Detecting Buying and Selling Territories in the Foreign Currency Exchange Market

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***Abstract*-The foreign currency exchange market is known for its unpredictability, making it a challenging environment for traders. The possibility to forecast with a certain degree of accuracy the directions of future price movements is a key component of successful trading. This paper presents a financial model, based on novel trading strategy. This strategy combines technical indicators, such as Moving Average and Relative Strength Index, which are calculated based on historical market data. Based on these technical indicators, buy and sell signals can be generated. These signals help define buying and selling territories within the data. As a result, the proposed financial model can identify potentially profitable trading opportunities, which can be applied in the foreign currency exchange market.**

Keywords-Technical Indicators, Moving Average, Relative Strength Index, Buy and Sell Signals

I. INTRODUCTION

The foreign currency exchange market is one of the largest and most volatile markets, with a daily average trading volume measured in trillions of USD per day [1]. There are multiple key problems, which traders need to consider, when entering this market. One major example is the unpredictability and volatility of the market, which can lead to unexpected losses. In addition, there is a high degree of complexity in analyzing and interpreting market data, making it difficult for traders to identify trends and profitable opportunities. Furthermore, increasing the capital increases the level of risk. Finally, traders might fall prey to scams or fraudulent schemes promising quick and easy profits. This paper proposes solutions, which have the potential to improve the trading outcomes and reduce the possible risks.

There are a number of solutions, which are available to mitigate these challenges. A possible solution is the utilization of automated trading systems, also known as algorithmic trading. These systems use mathematical models and pre-programmed trading strategies to make trading decisions, which eliminates emotional decision-making and improves trading discipline [2]. Another solution is to follow successful traders and replicate the decisions they made over a period of time. This is known as social trading and allows traders to learn and benefit from the strategies of previous trades [3]. An approached named *Next Cashtag Prediction* is being used on social trading platforms to generate valuable market information, which can be utilized by traders as presented in [4].

Furthermore, educational resources, such as face-to-face and online courses, webinars, and trading forums can provide traders with the necessary knowledge to develop sound trading skills. Additionally, the use of demonstration accounts, which simulate real market conditions with virtual money, can allow traders to practice and refine their trading strategies without risking real capital. This approach is known as Paper Trading.

This paper proposes a trading strategy that combines two technical indicators, namely Moving Average (MA) and Relative Strength Index (RSI), to generate buy and sell signals for a given currency pair, for example GBP to USD. The proposed algorithm uses historical data from Yahoo Finance to generate the charts and to calculate MA, RSI, and RSI-based MA values. The trading strategy then traverses the historical exchange rate data to identify buy and sell signals based on the mid-point values crossing above or below the MA and the RSI crossing above or below the RSI-based MA. The proposed trading strategy can be helpful to traders by providing a clear set of rules for opening and closing positions. This can help them avoid impulsive and emotional decision-making, which is a common pitfall in trading. Additionally, the use of multiple technical indicators in the proposed algorithm increases the reliability of the trading signals, reducing the likelihood of false signals and minimizing potential losses.

II. VISUALIZING FINANCIAL DATA

Visualizing data is key in the areas of Finance and Trade. Multiple types of charts are developed to

visualize various market activities and to help the decision-making process. This section takes a closer look at two popular types of financial charts, namely *Candlestick* and *Renko*. In addition to the data visualization, Candlestick charts provide an illustration of some of the values, which are utilized in the algorithms proposed in this paper.

A. Candlestick Charts

The Candlestick charts, illustrated in Figures 1 and 2, utilize four values for each period, namely Low (minimum price), Open (opening price), Close (closing price), and High (maximum price). Additionally, a Mid-point (M) value can be inferred by Formula 1.

$$M = (High + Low) / 2 \qquad (1)$$

Candlestick charts are particularly useful for illustrating short-term price movements, since they provide four values between the opening and closing of the market.

