buy and sell stocks. It is designed to make profits on both trades that start with buying stocks, i.e., trades in a long position, and those that start with selling stocks, i.e., trades in a short position. Experiments are performed using the seven international markets consisting of Euro Stoxx 50 (the European Union), Dow Jones Industrial Average (DJI) and NASDAQ (the United Sates), Bovespa (Brazil), Sensex (India), SSEC (China), and Nikkei 225 (Japan) [12].

The contributions of this study are as follows:

I. Developing a stock trade simulator that continuously tries to make profits by buying and selling a stock.
II. Profits are simulated over the seven global stock markets for long and short trades, with and without trade fees.
III. Detailed analysis on big trades for demonstrating usefulness and limitation of the developed simulator.

The remainder of the paper is organized as follows. Section II gives the background of the candlestick chart, and overviews the algorithm of the developed simulator. Section

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III shows experimental results including success rates and cumulative profits in seven markets. Section IV concludes the paper with our plans for future work.

II. STRUCTURE OF STOCK SIMULATOR

This section describes formations of a candlestick chart, criteria for finding trade opportunities, and outlines the developed stock trading simulator.

A. Formation of Candlestick

As depicted in Figure 1, a daily candlestick is formed with the market's opening, high, low, and closing prices of a market day [2][3]. The candlestick has a wide part, which is called *real body* representing the range between the opening and closing prices of that day's trading. The color of the *real body* represents whether the opening price or the closing price is higher. If the price rises, a hollow body is drawn indicating *bullish* or buying pressure. Otherwise, a filled body is drawn showing *bearish* or selling pressure.

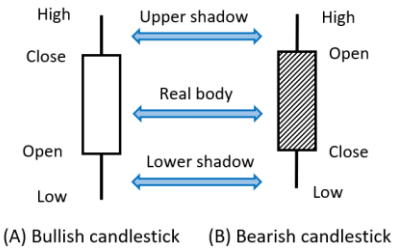

Figure 1. Candlestick formation.

The thin lines above and below the body, which are named *shadows*, represent the range of prices traded in a day. The high is marked by the top of the upper shadow and the low by the bottom of the lower shadow.

B. Criteria for Spotting Trade Timings

A candlestick chart is a graph in which candlesticks are presented in chronological order. It is used as a tool to get information on whether the current price is higher or lower than the historical stock price movements. Moving averages form a line graph by connecting the average of closing prices over a certain period of time. As for a period of time to compute an average, each country uses its own. For example, the short-term average is often calculated for 5 days, the medium-term average is for 25 days in Japan. The moving average graph is useful to decide whether a stock price is at the beginning stage of a rising trend or a falling one.

Candlestick patterns are usually described in a context of stock price trends. In this study, we focus on the difference between the closing price and the 5-day average. Figure 2 depicts a bullish reversal pattern that is commonly observed at the start of a rising trend. The pattern has two parameters, i.e., δ for the length of the candlestick body and ε for the difference between the closing price and the 5-day moving average. The optimum values for δ and ε vary for each stock market, which is discussed in the next subsection.

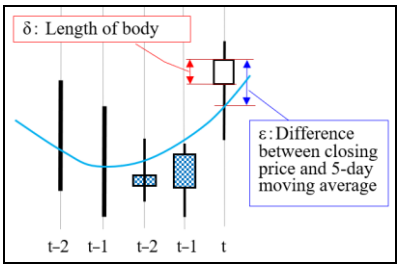

Figure 2. Bullish reversal pattern.

Figure 3 illustrates a bearish reversal pattern that is generally observed at the beginning of a falling trend. The pattern also has two parameters, i.e., δ and ε. In this study, the perfect symmetry of the bullish and bearish reversal patterns is presumed.

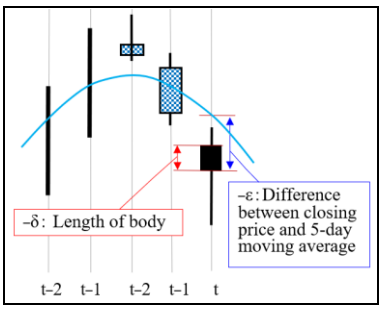

Figure 3. Bearish reversal pattern.

