

Comparison of Forecasting Using Fuzzy Time Series Chen Model and Lee Model to Foreign Exchange in EUR/USD and GBP/USD

Syehudin^{1*}, Anggyi Trisnawan Putra¹

¹ Department of Computer Science, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Semarang, Indonesia

*Corresponding author: syehudin1@students.unnes.ac.id

ARTICLE INFO

ABSTRACT

Article history

Received 17 February 2021

Revised 15 March 2021

Accepted 12 April 2021

Keywords

Forecasting

Fuzzy Time Series

Foreign Exchange

Each country has a currency value that applies in its territory and can be adjusted to the value of the currency of other countries. In this adjustment, there is a difference in value when the transaction is made, and the difference in profit can be taken, usually referred to as foreign exchange (forex). In forex trading, analytical calculations are needed to plan a decision to get a significant difference so that the profits will increase. One analysis technique that can maximize the search for an enormous profit difference is by using the prediction method using the fuzzy time series. This method is a method that predicts future data based on historical data or past data. The fuzzy time series method has several models, including the Chen model and Lee model. In determining which model is the best, it is necessary to test using the AFER (average forecasting error rate) based on the level of accuracy of the smallest error value. By using historical data of EUR/USD and GBP/USD from 19 February 2019 to 19 February 2020, it is known that Lee's fuzzy time series method predicts better accuracy because Chen's model in foreign currency EUR/USD has a more significant error rate of 0.0018 (0.18%) or greater than Lee's model which only has a value of 0.0016 (0.16%). Then the Chen model in foreign currency GBP/USD has an error rate of 0.00445 (0.445%) or greater than the Lee model, which only has an error rate of 0.00297 (0.297%).

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1 Introduction

Each country has the correct currency in its respective territory, and the exact value of that currency differs from the value of the corresponding currency in the territory of other countries. However, it can be defeated so that it can be used to transact in international trade or what is commonly known as foreign exchange. The function of foreign exchange itself is, for example, as a medium of international currency exchange, a means of controlling exchange rates, a means of international payment, and a tool to facilitate international trade. The price of foreign exchange itself has been determined through various processes of demand and supply that take place in a market mechanism or the exchange rate. Several factors affect the demand and supply of currencies, namely government policies, the country's economic conditions, and unpredictable factors such as natural disasters or riots that can immediately affect political, economic conditions.

The fluctuations and differences in the value of each currency can be used to find the difference in profit, which is commonly referred to as forex trading (foreign exchange). The concept of forex trading is not like a money changer used only to fulfill the need to exchange currencies for

transactions in different countries so that there is a physical exchange of money. The forex concept is to take the difference between the two currencies being transacted. The basic idea is to buy when the currency's value is substantial and sell when the currency's value is weak. In forex, analytical calculations are needed to decide to get a significant difference so that more profits. In looking for a profit or difference in forex trading, it takes a lot of consideration and analysis to decide to buy or sell a currency value to achieve maximum profit. There are so many analytical methods to estimate the best decision to buy or sell currency values with a certain degree of accuracy. One of them is using the fuzzy time series method. This method is a model for predicting future data based on historical data or past data.

2 Methods

This research was developed from several references that are related to the research method. Some of them are prediction using the weighted fuzzy time series method for forecasting inflation, the fuzzy time series method for the Chen model and the Markov chain for predicting rice prices, even the fuzzy time series method for the Chen and Lee models for predicting gold, bank, oil and so on with the same order. However, the researcher uses the fuzzy time series method with order one from the daily opening value of EUR / USD and GBP / USD.

The research method provides an overview of the research design, including the procedures and steps that must be taken, the research time, the data sources, and by what steps the data are obtained and then processed and analyzed. The procedure is shown in Figure 1.

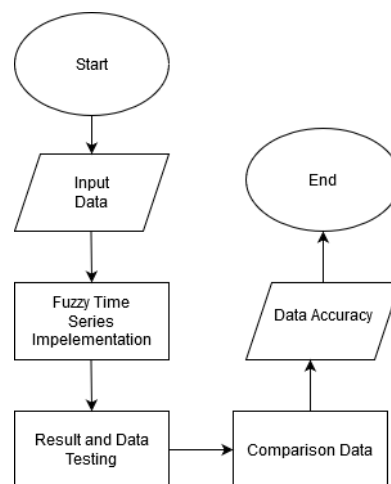


Figure 1. Flowchart method

2.1 Data Collection

The data is obtained from investing.com and takes 262 daily information on EUR / USD and GBP / USD, which is one-year data from the opening price from 19 February 2019 to 19 February 2020 but closed on Saturdays and Sundays (weekends).

2.2 Fuzzy Time Series

2.2.1 Determine the set of universes

At this stage, the minimum and maximum values of the actual data to be studied are sought.

2.2.2 Specifies the number and range of classes

The research uses the Sturges rule to determine the number of intervals divided into several intervals according to calculations, although there are many ways to decide the number of intervals. After the number of intervals is known, the next step is to calculate the width of the interval to divide the data by the number of equal intervals.

