

IMPLEMENTATION OF FUZZY TIME SERIES CHEN FOR FORECASTING INDONESIAN OIL AND GAS IMPORTS VALUE

Septri Damayanti^{1*}, Siska Yosmar², Nur Afandi³

^{1,2,3}Mathematics Study Program, Department of Mathematics, Faculty of Mathematics and Natural Sciences, Bengkulu University

WR. Supratman, Kandang Limun, Muara Bangka Hulu, Bengkulu, 38371, Indonesia

Corresponding author's e-mail: *septridamayanti@unib.ac.id

ABSTRACT

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Indonesia is an importing country that frequently imports goods from abroad continuously every year. Imported goods are oil and gas and non-oil and gas. This oil and gas import value data is an example of time series data, where the data is obtained from data recapitulation at the Central Bureau of Statistics (BPS). Time series analysis is a method for predicting an event that will come by looking at data from the previous time. One of the newest methods of time series analysis used in this research is Fuzzy Time Series Chen method. The purpose of this research is to find out how the implementation of Fuzzy Time Series Chen method in predicting the value of Indonesian oil and gas imports and to know the results of forecasting the value of Indonesian oil and gas imports. In predicting the value of Indonesia's oil and gas imports using Fuzzy Time Series Chen method, the results of forecasting the value of Indonesia's oil and gas imports in August 2022 were US\$ 3743.213 million with a MAPE value of 19.969%.



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1. INTRODUCTION

The more advanced the world trading system and the higher the level of human needs raise an increasingly modern method of trading between countries in which one part of the trade imports. Import is the process of entering goods from abroad into the country. Indonesia is an importing country that frequently imports goods from abroad continuously every year. Imported goods are oil and gas and non-oil and gas. Oil and gas include oil and gas, while non-oil and gas include food and live animals, beverages and tobacco, vegetable and animal oils, chemicals and their products, manufactured goods, machinery, transportation equipment, and so on [1].

The size of the total value of oil and gas and non-oil imports is always changing every year and does not always show an increasing trend, even in certain years, the value of imports of goods from abroad decreases, depending on the capacity of imports carried out, especially oil and gas imports. Indonesia has been known as an importer of oil and liquefied petroleum gas (LPG) for more than a decade, especially when domestic crude oil production continued to decline, the capacity of fuel oil refineries (BBM) did not increase, but demand continued to increase. However, during the current pandemic, Indonesia's oil and gas (oil and gas) imports are still high compared to the previous year [2].

Based on data from the Central Bureau of Statistics (BPS), Indonesia's oil and gas imports recorded that oil and gas imports in February 2022 had increased by 30.19 percent to US\$ 2.90 billion from the previous US\$ 2.23 billion in January 2022. Margo Yuwono, Head of BPS, explained that one of the factors causing the soaring oil and gas imports is the increase in the average price of Indonesian Crude Oil (ICP) to US\$ 95.72 per barrel in February 2022 from the previous US\$ 85.89 per barrel in January 2022 [3]. Another cause is Russia's invasion of Ukraine. This news has an immediate impact on commodity prices, one of which is crude oil. World oil prices have skyrocketed. This condition is certainly detrimental to many parties, including Indonesia. Therefore, determining the target of import activities must be supported by accurate data information. To maintain this, it is necessary to use appropriate forecasting methods in order to support policymakers' decisions to determine the next target.

This oil and gas import value data is an example of time series data. Time series analysis is a method for predicting an event that will come by looking at data from the previous time. One of the newest methods of time series analysis is the Fuzzy Time Series which combines fuzzy logic with time series analysis. Fuzzy logic is a counting methodology with linguistic variables as a substitute for counting with numbers. Meanwhile, the fuzzy time series was discovered by Song Chissom in 1993 [4] using the principle of fuzzy logic as its basis. One of the methods in fuzzy time series is fuzzy time series Chen.

Following are some previous studies, including Vivianti's research on implementing of the fuzzy time series method for forecasting the number of visitors at Fort Rotterdam [5]. Rachim conducted a study comparing fuzzy time series with the Chen and S. R. Singh methods [6]. Moreover, Usmia researched forecasting gross regional domestic product data for the Special Region of Yogyakarta using a combination of fuzzy time series Chen with Particle Swarm Optimization [7].