Figure 4 shows the pseudocode that outlines the algorithms of the developed simulator. Stock data are stored in arrays, such as *Open[]* for the opening prices, *Close[]* for the closing prices, *Pbody[]* for the lengths of candlesticks, and *CP5av[]* for the difference between the closing price and the 5-day moving average. Stock data are stored in chronological order, i.e., the larger index values of an array represent the further past trading dates.

```
01  Trade_Simulation( int IndexFrom, int IndexTo ) {
02      for ( j= IndexFrom; j>=IndexTo; j-- ) {
03          if ( the first trade ) {
04              if ( CP5av[j] > 0.0 ) {
05                  flg= 1;       // to buy stock
06              } else if ( CP5av < 0.0 ) {
07                  flg= -1;      // to sell stock
08              }
09              traded_p =  ((Open[j] + Close[j]) / 2) ;
10              trade_days= 0;
11          /*  While buying stocks, the downward reversal signal is detected */
12          } else if ( flg > 0  & CP5av[j] < - epsilon & Pbody[j] < -delta ) {
13              diff = ((Open[j] + Close[j]) / 2) - traded_p - buying_cost;
14              profit= profit + diff;          // Total profit
15              traded_p =  ((Open[j] + Close[j]) / 2) ;
16              flg= -1;                // to sell stock
17              trade_days= 0;
18          /*  While selling stocks, the upward reversal signal is detected */
19          } else if ( flg < 0 & CP5av[j] > epsilon & Pbody[j] > delta ) {
29              diff = traded_p - ((Open[j] + Close[j]) / 2)  - selling_cost;
21              profit= profit + diff;          // Total profit
22              traded_p = ((Open[j] + Close[j]) / 2) ;
23              flg= 1;                 // to buy stock
24              trade_days= 0;
25          }
26          trade_days++;
27      }
28  }
```

Figure 4. Outline of developed simulator algorithms.

The method *Trade_simulation* takes two integer parameters, i.e., *IndexFrom*, and *IndexTo*. These variables specify the start and end of a simulation, respectively.

The position of a trade is indicated by the value of a variable named *flg*, i.e., 1 for a long position, and –1 for a short position. At the start of a trading simulation, the position is determined by the value of *CP5av[j]*. If *CP5av[j]>0* then the variable *flg* is assigned to 1, otherwise to –1.

If the bearish or downward reversal pattern shown in Figure 3 is detected during the period of buying a stock, the simulator sells the stock and calculates the profit *diff* of the trade and the cumulative profit *profit*, updates the trade price *trade_p*, and assigns the variable *flg* to –1 to enter a short position, etc. The profit *diff* is calculated as the profit of one stock at the market price. The trade price *trade_p* is calculated by adding the opening and closing prices, and dividing by 2.

If the bullish or upward reversal pattern shown in Figure 2 is found during the period of selling a stock, the simulator buys a stock back and assigns the variables in the symmetrically same way as the detection of the bearish reversal pattern.

C. Calculating trading fee

Purchasing stocks comes with a trading fee. The trading fee varies across brokers and depends on the amount of the trade. Table I summarizes trading fees of some Japanese online brokers. This study assumes the trading fee is 0.1% of the amount of a traded stock price due to the fact that the fee is reasonable for the trade amount between 1M JPY (≒ 8,700 USD) to 3M JPY (≒26,000 USD).

TABLE I. TYPICAL TRADING FEE OF JAPANESE ONLINE BROKERS

	～ ¥1M	¥1M ～ ¥3M	¥3M ～ ¥5M
SBI	0	0	¥2,576
Rakuten	0	¥3,300	¥5,500
Manex	¥550	¥2,750	¥5,500

In a short sale, a trader must borrow the stock to sell from an investment firm with a payment of margin interest. The leverage of trades is assumed to be one, because the symmetry of long and short trades is presumed in this study. Margin interest slightly varies across brokers. Typically, it consists of an annual interest and a fixed one. In this study, the margin interest is calculated using the following formula:

$$(\text{Stock price}) * (2.80\% / 365 * N + 1.15\%) \quad (1)$$

N is the total number of days for borrowing stocks. 1.15% indicates the fixed interest, which greatly affects short sale profits, as described in Section III.