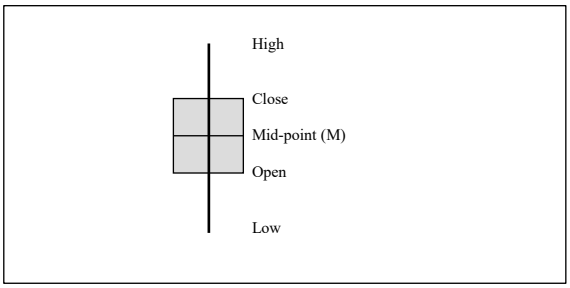

Figure 1: Components in Candlestick charts. Two cases can be observed. If the closing price is greater than the opening price, the chart illustrates a *bullish* pattern. Otherwise, a *bearish* pattern is observed. In many cases in practice, these two types are color-coded.

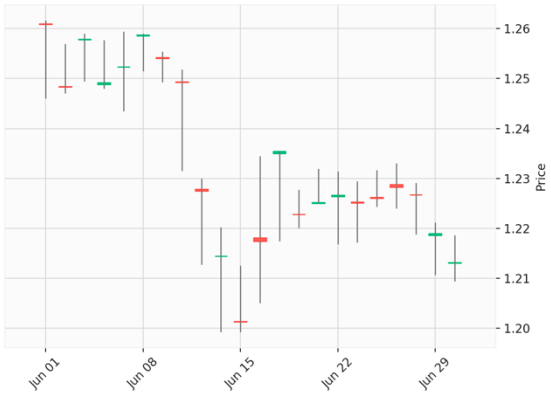

Figure 2: Candlestick chart visualizing GBP to USD exchange rate for June 2022. Data is obtained from Yahoo Finance.

B. Ranko Charts

A possible alternative to the Candlestick chart is the Renko chart. This is a visualization technique that has been increasingly employed by traders in the foreign currency exchange market. This technique involves the use of Renko bricks, also called blocks or boxes. Those bricks, which are visualized on the chart as rectangles, represent the price movements. Each brick represents a fixed price movement in the market, regardless of the time it takes for the movement to occur. The size of the bricks, which corresponds to a specific price movement, can be customized to fit the trading strategy of the trader. Additionally, Renko bricks can be color-coded, based on the direction of the price movement. Renko charts are unique due to the fact that they ignore time and focus on price action [5].

One of the main benefits of using Renko charts is their ability to filter out small fluctuations, which can be considered noise in the market data, and thus allowing the traders to focus on more significant price movements. This makes them particularly useful for traders, who prefer to trade based on price action, rather than relying on other indicators, such as *Moving Average Convergence/Divergence* of *Bollinger Bands*. Renko chart can also help traders identify key levels of *support* and *resistance* in the market, which can be used to support trading decisions.

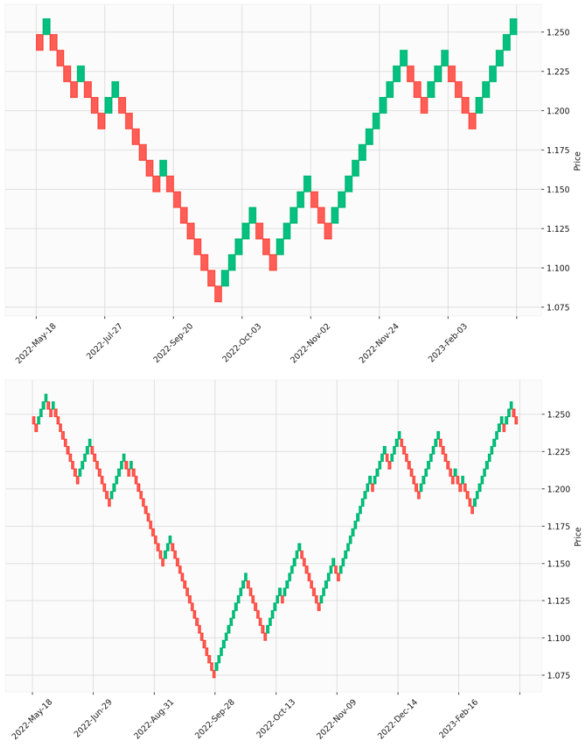

Figure 3: Two Renko charts with different sizes of bricks visualizing the closing position of the GBP to USD for the period of 1 year, from 18 May 2022 until 18 May 2023

While Renko charts are not without limitations, for example in some cases brick size might be optimal for past data but not optimal for future data, they are powerful tool when used in conjunction with other technical indicators. As a result, they can allow traders to make informed decisions.