From some of the previous fuzzy time series Chen studies, no one has ever discussed fuzzy time series Chen for the case of oil and gas import values, even though the case of an increase in the value of oil and gas imports is becoming an important issue in the world, especially for Indonesia. Furthermore, fuzzy time series is also one of the newest methods of analyzing time series data. Therefore, the author is interested in researching fuzzy time series Chen method in predicting the value of Indonesia's oil and gas imports. The purpose of this research is to find out how to implement Fuzzy Time Series Chen method in predicting the value of Indonesian oil and gas imports and to find out the results of forecasting the value of Indonesian oil and gas imports.

2. RESEARCH METHODS

2.1 Research Objects and Research Variables

In this study, the data used were secondary data obtained from data recapitulation at the Central Bureau of Statistics (BPS). The population in this study is all data on the value of Indonesian oil and gas imports (US\$ million). While the sample used in this study is data on the value of Indonesia's oil and gas imports from January 2015 to July 2022, as many as 91 data [3].

The variable used in this study is the value of oil and gas imports. The data shows the value of oil and gas imports in Indonesia in million US\$ per month from January 2015 to July 2022.

2.2 Data Analysis

2.2.1 Fuzzy Logic

Fuzzy logic was first developed by Lotfi Azker Zadeh through his writings in 1965 on fuzzy set theory. Fuzzy sets are the concepts that underlie the birth of fuzzy logic. Zadeh expands the theory of classical sets to become fuzzy sets so that classic sets are special occurrences of fuzzy sets. A fuzzy set is a set whose members have a certain degree of membership and whose value is within a closed interval $[0,1]$. A value of 0 indicates wrong, a value of 1 indicates true, and there are still values that lie between true and false, in other words the truth of an item is not only true or false [8].

2.2.2 Fuzzification and Defuzzification

Fuzzification is the first stage of the fuzzy inference process. At this stage, the input data is received, and the system determines the value of its membership function and changes the numeric variables (non-fuzzy variables) into linguistic variables (fuzzy variables). Meanwhile, defuzzification is a process that combines all fuzzy outputs into a specific result that can be used for each output system [9]. Therefore, the selection of the appropriate defuzzification method also has an influence on the fuzzy logic control system in producing the optimum response [10].

2.2.3 Fuzzy Time Series Chen

Fuzzy time series (FTS) is a data forecasting method that uses fuzzy principles as its basis. Forecasting systems with fuzzy times series capture patterns from past data and then use them to project future data. Fuzzy sets can be interpreted as a class of numbers with fuzzy boundaries. The values used in forecasting the fuzzy time series are the fuzzy sets of real numbers over a predetermined set of universes. Fuzzy sets are used to replace historical data to be forecast [11].

One of the methods in fuzzy time series is fuzzy time series Chen. The steps in completing the fuzzy time series forecasting with the Chen method are as follows [12]:

1. Determining the universe of discourse of historical data, namely:

$$U = [X_{min} - D_1, X_{max} + D_2] \quad (1)$$

where:

X_{min} : Minimum data

X_{max} : Maximum data

D_1 and D_2 is an arbitrary positive number determined by the researcher to determine the universal set of historical data sets.

Determining the width of interval using the following equation.

$$\text{width of interval} = \frac{X_{max} - X_{min}}{\text{number of intervals}} \quad (2)$$

With the number of intervals determined using the Sturges formula.

$$\text{number of intervals} = 1 + 3,322 \log(n) \quad (3)$$

Next, determine the defuzzification linguistic value and define the fuzzy set in the universe set.

2. Defining the fuzzy set A_i and fuzzifying the observed historical data. The membership degree value of $\mu_{A_i}(u_i)$ is determined according to the following rules:

Rule 1: If historical data X_t included in u_i , then the membership degree value for u_i is 1, and u_{i+1} is 0,5 and if it's not u_i and u_{i+1} , it's declared null.

Rule 2: If historical data X_t is included in u_i , $1 \leq i \leq p$ then the membership degree value for u_i is 1, for u_{i-1} and u_{i+1} is 0,5 and if not u_i , u_{i-1} and u_{i+1} , means declared zero.

Rule 3: If historical data X_t is included in u_p , then the membership degree value for u_p is 1, for u_{p-1} is 0,5 and if not u_p and u_{p-1} , it is null.