D. Determining Optimal δ and ε

All market data used in this study are downloaded from the *Investing.com*'s Web site [12]. Price data are converted into percentage ratios. For example, let *Close[j]* indicate the closing price of the *j*-th trading day stored in the simulator. The price change ratio in percentage is calculated by the following formula:

$$PriceChangeRatio[j] = (Close[j] - Close[j+1]) * 100 / Close[j+1] \ (1 \leqq j \leqq n) \quad (2)$$

Since the proposed model of stock trading has two parameters, i.e., δ and ε, an exhaustive search method or a brute-force approach is applied to find the optimum combination of the parameters in the sense of maximizing profits. Table II shows the result of the exhaustive search on δ and ε using NASDAQ stock price data for ten years, i.e., strictly between Nov. 30, 2011 and Dec. 1, 2021 in a long position. The maximum profit is achieved when the value of δ= 0.2% and ε= –2.4%, i.e., between –2.3% and –2.5%. The profit values in US dollar in Table II are those without the trading fee.

TABLE II. RESULT OF EXHAUSTIVE SEARCH ON δ AND ε

ε \ δ	0.1	0.15	0.2	0.25	0.3
-2.7	50383.1	51545.6	51784.2	50117.3	49072.6
-2.6	49477.1	50639.6	51784.2	50117.3	49072.6
-2.5	49957.6	51120.1	52264.7	50597.8	49553.1
-2.4	49949.1	51120.1	52264.7	50597.8	49553.1
-2.3	49949.1	51120.1	52264.7	50597.8	49553.1
-2.2	49055	50226	51370.6	50297.4	49252.7
-2.1	49393.4	50564.4	51709	50635.8	49591.1
-2	48837.7	50008.7	51153.3	49968.1	48944.5

The optimal combinations of δ and ε concerning the seven global markets are listed in Table III. The value of the parameter δ is positive except for SSEC, which indicates that the candlestick body is hollow or Doji [2], i.e., the opening price and the closing prices are virtually equal, when the price is rising. Meanwhile, the candlestick body is filled or Doji when the price is falling.

TABLE III. OPTIMAL COMBINATIONS OF δ AND ε FOR SEVEN GLOBAL MARKETS

Market	δ	ε
Euro Stoxx 50	0.05	–2.4
DJI	0	–1.7
NASDAQ	0.2	–2.4
Bovespa	0	–3.2
Sensex	0	–2.9
SSEC	–0.2	–2.3
Nikkei 225	0.05	–2.8

The value of the parameter ε is negative in all markets. This indicates that the closing price is before crossing the 5-day average upward during a price increase, whereas before crossing downward during a price decrease.

III. EXPERIMENTAL RESULTS

This section discusses simulated success rates and profitability of stock trading in the seven markets under

consideration. It also includes analyses of the cumulative profits over ten-year trade simulations, which show strong liner dependency upon the number of trades.

A. Success Rate and Profitability

Stock trade simulations are performed over the ten years' daily stock data using the seven markets, i.e., Euro Stoxx 50 (the European Union), Dow Jones Industrial Average and NASDAQ (the United Sates), Bovespa (Brazil), Sensex (India), SSEC (China), and Nikkei 225 (Japan) [12]. The success rate of stock trading in the study is defined by the following formula:

Success rate=
the number of profitable trades
/ the total number of trades (3)

Strictly, the number of profitable trades indicates the number of trades that result in a positive profit.

A trade profit is calculated by the subtraction of a purchasing price from a selling price. In a long position, a trader firstly purchases a stock at a market price, and eventually sells it to fix profits and/or losses. A profit is generated when a market price increases. Meanwhile, in a short position, a trader firstly borrows a stock with margin interest from a broker and sells the stock at a market price, and eventually buys them back to fix profits. A profit is generated when a market price declines.

Table IV summaries the success rates for each market in both long and short positions, with and without the trading fee or interest. Cells with the largest success rates among the markets are highlighted with a yellow background color, and cells with the smallest value are filled with a light blue color. The success rates in a short position with interest are notably low compared to other success rates. This indicates that the margin interest (1) has a significant influence on the success rates.