Overall, Renko charts can be a valuable addition to a trader's toolbox, particularly for those who are looking for a more prominent visual representation of price action, regardless of the timeframe. However, like any trading technique, it is important to thoroughly back-test and evaluate Renko charting before incorporating it into a trading strategy.

III. Moving Average

Another technique utilized in this paper is Moving Average (MA), also known as Moving Mean. This statistical technique is usually applied on time series and has applications in finance, digital signal processing and others. The MA calculates the average values of subsets of a dataset, or a time series. These subsets, also called windows (W), have fixed size of N data points. Each consecutive window is obtained by removing the first value from the previous window and adding the next value [6]. This approach, illustrated in Figure 4, is also called *Simple Moving Average*, in order to distinguish from other MA, such as *Exponential Moving Average* and *Weighted Moving Average*.

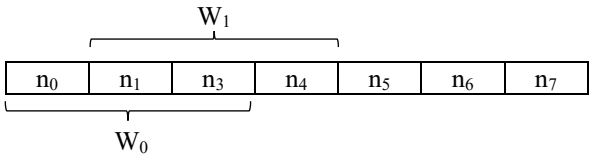

Figure 4: Moving Average on a data with window size of 3 data points

By the process of averaging, MA reduces short term fluctuations in the data and highlights long term trends and patterns. Traders use MA to determine a general direction of prices. MA can also help determine the entry and exit trading signals and define buying and selling territories. By varying the size of the window, MA can be implemented as short, intermediate and long-term indicator. A possible drawback of utilizing MA is that it would be slow to reflect price changes. This can be addressed by combining MA with other indicators, as suggested in this paper.

IV. Relative Strength Index

The Relative Strength Index (RSI) is a popular technical indicator, which identifies overbought and oversold market conditions. The RSI measures the magnitude of recent price changes to evaluate the market's strength and potential direction. The RSI value ranges from 0 to 100, with values above 70 indicate overbought conditions and values below 30 indicate oversold conditions [7]. The RSI is calculated using Equation (2).

$$RSI = 100 - [100/(1 + RS)] \qquad (2)$$

RS (Relative Strength) is the average of x days' up-closes divided by the average of the x days' down-closes. Typically, a period of 14 days is selected for the value of x.

In the foreign currency exchange market, traders use the RSI to identify potential entry and exit points. When the RSI value rises above 70, it signals that the market is overbought and traders may consider selling the corresponding currency. Conversely, when the RSI falls below 30, it signals that the market is oversold and traders may consider buying. Traders may also use the RSI to identify divergences between the indicator and the price, which can indicate a potential trend reversal. Overall, the RSI is a useful tool for traders to identify overbought and oversold market conditions and to help determine potential entry and exit points [8].

However, as with other technical indicator, it would improve the overall process if RSI is utilized in conjunction with other trading techniques.

V. RSI-MA Based Approach

This paper proposes a solution, which utilizes four technical indicators, which are incorporated within the market data. The trading algorithm employs the Mid-point price (M), as illustrated in Figure 1, the Moving Average of the Close value (MA), the RSI and the Moving Average of the RSI (RSI_MA). Buy and sell signals for set period and set currency pair are generated based on the values of those indicators. Algorithm 1 illustrates the proposed solution.

The proposed trading strategy triggers a buy signal, if the Mid-point is greater than the Moving Average of the Close value (M>MA). This indicates a potential upward price movement. In order to confirm this trend, the aforementioned condition is combined by checking whether the RSI is greater than its Moving Average (RSI>RSI_MA). Equation (3) illustrates this condition.

$$(M > MA)AND(RSI > RSI\_MA) \qquad (3)$$

Conversely, the sell signal is triggered if the Mid-point has smaller value that the Moving Average of the Close value and the RSI is smaller than the Moving Average of the RSI, as shown in Equation (4).

$$(M < MA)AND(RSI < RSI\_MA) \qquad (4)$$

The position size for each trade is determined by the lot size variable. Its standard value is 100,000 units of the selected currency. In this study, the algorithm was tested with lot size of 0.01. When a position is opened, the entry price, side (buy or sell), and lot size are stored in a **Position**, which can be implemented as linear data structure.