For example A_1, A_2, \dots, A_k are fuzzy sets that have linguistic values from a linguistic variable, the definition of fuzzy sets A_1, A_2, \dots, A_k in the universe of speech U is as follows:

$$A_1 = 1/u_1 + 0,5/u_2 + 0/u_3 + 0/u_4 + 0/u_5 + \dots + 0/u_p$$

$$A_2 = 0,5/u_1 + 1/u_2 + 0,5/u_3 + 0/u_4 + 0/u_5 + \dots + 0/u_p$$

$$\begin{aligned}
 A_3 &= 0/u_1 + 0,5/u_2 + 1/u_3 + 0,5/u_4 + 0/u_5 + \dots + 0/u_p \\
 &\vdots \\
 A_p &= 0/u_1 + 0/u_2 + 0/u_3 + \dots + 0,5/u_{p-1} + 1/u_p
 \end{aligned}
 \tag{4}$$

Where: $u_i (i = 1, 2, \dots, p)$ is an element of the universe set and the number marked with the symbol “/” denotes the membership degree of $\mu_{A_i}(u_i)$ to $A_i (i = 1, 2, \dots, p)$ where value is 0, 0,5 or 1.

3. Performing and creating Fuzzy Logical Relationship (FLR) tables based on historical data.
4. Classify the FLR that has been obtained from stage 3 into groups to form a Fuzzy Logical Relationship Group (FLRG) and combine the same relationships.
5. Defuzzification, namely the process of calculating the output results of the forecast to then calculate it so that you get the results from the crisp numbers, then add the actual data from the previous time to get the forecasting results. Forecasting values in the Chen model fuzzy time series method there are several forecasting rules must be considered, including:

Rule 1: If the result of the t fuzzification is A_j and there is a fuzzy set that does not have a fuzzy logic relationship, for example $A_i \rightarrow \emptyset$, where the maximum value of the membership function of A_i is in the interval u_i and the middle value of u_i is m_i , then the forecasting result F_{t+1} is m_i .

Rule 2: If the result of the t fuzzification is u_i and there is only one FLR in FLRG, for example if $A_i \rightarrow A_j$ where A_i and A_j are fuzzy sets and the maximum value of the membership function of A_j is in the interval u_j and the middle value of u_i is m_j , then the result forecasting F_{t+1} is m_i .

Rule 3: If the result of fuzzification in the t is A_j and A_j has several FLR in FLRG, for example $A_i \rightarrow A_{j1}, A_{j2}, \dots, A_{jk}$ where $A_i, A_{j1}, A_{j2}, \dots, A_{jk}$ is a fuzzy set and the maximum membership value of $A_{j1}, A_{j2}, \dots, A_{jp}$ is in the intervals $u_{j1}, u_{j2}, \dots, u_{jk}$ and $m_{j1}, m_{j2}, \dots, m_{jp}$, then the results of forecasting F_{t+1} are as follows:

$$F_{t+1} = \frac{m_{j1} + m_{j2} + \dots + m_{jk}}{k} \tag{5}$$

Where k is the number of middle values and to find the middle value (m_i) in the interval of the fuzzy set the following equation can be used:

$$m_i = \frac{(\text{batas atas} + \text{batas bawah})}{2} \tag{6}$$

6. Calculating the error value using the Mean Absolute Percentage Error (MAPE) to measure the accuracy of the forecast results. MAPE value can be calculated using the following formula [13]:

$$MAPE = \frac{100\%}{n} \sum_{t=1}^n \left| \frac{X_t - F_t}{X_t} \right| \tag{7}$$

Where:

X_t : Historical data

F_t : Forecasting value in period t

n : Amount of data

Forecasting ability is very good if it has a MAPE value of less than 10% and has good forecasting ability if the MAPE value is less than 20%.

3. RESULTS AND DISCUSSION

3.1 Descriptive Statistics

A descriptive analysis was carried out to briefly explain the general picture regarding data on Indonesia's oil and gas import values from January 2015 to July 2022.