TABLE IV. SUMMARY OF THE SUCCESS RATES

	Success rate in long position		Success rate in short position	
	Without fee	With fee	Without interest	With interest
DowJ	72.0%	64.3%	64.0%	15.9%
NASDAQ	73.1%	70.0%	61.3%	23.2%
Bovespa	70.8%	65.9%	69.6%	31.0%
Euro Stoxx 50	70.8%	64.6%	62.3%	21.3%
Sensex	79.4%	73.2%	57.4%	20.7%
SSEC	67.4%	62.1%	68.3%	22.0%
Nikkei 225	66.1%	62.9%	59.6%	22.8%
Average	71.4%	66.1%	63.2%	22.4%

Table V shows a summary of the profitability for each market in both long and short positions, with and without the fee or interest. Like Table IV, cells with the largest success rate are highlighted with a yellow color, and cells with the smallest are filled with a light blue color.

The profit ratio is calculated by the following formula:

Profit ratio= Simulated profits / Base stock price (4)

The base stock price is a 25-day average at the beginning of the simulation, i.e., the 25-day average on Nov. 30, 2011, for each market.

TABLE V. SUMMARY OF PROFIT RATIOS

	Ratio in long position		Ratio in short position		Stock price increase ratio
	Without fee	With fee	Without interest	With interest	
DowJ	7.35	6.24	5.39	-7.55	3.02
NASDAQ	12.45	11.24	7.48	-6.76	6.01
Bovespa	8.75	7.93	7.94	-1.69	1.82
Euro Stoxx 50	6.71	5.85	5.89	-4.24	1.9
Sensex	8.93	7.80	6.46	-6.80	3.54
SSEC	6.60	5.74	6.11	-3.97	1.44
Nikkei 225	9.62	8.31	7.35	-8.03	3.41
Average	8.63	7.59	6.66	-5.58	3.02

NASDAQ has the maximum profit ratio of 11.24 times the 25-day average on Nov. 30, 2011 in ten years in a long position with the trading fee. Meanwhile, profit ratios in a short sale are catastrophic. Losses reach 6.76 times the base stock price in NASDAQ. Again, the simulations prove that the margin interest (1) has a heavy negative impact on profits.

B. Analysis of Cumulative Profits

One of the important aspects of stock trading is stability of investment returns on an annual basis. Figure 5 shows the graphs of cumulative profits in a long position with the trading fee for each of the seven markets being discussed. The cumulative profits' graphs without the fee have the same shapes except for the slopes of increase are 1.001 times of those in Figure 5.

As the graphs show, the cumulative profits almost constantly increase as stock trades continue. NASDAQ achieves the best ratio of 11.24 times at the end of a simulation. Linear regression equations with the R-squared (R^2) are added near the graphs. R^2 is a statistical measure of how close the original data are to the approximate regression line. All R^2s of the seven markets are greater than 0.9302 which indicates significant correlation between the cumulative profits and the number of trades.

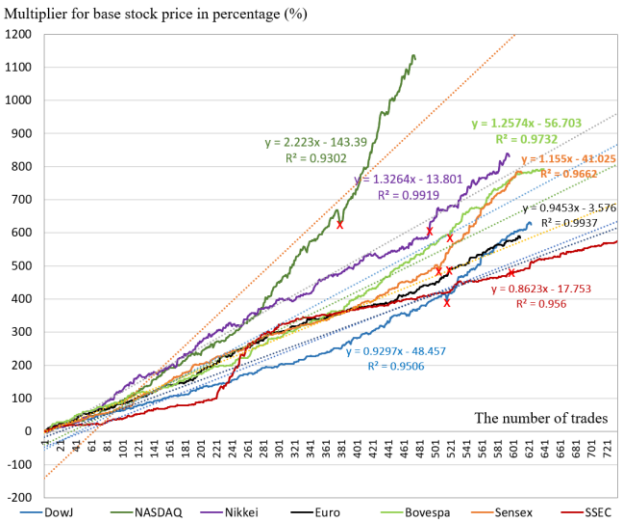

Figure 5. Cumulative profits in long position with fee.

Scarlet "X" marks on the graphs indicate the trade in the vicinity of the lowest price day, i.e., around March 18, 2020 [13]. Since that day, most stock markets have seen obvious increases in cumulative profits.

Figure 6 shows the line graphs of cumulative profits in a short position without the margin interest. All R^2s are greater than 0.9486 indicating significant correlation between the cumulative profits and the number of trades. In other words, the proposed reversal criterion in Figure 3 fairly predicts the bearish trend in all seven markets on an annual basis.