Algorithm 1

```
for all data points do
  Calculate Mid-point values (M)
  Calculate Moving Average based on Close (MA)
  Calculate RSI
  Calculate Moving Average based on RSI (RSI_MA)
end for
j = 0
Position_all = None
for i = 0 to N - 1 do
 if ( M_i > MA_i ) AND ( RSI_i > RSI_MA_i ) then
  if ( Position_j = None ) OR ( Position_j = Sell ) then
   Position_j = Buy
  end if
 end if
 if ( M_i < MA_i ) AND ( RSI_i < RSI_MA_i ) then
  if ( Position_j = None ) OR ( Position_j = Buy ) then
   Position_j = Sell
  end if
 end if
 j = j + 1
end for
```

Where: N: number of data points after calculating the technical indicators
Close: columns from the dataset

VI. RSI-MA Based Re-Entry Approach

The proposed trading algorithm can be further improved and extended by including a re-entry strategy. If a position is open and the RSI value crosses below the RSI_MA value for a buy position or crosses above the RSI_MA value for a sell position, the algorithm starts looking for an exit signal. The exit signal is generated if the price moves against the position. In this case, a bearish candle occurs for a buy position, or a bullish candle occurs for a sell position.

Algorithm 2

```
for i = 0 to N-1 do
  if ( Position_i = Buy ) AND ( RSI_i < RSI_MA_i ) then
    for j = i+1 to N-2 do
      if ( Close_j < Close_j+1 ) then
        ExitPrice = Close_j
        Profit_j = ( ExitPrice - EntryPrice ) × LotSize
        Position_j = Buy
        EntryPrice = Close_j
      end if
    end for
  end if
  if ( Position_i = Sell ) AND ( RSI_i > RSI_MA_i ) then
    for j = i+1 to N-2 do
      if ( Close_j > Close_j+1 ) then
        ExitPrice = Close_j
        Profit_j = ( ExitPrice - EntryPrice ) × LotSize
        Position_j = Sell
        EntryPrice = Close_j
      end if
    end for
  end if
end for
```

When an exit signal is generated, the algorithm closes the existing position and re-opens a new position in the opposite direction with the same lot size. The profit or loss for each closed position is calculated as the difference between the entry and exit prices, multiplied by the lot size. Algorithm 2 illustrates this approach. This trading strategy attempts to generate profits from short term fluctuations in the currency pair's exchange rate. This is relatively low-risk strategy for traders. Note, that variable *Profit* from Algorithm 2 can have a positive or a negative value.

VII. Experiment

The proposed Algorithms 1 and 2 has been implemented by using the Python programming language [9] along with the numerical library pandas [10] and the plotting libraries Matplotlib and mplfinance [11]. The data is acquired from Yahoo Finance [12] in the form of Comma-Separated Values (CSV) dataset. Table 1 demonstrates the first 4 rows of the dataset.

Table 1: The GBP-USD exchange rate, as provided by Yahoo! Finance

Date	Open	High	Low	Close	Adj Close	Vol
18/05/2022	1.249048	1.250062	1.237425	1.248439	1.248439	0
19/05/2022	1.234766	1.25227	1.234065	1.234583	1.234583	0
20/05/2022	1.246556	1.249875	1.243967	1.246215	1.246215	0

The dataset is indexed by its first column, Date. Columns "High" and 'Low" are used for the generation of the Mid-point values. Column 'Close" is used for calculating the values of MA, RSI and RSI_MA. The combined results of Algorithms 1 and 2 utilising the aforementioned dataset are shown in Figure 5.

VIII. Results

Algorithms 1 and 2 generate the trading plot of the historical foreign currency exchange data for the given period, along with markers indicating buy and sell signals based on Mid-point prices, MA, RSI and RSI-based MA. The plot shows the closing prices for the foreign currency exchange data over time, with buy signals indicated by green triangles pointing upwards and sell signals indicated by red triangles pointing downwards. The signals are generated by checking whether the current Mid-point price is greater than the current MA value and whether the current RSI value is greater than the current RSI-based MA value. If both conditions are met, a buy signal is indicated, and if both conditions are not met, a sell signal is indicated. Otherwise, no signals are generated.