Table 1. Value of Indonesia's Oil and Gas Imports (Million US\$)

Time	Value of Oil and Gas Imports (Million US\$) Year							
	2015	2016	2017	2018	2019	2020	2021	2022
January	2115.1	1221.5	1828.1	2259.2	1656.6	1987.1	1551.8	2229.2
February	1719.6	1122.9	2473.1	2234.8	1584	1747.6	1304.3	2902.3
March	2268	1552.4	2277	2239.1	1520.8	1606.5	2279.1	3492.2

Time	Value of Oil and Gas Imports (Million US\$) Year							
	2015	2016	2017	2018	2019	2020	2021	2022
April	2336.3	1362.1	1646.8	2328.2	2235.4	854.3	2023.4	3813.9
May	2080.5	1668.5	1791.6	2861.4	2182.2	657.5	2061.9	3353.7
June	2577.5	1772.2	1600.6	2141	1713	677	2297.8	3673
July	2294.3	1506.4	1778.7	2660	1748.1	958.2	1793.8	4455.3
August	2108	1795.9	2011.2	3045.7	1630.5	949.8	2049.2	-
September	1912.4	1766.4	1934.6	2290.5	1591.9	1173	1866.8	-
October	1763	1545.1	2206.9	2916.9	1755.3	1078.8	1898.1	-
November	1640.4	1724.1	2204.4	2866.7	2134.4	1085	3025	-
December	1798	1701.9	2563.2	2025.3	2133.2	1481.8	3377.8	-

Source: (Central Bureau of Statistics, 2022)

Based on **Table 1** above, it can be explained that the value of Indonesia's oil and gas imports from January 2015 to July 2022 as whole experienced increases and decreases in value each month. The average value of Indonesia's oil and gas import data is US\$ 2012.397 million with the highest oil and gas import value of US\$ 4455.3 million in July 2022 and the lowest oil and gas import value was in May 2020 of US\$ 657.5 million. The movement of the increase and decrease in the value of Indonesia's oil and gas imports from January 2015 to July 2022 can be seen in **Figure 1** below.

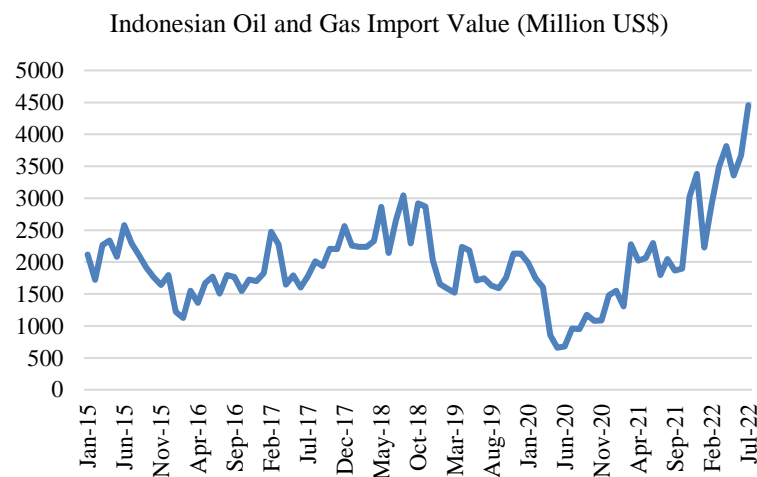


Figure 1. Plot of data on Indonesia's oil and gas import values from January 2015 to July 2022

3.2 Universe of Discourse

In Fuzzy Time Series Chen method, the first step is to form a universe set. This universal set is formed from the actual data available. The universal set is denoted by U by definition $[X_{min}; X_{max}]$. Where X_{min} is the lowest data and X_{max} is the highest data. In the data on the value of Indonesian oil and gas imports, an X_{min} value of US \$ 657.5 million and an X_{max} value of US \$ 4455.3 million is obtained, so that a universal set $U = [657.5; 4455.3]$ is formed.

3.3 Calculating of Intervals

The first step in forming intervals is to determine the number of class intervals and the length of the intervals. Determining the number of class intervals using the Sturges formula, with a lot of data in this study as many as 91 data. The number of class intervals is obtained as follows.

$$\begin{aligned} \text{number of class intervals} &= 1 + 3.322 * \log(n) \\ \text{number of class intervals} &= 7.508 \end{aligned}$$

From the calculation results, the value of the number of intervals is 7.508, the researcher rounds the results to 8 intervals. After obtaining the number of intervals, then determine the length of the interval. The determination of the interval length is obtained by the following calculation:

$$\begin{aligned}\text{interval length} &= \frac{X_{max}-X_{min}}{\text{number of class intervals}} \\ &= \frac{4455.3-657.5}{8} \\ &= 474.725\end{aligned}$$