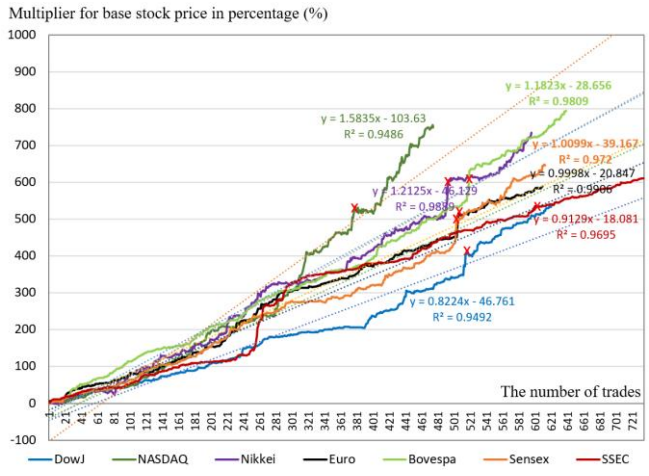

Figure 6. Cumulative profit in short position without margin interest.

Figure 7 shows the line graphs of cumulative profits including the margin interest. All lines are in the negative region, which means losses. The margin interest defined by (1) overwhelms the profits generated by the simulator.

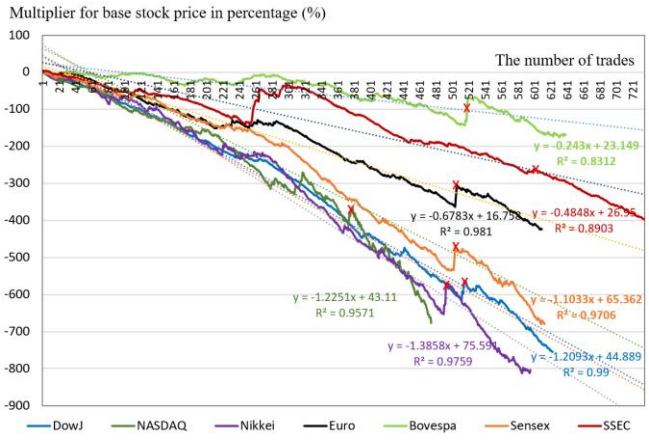

Figure 7. Cumulative profit in short position with margin interest.

Table VI shows the number of stock-holding days for all trades using NASDAQ historical data in long and short positions. Bullish reversals of 158 out of 476, i.e., 33.2%, are proved to be fail, which causes to change from a long position to a short position in one market day. On the other hand, bearish reversals of 227 out of 475, i.e., 47.8%, occurred in one market day. In this case, most trades yield losses for the payment of the margin interest of slightly greater than 1.15% according to (1).

TABLE VI. THE NUMBER OF HOLDING DAYS IN NASDAQ

Holding Days	Long position		Short position	
	Number of occurrences	Ratio (%)	Number of occurrences	Ratio (%)
1	158	33.2%	227	47.8%
2	111	23.3%	121	25.5%
3	69	14.5%	50	10.5%
4	39	8.2%	32	6.7%
5	24	5.0%	18	3.8%
6	20	4.2%	7	1.5%
7	15	3.2%	11	2.3%
8	15	3.2%	3	0.6%
9	7	1.5%	3	0.6%
10	6	1.3%	2	0.4%
11	4	0.8%	1	0.2%
12	4	0.8%	0	0.0%
13	1	0.2%	0	0.0%
14	2	0.4%	0	0.0%
15	1	0.2%	0	0.0%
Total	476	100.0%	475	100.0%

In summary, the developed simulator has lower accuracy in a bearish trend prediction than a bullish trend prediction. Furthermore, the margin interest for borrowing stocks for taking a short position worsens profits, leading to notable losses.

C. *Trading Frequency and Profits*

As shown in Table VI, 33.2% of the trades based on the proposed method have one-day stock holding in a long position and 47.8% in a short position. Figure 8 shows a candlestick chart that includes a trade in which the number of days to hold stock is one, causing high frequency of trading. Since the stock price rises on the market day *t*, the simulator buys a stock in anticipation of a price increase. Since the stock price remarkably fall on the day *t+3*, the simulator sells the stock short. However, on the next day *t+4*, the price of the stock notably goes up, signaling the simulator to change positions and buy a stock. The number of holding days is one for this trade. Because the traded price of the stock on the day *t+4* is higher than the traded price on the day *t+3* in Figure 8, a loss, i.e., –SP1, is incurred.