2.2.3 Determine the fuzzy set against the set universe

This stage changes the set of universes that have been divided and are still a set of crisp numbers into a fuzzy set based on intervals. Fuzzy sets are formed with the size of the $n \times n$ matrix. The value of n is the value obtained from the results of the universe of discourse.

$$\begin{aligned} A_1 &= a_{11}/u_1 + a_{12}/u_2 + \dots + a_{1n}/u_n \\ A_2 &= a_{21}/u_1 + a_{22}/u_2 + \dots + a_{2n}/u_n \\ &\dots \\ A_k &= a_{k1}/u_1 + a_{k2}/u_2 + \dots + a_{kn}/u_n \end{aligned}$$

2.2.4 Fuzzification of historical data

This stage determines the membership value of each fuzzy set from historical data, with membership values being 0 to 1.

2.2.5 Determine Fuzzy Logical Relationship (FLR)

Rationalize the Fuzzy Logical Relationship, for example, and there are $F(i) = A_i$ dan $F(i + 1) = A_j$. The relationship between two consecutive observations, $F(i)$ and $F(i + 1)$, becomes $F(i) \rightarrow F(i + 1)$, is called the fuzzy logic relation, denoted by $A_i \rightarrow A_j$, where A_i is named with LHS (Left Hand Side) or current data and A_j is named with RHS (Right Hand Side) or subsequent data.

2.2.6 Determine Fuzzy Logical Relationship Group (FLRG)

The value of each relationship obtained will be combined or commonly known as FLRG (Fuzzy Logical Relationship Group). The way of grouping is from the same left side. For this sequence of FLRG formation, several models are often used, namely the Chen and Lee model. The difference between the two models is the way they are grouped.

a. Chen Model

If there is the same relation, it will not be calculated according to Chen's model. The example is $(A_i) = A_i \rightarrow A_{j1}, A_i \rightarrow A_{j1}$ and $A_i \rightarrow A_{j2}$. Chen model will result $A_i \rightarrow A_{j1}, A_i \rightarrow A_{j2}$, where the relation $A_i \rightarrow A_{j1}, A_i \rightarrow A_{j1}$ it is enough to take one of them because the two relations are considered the same.

b. Lee Model

However, it is different from Lee's model because it includes all existing relationships even though the relation is the same. The example is $(A_i) = A_i \rightarrow A_{j1}, A_i \rightarrow A_{j1}$ and $A_i \rightarrow A_{j2}$. Lee model will result $A_i \rightarrow A_{j1}, A_i \rightarrow A_{j1}$ and $A_i \rightarrow A_{j2}$. result of the relation $A_i \rightarrow A_{j1}, A_i \rightarrow A_{j1}$ must be calculated of Lee models.

2.2.7 Defuzzification

At this stage, the fuzzy output will be converted into a crisp value based on the membership function to calculate the predicted results.

2.3 Accuracy

The method of measuring the model's accuracy using the average forecasting error rate (AFER) value, as shown in Equation 1.

$$AFER = \sum_{i=1}^n \frac{|A_i - F_i|/A_i}{n} \times 100\% \quad (1)$$

3 Results and Discussion

Determining the best model between Chen and Lee's models can be found using the error rate measure in the model. The smaller the error rate or error value, the better the model can be concluded. There are various ways and formulas in measuring the error rate, but in this study, the AFER (average

forecasting error rate) formula is used. Data comparison is made by comparing the error rate in each model. The following is a sample comparison of the actual value, predicted value, and the error rate of the Chen model EUR/USD graphic in Figure 2 and Chen model EUR/USD table in Table 1. Then Lee model EUR/USD graphic in Figure 3 and Lee model EUR/USD table in Table 2. Then Chen model GBP/USD graphic in Figure 4 and Chen model GBP/USD table in Table 3. Then Lee model GBP/USD graphic in Figure 5 and Lee model GBP/USD table in Table 4.

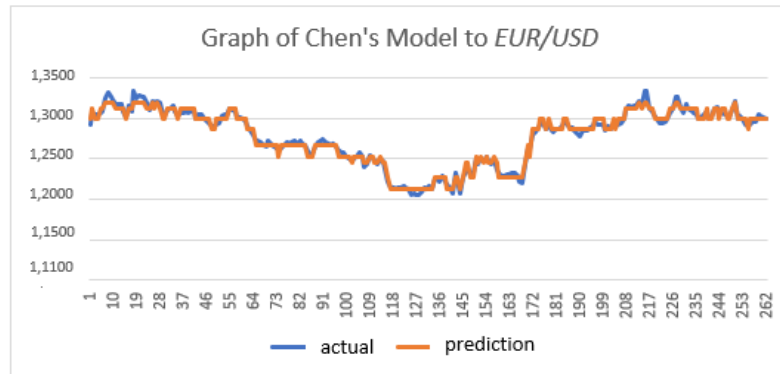


Figure 2. The graph of Chen’s model to EUR/USD

Table 1. The sample comparison of Chen’s model to EUR/USD

Number	Actual Value	Prediction Value	Accuracy
1	1,131	1,1276	0,00301
2	1,1342	1,1276	0,00582
3	1,1338	1,1276	0,00547
...
262	1,0792	1,0827	0,00324