After obtaining the number of class intervals of 8, and the length of the class intervals of 474.725, the universe sets (U) that are formed are $U_1, U_2, U_3, U_4, U_5, U_6, U_7$, and U_8 , with universal set intervals and middle values (m) as in **Table 2** below:

Table 2. Interval length

No	Interval	m
1	$U_1 = [657.5; 1132.225]$	894.863
2	$U_2 = [1132.225; 1606.95]$	1369.588
3	$U_3 = [1606.95; 2081.675]$	1844.313
4	$U_4 = [2081.675; 2556.4]$	2319.038
5	$U_5 = [2556.4; 3031.125]$	2793.763
6	$U_6 = [3031.125; 3505.85]$	3268.488
7	$U_7 = [3505.85; 3980.575]$	3743.213
8	$U_8 = [3980.575; 4455.3]$	4217.938

3.4 Calculating of Fuzzy Set

The formation of fuzzification aims to simplify by converting numeric data into linguistic data based on the intervals obtained. The set of universes $U_1, U_2, U_3, U_4, U_5, U_6, U_7$, and U_8 is obtained, which are assumed to be $A_1, A_2, A_3, A_4, A_5, A_6, A_7$, and A_8 to become a fuzzy set of linguistic values of linguistic variables. Fuzzy set values are among 0, 0.5, or 1, with $1 \leq i \leq 8$, where 8 is the number of class intervals. Thus the fuzzy set A_i is obtained which is formed as follows:

$$\begin{aligned}A_1 &= 1/u_1 + 0.5/u_2 + 0/u_3 + 0/u_4 + 0/u_5 + 0/u_6 + 0/u_7 + 0/u_8 \\ A_2 &= 0.5/u_1 + 1/u_2 + 0.5/u_3 + 0/u_4 + 0/u_5 + 0/u_6 + 0/u_7 + 0/u_8 \\ A_3 &= 0/u_1 + 0.5/u_2 + 1/u_3 + 0.5/u_4 + 0/u_5 + 0/u_6 + 0/u_7 + 0/u_8 \\ A_4 &= 0/u_1 + 0/u_2 + 0.5/u_3 + 1/u_4 + 0.5/u_5 + 0/u_6 + 0/u_7 + 0/u_8 \\ A_5 &= 0/u_1 + 0/u_2 + 0/u_3 + 0.5/u_4 + 1/u_5 + 0.5/u_6 + 0/u_7 + 0/u_8 \\ A_6 &= 0/u_1 + 0/u_2 + 0/u_3 + 0/u_4 + 0.5/u_5 + 1/u_6 + 0.5/u_7 + 0/u_8 \\ A_7 &= 0/u_1 + 0/u_2 + 0/u_3 + 0/u_4 + 0/u_5 + 0.5/u_6 + 1/u_7 + 0.5/u_8 \\ A_8 &= 0/u_1 + 0/u_2 + 0/u_3 + 0/u_4 + 0/u_5 + 0/u_6 + 0.5/u_7 + 1/u_8\end{aligned}$$

The next stage is fuzzification based on the intervals that have been obtained, so that linguistic values can be determined according to the number of intervals that have been formed. The fuzzification results are obtained as shown in **Table 3** below.

Table 3. Fuzzification

No	Time	Value of Oil and Gas Imports (Million US\$)	Fuzzification
1	January 2015	2115.1	A_4
2	February 2015	1719.6	A_3
3	March 2015	2268	A_4
4	April 2015	2336.3	A_4
5	May 2015	2080.5	A_3

No	Time	Value of Oil and Gas Imports (Million US\$)	Fuzzification
6	June 2015	2577.5	A_5
⋮	⋮	⋮	⋮
86	February 2022	2902.3	A_5
87	March 2022	3492.2	A_6
88	April 2022	3813.9	A_7
89	May 2022	3353.7	A_6
90	June 2022	3673	A_7
91	July 2022	4455.3	A_8

3.5 Fuzzy Logic Relationship (FLR) and Fuzzy Logic Relationship Group (FLRG)

Fuzzy Logic Relationship (FLR) is identified based on historical data that has been fuzzified in the previous stage. FLR is written $A_i \rightarrow A_j$, where A_i is the set of the left side or previous observations, namely $F_{(t-1)}$ and A_j is the set of the right side or current observations, namely $F_{(t)}$ in time series data. The FLR values can be seen in **Table 4** below.