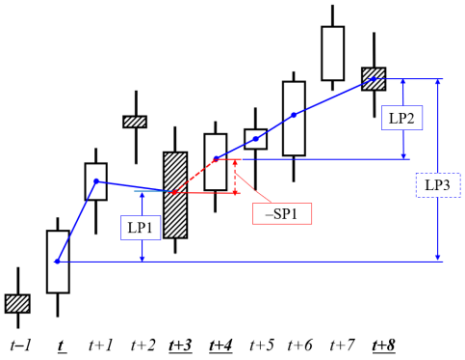

Figure 8. Candlestick chart including one-day stock holding.

The losses of –SP1 also worsen profits in a long position. If the short sale on the day *t+3* was avoided, the simulator could earn a profit LB3 calculated by the following formula:

$$LP3 = LP1 + SP1 + LP2 \quad (5)$$

Figure 9 shows a candlestick chart consisting of favorable trades whose holding days of a stock are longer than one. The developed simulator sells the stock in a short position because a stock price falls on the market day *t+3*. The stock price continues to fall on the next day *t+4*.

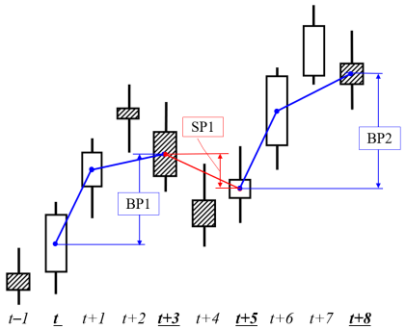

Figure 9. Candlestick chart consisting of favorable trades.

Since the stock price rises on the day *t+5*, the simulator takes a long position and buys the stock back. In this case, the traded price of the stock on the day *t+5* is fortunately lower than that on the day *t+3* as shown in Figure 9, a profit, i.e., SP1, is generated.

It is important to note that a trade with a one-day stock holding frequently results in losses, and causes low success rates. Methods using candlestick patterns are effective to avoid unsuccessful trading, which is discussed in [13].

D. Analysis of Trades in Long Position

Figure 10 is a scatter plot of all trades in a long position with the trading fee using the NASDAQ historical stock data. The Y-axis represents profits and the X-axis shows the number of days to hold a stock. As R^2 is 0.2161, there is an insignificant correlation between profits and holding days.

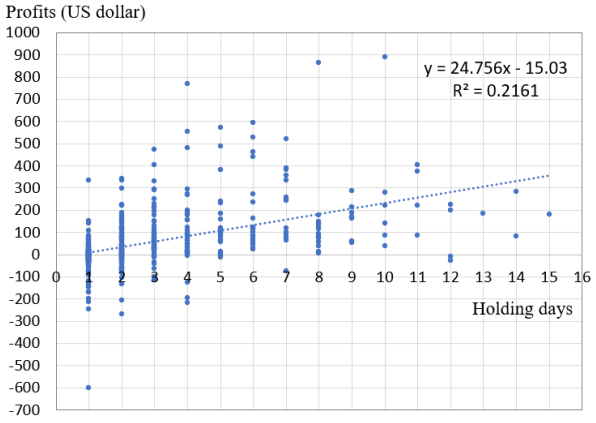

Figure 10. Scatter plot of profits and holding days in long position.

Points with a negative value on the Y-axis yield losses. They mostly occur in the range of one to four on the X-axis. In other words, trades with more than four holding days are generally profitable.

Figure 11 shows the candlestick chart of the most profitable trade whose point is located at the upper center in Figure 10. The trade begins on Mar. 30 and ends on Apr. 14, 2021 with ten holding days. The simulator makes sensible buying and selling decisions as far as this trade is concerned. The profits are UD$890.80 with the fee, and UD$903.90 without the fee.