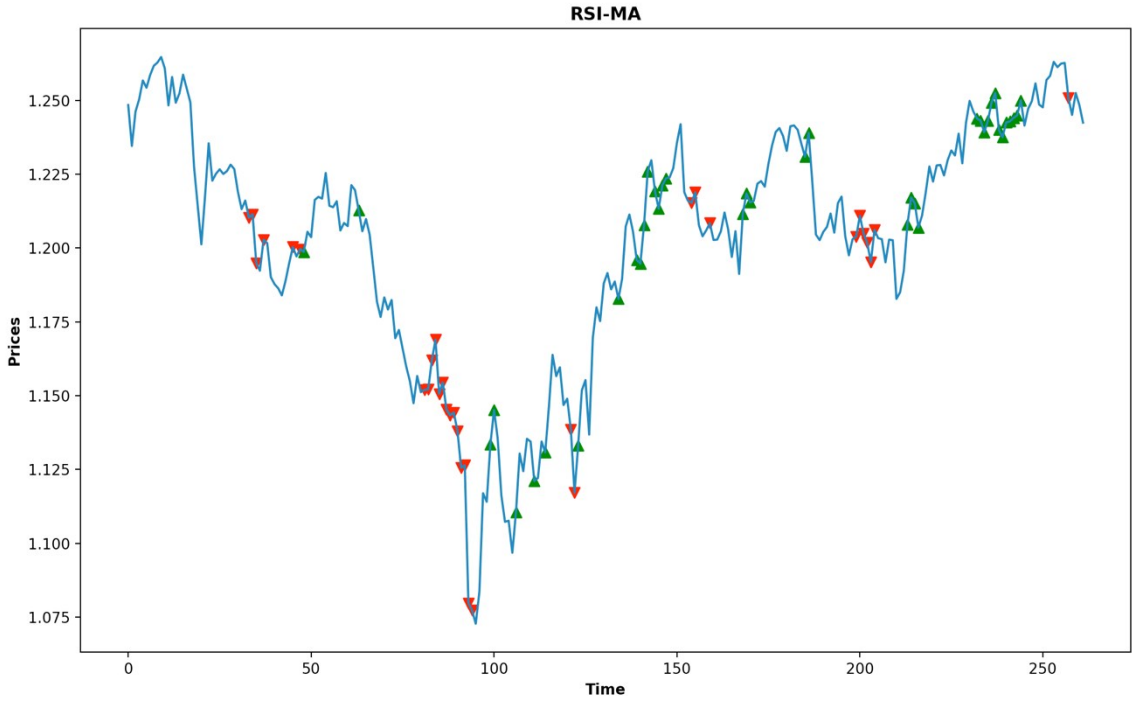

Figure 5: Buy and Sell signals generated by Algorithms 1 and 2 and visualized by using the Python library Matplotlib and data obtained from Yahoo Finance. The number of data points correspond with the number of work days in the selected year. The selected data points are from May 2022 until May 2023, which amounts to 261 data points.

By visually inspecting the plot, it can be seen that the algorithms generate a number of buy and sell signals throughout the historical data. However, it is important to note that the effectiveness of these signals in predicting future prices is not based on a single aspect, but rather other factors like policies, news and additional technical indicators.

IX. Conclusions and Future Works

The strategy proposed in this paper is designed to be straightforward to implement using various programming languages and as a result making it suitable for traders. The experimental results demonstrate that the proposed strategy can achieve superior returns, compared to traditional buy-and-hold strategies. This strategy could be a valuable tool for retail traders looking to improve their trading performance in the foreign currency exchange market. The proposed trading strategy combines the powers of technical indicators, in order to identify profitable trading opportunities in the foreign exchange market. This strategy could be a valuable addition to the arsenal of any trader looking to improve their trading performances in the foreign currency exchange markets.

Future work based on this approach can be pursued in several directions, with the aim to enhance the proposed trading strategy. The integration of additional indicators, such as Moving Averages Convergence/Divergence (MACD) or Bollinger Bands, could provide a more comprehensive view of the market trends. Exploring machine learning algorithms for improved buy and sell signals, integrating sentiment analysis to capture market sentiment, and conducting live testing and real-time implementation are also important areas of future work. Development of educational resources, user-friendly interfaces, and compliance with regulations could be considered, along with real-time market data integration and case studies. By pursuing these avenues, the proposed trading strategy can be further developed and refined.

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