Table 4. Fuzzy Logic Relationship (FLR)

No	Time	Value of Oil and Gas Imports (Million US\$)	Fuzzification	FLR
1	January 2015	2115.1	A_4	-
2	February 2015	1719.6	A_3	$A_4 \rightarrow A_3$
3	March 2015	2268	A_4	$A_3 \rightarrow A_4$
4	April 2015	2336.3	A_4	$A_4 \rightarrow A_4$
5	May 2015	2080.5	A_3	$A_4 \rightarrow A_3$
6	June 2015	2577.5	A_5	$A_3 \rightarrow A_5$
⋮	⋮	⋮	⋮	⋮
86	February 2022	2902.3	A_5	$A_4 \rightarrow A_5$
87	March 2022	3492.2	A_6	$A_5 \rightarrow A_6$
88	April 2022	3813.9	A_7	$A_6 \rightarrow A_7$
89	May 2022	3353.7	A_6	$A_7 \rightarrow A_6$
90	June 2022	3673	A_7	$A_6 \rightarrow A_7$
91	July 2022	4455.3	A_8	$A_7 \rightarrow A_8$

The next step is to form a Fuzzy Logic Relationship Group (FLRG). Based on the results of the FLR previously obtained by grouping each FLR side that has the same left side or $F_{(t-1)}$ then combining it with the appropriate group. The FLRG results can be seen in **Table 5** below.

Table 5. Fuzzy Logic Relationship Group (FLRG)

Group	FLRG
Group 1	$A_1 \rightarrow A_1, A_2$
Group 2	$A_2 \rightarrow A_1, A_2, A_3, A_4$
Group 3	$A_3 \rightarrow A_2, A_3, A_4, A_5$
Group 4	$A_4 \rightarrow A_3, A_4, A_5$
Group 5	$A_5 \rightarrow A_4, A_5, A_6$
Group 6	$A_6 \rightarrow A_4, A_7$
Group 7	$A_7 \rightarrow A_6, A_8$
Group 8	$A_8 \rightarrow A_7$

3.6 Defuzzification

The defuzzification process in Fuzzy Time Series Chen uses the middle value of each fuzzy group. The results of defuzzification in this study can be seen in **Table 6**.

Table 6. Chen's fuzzy time series defuzzification

Group	FLRG	F(t)	Forecasting
1	$A_1 \rightarrow A_1, A_2$	$\frac{m_1+m_2}{2}$	1132.226
2	$A_2 \rightarrow A_1, A_2, A_3, A_4$	$\frac{m_1+m_2+m_3+m_4}{4}$	1606.951
3	$A_3 \rightarrow A_2, A_3, A_4, A_5$	$\frac{m_2+m_3+m_4+m_5}{4}$	2081.676
4	$A_4 \rightarrow A_3, A_4, A_5$	$\frac{m_3+m_4+m_5}{3}$	2319.038
5	$A_5 \rightarrow A_4, A_5, A_6$	$\frac{m_4+m_5+m_6}{3}$	2793.763
6	$A_6 \rightarrow A_4, A_7$	$\frac{m_4+m_7}{2}$	3031.126
7	$A_7 \rightarrow A_6, A_8$	$\frac{m_6+m_8}{2}$	3743.213
8	$A_8 \rightarrow A_7$	m_7	3743.213

The defuzzification process in Fuzzy Time Series Chen uses the middle value of each fuzzy group. The results of defuzzification in this study can be seen in **Table 6**. The forecasting value from the defuzzification is then directly extracted into data on the value of Indonesia's oil and gas imports based on the results of the previous fuzzification. The results of forecasting the value of Indonesia's oil and gas imports for the entire data are as follows.