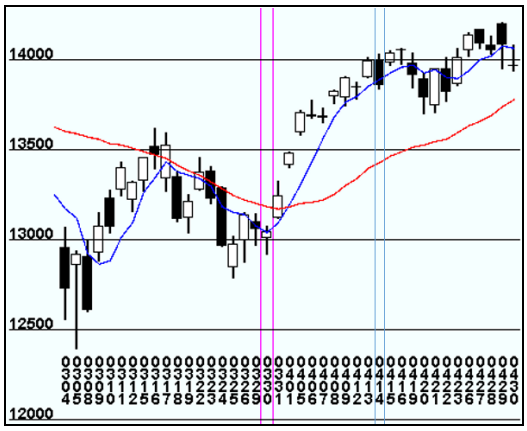

Figure 11. Candlestick chart on the most profitable trade occurred in 2021.

The trade that ends in the least profit is located at the lower left corner in Figure 10. The magenta vertical lines in Figure 12 indicate the traded date.

Figure 12. Candlestick chart on the least profitable trade.

The simulator takes a long position on Friday, Mar. 13, 2020. But the stock price plummets on the very next market day, i.e., Monday, Mar. 16, 2020. The simulator reverses the position, causing a loss of US$601.70 with the trading fee or US$594.00 without the fee. During the periods when prices rise and fall frequently, as in this example, it is difficult to make good decisions based on the proposed criterion in Figure 2. The use of sophisticated candlestick patterns is discussed in [13] for achieving profitable trades.

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E. Analysis of Trades in Short Position

Figure 13 shows a scatter plot of all trades in a short position with the margin interest (1). The most lucrative trade is located at the upper center in Figure 13. The trade begins on Feb. 20 and ends on Mar. 2, 2020 with seven holding days as the orange and green vertical lines indicate in Figure 12. The profits are US$847.80 with the interest or US$965.40 without the interest.

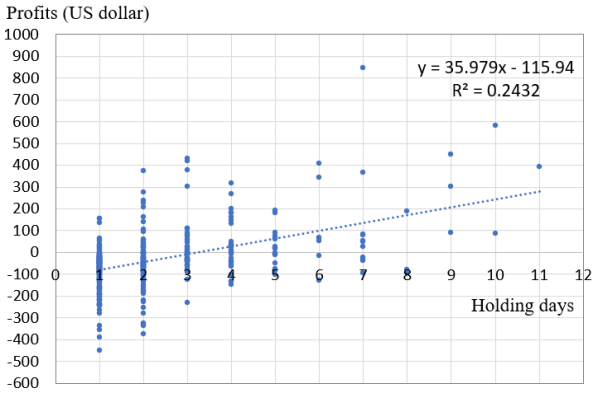

Figure 13. Scatter plot of profits and holding days in short position.

The most unsuccessful trade begins on Apr. 3, 2020 and ends on the following day, which is located at the lower left corner. Coincidentally, the trade with the worst losses is included in Figure 12, and is indicated by the red and dark gray vertical lines. As is the case for a long position, the simulator changes to the opposite position only in one market day. The losses are US$447.50 with the interest or US$361.50 without the interest.

IV. Conclusion and Future Work

This study deals with a stock trade simulator that tries to make profits in both long and short positions. The trade opportunities are decided based on the criteria using two parameters, i.e., the length of the candlestick body, and the difference between the closing price and the 5-day moving average. The symmetry of bullish and bearish reversal patterns is presumed. The optimal values of the parameters are determined thorough an exhaustive search method for seven global markets, i.e., Dow Jones Industrial Average, NASDAQ, Bovespa, Euro Stoxx 50, Sensex, SSEC, and Nikkei 225.

Stock trade simulations with and without stock trading fees are performed using the daily historical stock data of the seven markets for a period of ten years. The profits simulated in each market in a long position are noteworthy. The best performance is recorded in NASDAQ with 11.24 times the stock price at the beginning of the trade in ten-year simulation with fees. However, significant losses occur in each market in a short position. Margin interest to loan stocks is generally greater than a simulated profit in a short trade, especially when the trading period is one or two days.

Through a series of experiments, we find that the developed simulator has some limitations. The average of success rates in a long position remains in the middle of 60%, while it is at the beginning of 20% in a short position. The improvement of success rates is a major issue. In a highly volatile period of price fluctuation, the proposed criteria tend to result in a false prediction, incurring notable losses. There is an idea to refrain from trading stocks during the periods of market turbulence. This means developing a simulator with three states, i.e., buying, selling, and no trading.

Another interesting study subject is to simulate trades using individual stocks. This type of research is expected to be an important contribution toward practical stock trading.

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