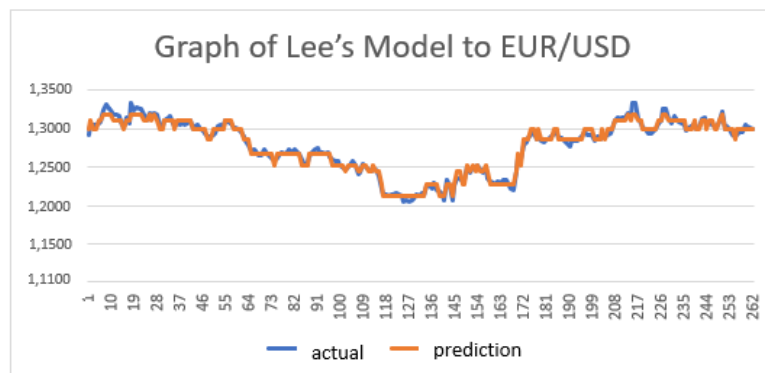


Figure 3. The graph of Lee’s model to EUR/USD

Table 2. The sample comparison of Lee’s model to EUR/USD

Number	Actual Value	Prediction Value	Accuracy
1	1,131	1,1301	0,0008
2	1,1342	1,1301	0,00361
3	1,1338	1,1301	0,00326
...
262	1,0792	1,0827	0,00324

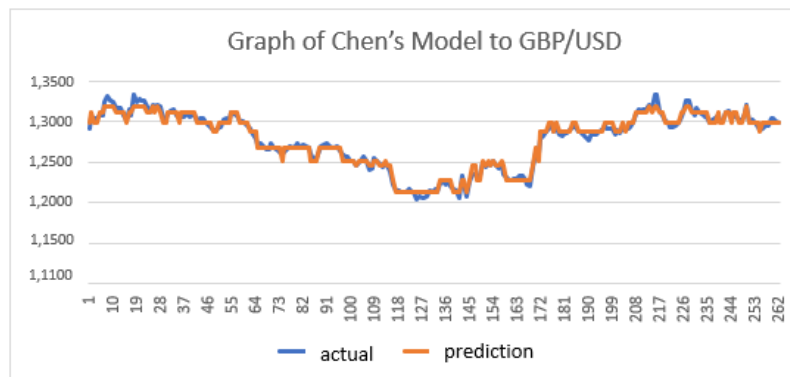


Figure 4. The graph of Chen's model to GBP/USD

Table 3. The sample comparison of Chen's model to GBP/USD

Number	Actual Value	Prediction Value	Accuracy
1	1,2922	1,2982	0,00464
2	1,3061	1,3126	0,00498
3	1,3052	1,2982	0,00536
...
262	1,2998	1,2982	0,00123

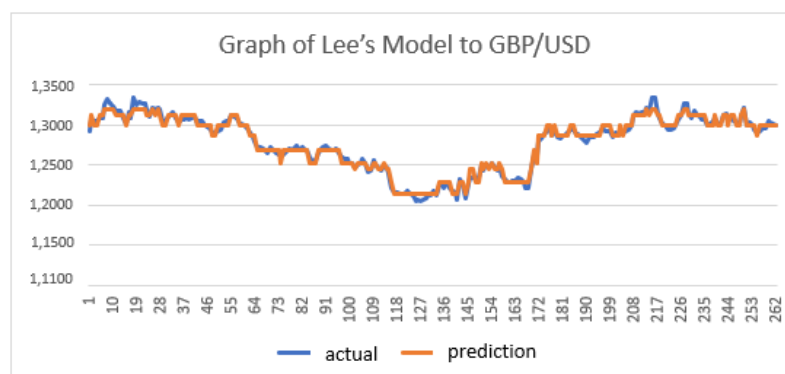


Figure 5. The graph of Lee's model to GBP/USD

Table 4. The sample comparison of Lee's Model to GBP/USD

Number	Actual Value	Prediction Value	Accuracy
1	1,2922	1,2989	0,00518
2	1,3061	1,312	0,00452
3	1,3052	1,2989	0,00483
...
262	1,2998	1,2989	0,00069

4 Conclusion

The best model for predicting foreign exchange at the daily opening value of EUR/USD and GBP/USD from the Chen and Lee fuzzy time series method from 19 February 2019 to 19 February 2020 is the Lee model. In the Chen model, EUR/USD foreign exchange has a more significant error rate of 0.0018 (0.18%) or more than the Lee model, which only has a value of 0.0016 (0.16%). Then the Chen model GBP/USD foreign exchange has an error rate of 0.00445 (0.445%) or greater than Lee's model, which only has an error rate of 0.00297 (0.297%).

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