Table 7. Forecasting with Fuzzy Time Series Chen

No	Time	Value of Oil and Gas Imports (Million US\$)	Forecasting of Oil and Gas Import Value (Million US\$)	Error
1	January 2015	2115.1	-	-
2	February 2015	1719.6	2319.038	34.859
3	March 2015	2268	2081.676	8.215
4	April 2015	2336.3	2319.038	0.739
5	May 2015	2080.5	2319.038	11.465
6	June 2015	2577.5	2081.676	19.237
:	:	:	:	:
86	February 2022	2902.3	2319.038	20.097
87	March 2022	3492.2	2793.763	20.000
88	April 2022	3813.9	3031.1255	20.524
89	May 2022	3353.7	3743.213	11.614
90	June 2022	3673	3031.1255	17.475
91	July 2022	4455.3	3743.213	15.983
MAPE				19.969

Determining the forecast value for the next period can be done by looking at the FLR in the previous period. After that, the FLR is matched with the FLRG that has been formed, the forecast for the value of Indonesia's oil and gas imports in the next period, namely August 2022, is obtained as follows.

Table 8. Forecasting of Chen's fuzzy time series for the next period

Time	Value of Oil and Gas Imports (Million US\$)	Fuzzification	FLR	Forecasting (Million US\$)
July 2022	4455.3	A_8	$A_7 \rightarrow A_8$	3743.213
August 2022		A_7	$A_8 \rightarrow A_7$	3743.213

Researchers will predict the value of Indonesia's oil and gas imports in August 2022. Based on **Table 8**, it is known that in August 2022. The FLR formed is $A_8 \rightarrow A_7$. Therefore, a forecast is obtained for the value of Indonesia's oil and gas imports in the August 2022 period, which is US\$ 3743.213 million. The results of Fuzzy Time Series Chen forecasting will be compared with actual data on the value of Indonesia's oil and gas imports. This comparison can be seen from the plot in **Figure 2** below.

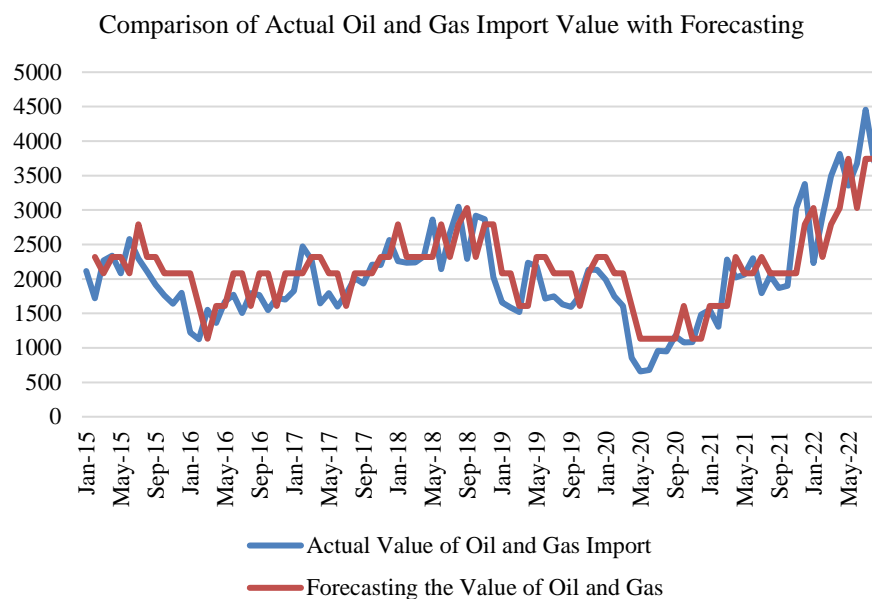


Figure 2. Plot comparison of actual and forecasting oil and gas import values

Based on the plot in **Figure 2**, it can be seen that the blue line shows the actual data and the red line shows Fuzzy Time Series Chen forecasting. It can be seen that the actual and forecast data have slight differences but are still close to the actual data values.

4. CONCLUSIONS

Based on the results of the analysis and discussion in the research that has been conducted, it is concluded that the average value of Indonesia's oil and gas import data is US\$ 2012.397 million, with the highest oil and gas import value of US\$ 4455.3 million in July 2022, and the value the lowest oil and gas imports were in May 2020, namely US\$ 657.5 million. From the results of Fuzzy Time Series Chen analysis on data on Indonesia's oil and gas import values from January 2015 to July 2022, a MAPE forecasting accuracy measure of 19.969% was obtained, so it can be said that this method is good for predicting Indonesian oil and gas import value data. And the forecasting value for the next period in August 2022 on Indonesia's oil and gas import value data using Fuzzy Time Series Chen is US \$ 3743.213 million.

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