

FORECASTING INDONESIAN ISLAMIC BANK (BSI) SHARE PRICES USING THE FUZZY TIME SERIES CHENG METHOD

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ABSTRACT

Shares were one of the most popular financial market instruments. In Indonesia, stock market activity continued to increase so that stock investment was in great demand by the public, especially in the banking sector. Indonesia had a majority Muslim population. Based on this, Indonesia had good potential in the field of Islamic finance, especially Islamic banking. One of the Islamic banks that had achieved positive performance was Bank Syariah Indonesia (BSI). BSI's stock price every day from February 1, 2021, to January 11, 2023, tended to experience a downward trend and fluctuated, making it difficult for investors to see the prospects of a company in the future. For this reason, a forecasting technique was needed. A good forecasting method used for data with trend patterns both down and up was Cheng's Fuzzy Time Series (FTS) method. So, this study used Cheng's FTS method to predict BSI's share price in the future. The calculation of the accuracy of the prediction results in this study used Mean Absolute Percentage Error (MAPE). The results showed that the forecasted value of BSI's share price for the period January 12, 2023, to January 31, 2023, was constant at 1,353.267 million with a MAPE value of 3.09%.

Keywords: *FTS Cheng, BSI Share Price, Forecasting*

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INTRODUCTION

Shares are one of the most popular financial market instruments. In Indonesia, stock market activity continues to increase. Judging from the last seven years, companies listed on the Indonesia Stock Exchange (BEI) have grown 6.50% yearly (Kementrian Koordinator Bidang Perekonomian RI, 2022). Therefore, stock investment is quite popular among people today, especially stock in the banking sector. Referring to data released World Population Review (2022), Indonesia is a country with a Muslim population of around 231 million people. This makes Indonesia the country with the largest Muslim population in the world, and occupies the first position. Based on these data, Indonesia has enormous potential in the Sharia economy, and finance, especially the banking sector. One of the banks in Indonesia that operates in the sharia banking sector is Bank Syariah Indonesia.

Bank Syariah Indonesia (BSI) is the result of the merger of Bank Syariah Mandiri, BNI Syariah, and BRI Syariah into one. PT Bank Syariah Indonesia (BSI) was officially introduced at the opening of share trading on the Indonesian Stock Exchange (BEI). After this was discovered, the issuer with the stock code BRIS recorded positive performances, including was an increase in the share price per share of up to five times (Wajdi, 2022). Based on data released in 2022 by PT Bank Syariah Indonesia (BSI), it is known that BSI share prices fluctuate every day. These fluctuating share prices make it difficult for investors to see a company's future prospects, so forecasting techniques are needed. The technique that can be used in stock price forecasting is time series analysis.

Time series analysis is a series of observational data that occurs based on time indices sequentially at fixed time intervals (Yulistiani & Suliadi, 2019). According to Wang et al. (2016), the method developed to overcome the weaknesses of previous forecasting methods such as Single Exponential Smoothing (SES) and Moving Average (MA) is the Fuzzy Time Series (FTS) method. Many FTS methods have been developed, including is Cheng's fuzzy time series. FTS Cheng is a method that has a slightly different way of forming FLRG, namely using Fuzzy Logical Relationship (FLR) by including all relationships, and giving weighting based on the sequence, and repetition of the same FLR (Mustika, 2021).

One of the studies related to BSI share prices was carried out by Wajdi (2022) by modeling BSI share prices using the fuzzy Markov Chain time series method. It was found that FTSMC provided an accuracy value of less than 10%, namely with a MAPE value of 6.40%. Other research regarding Cheng's fuzzy time series method was carried out by Lestari et al. (2017) using the fuzzy time series Chen, and fuzzy time series Cheng methods in the case of production results in Majalengka Regency. The results of research using MAPE show that the method with the best accuracy was using the Cheng fuzzy time series method with forecasting accuracy reaching 95.76%. Fauzi et al. (2021) also compared the fuzzy time series methods of Cheng, and Ruey Chyn Tsaur in the case of farmer exchange rates in Central Java Province. The results show that FTS Cheng's forecasting is better than FTS Ruey Chyn Tsaur, with the MSE and MAPE results of FTS Cheng being 0.33, and 0.43% while the results of FTS Ruey Chyn Tsaur are 0.41, and 0.47%. The fuzzy time series Cheng model will be used in this research will be used to predict the share price of Bank Syariah Indonesia (BSI).

MATERIALS AND METHODS

The data used in this research is secondary data obtained from the official website of Bank Syariah Indonesia (BSI), namely bankbsi.co.id. The variables used are daily BSI share price data using active days, namely Monday to Friday from February 1, 2021, to January 11, 2023.

The data analysis in this research was carried out using Cheng's fuzzy time series method. Data analysis in this research used Excel software. The following are the stages that will be carried out to analyze the data in this research:

1. Entering data.
2. Data exploration. Data exploration was carried out to identify patterns in Bank Syariah Indonesia (BSI) share price data daily.
3. Formation of universal groups. The universe set is formed using the minimum and maximum values D_1 and D_2 values determined by the researcher.
4. Determine the number of fuzzy sets. The number of fuzzy sets is determined using Sturges' rule.
5. Defining the degree of fuzzy set membership on A_i and fuzzyfication. This definition aims to simplify things by converting numerical data into linguistics.
6. Determine Fuzzy logical relationship (FLR). FLR is identified based on historical data that has been fuzzy in the previous stage.

7. Determine the fuzzy logical relationship group (FLRG) and carry out weighting. FLRG formation is carried out by grouping all the FLRs formed into interconnected FLRGs.
8. Defuzzification. Defuzzification is carried out by changing the fuzzy output into a firm (numerical) value which produces a forecast value.
9. Evaluate prediction results and carry out forecasting. Evaluation of prediction results is carried out using MAPE.
10. Interpret forecasting results
11. Conclusion.

RESULTS AND DISCUSSION

Data Exploration

Data exploration is used to determine the pattern of Bank Syariah Indonesia (BSI) share price data. The following is a graph showing the BSI share price data pattern from February 1, 2021, to January 11, 2023.



Figure 1. Time Series Plot of BSI Share Prices

Based on Figure 1. Every day BSI share price movements experience fluctuating changes, and in general, the BSI share price data pattern experiences a downward trend. This matter can be seen in the period February 28, to May 24, 2021, stock prices BSI experienced a significant decline. Next, experience significant increase in the period June 25, to July 28, 2021. Then, it decreases and continues to change over time. So, based on this, BSI share price data can be indicated experiencing volatility or experiencing frequent changes in a short period of time. Apart from that, the graph shows the BSI share price the highest occurred on February 25, 2021, namely IDR 2960 million, and price the lowest share occurred on December 20, 2022, namely IDR 1100 million. The following are the steps in forecasting BSI share prices using Cheng's fuzzy time series method.

Formation of the Universal Set

BSI share price data from February 1, 2021, to January 11, 2023, experienced the lowest price of IDR 1100 million and the highest price of IDR 2960 million. In forming a universal set, the values D_1 and D_2 are first determined which is a positive integer value. on this research uses the values $D_1 = 41$ and $D_2 = 46$ determined based on the smallest MAPE value. So, the universal set is obtained as follows:

$$\begin{aligned}
 U &= [Y_{min} - D_1; Y_{max} + D_2] \\
 &= [1100 - 41; 2960 + 46] \\
 &= [1059; 3006]
 \end{aligned}$$

Determine the Number of Fuzzy Sets

Determining the number of fuzzy sets is calculated using Sturges' rule. The steps in determining fuzzy sets are as follows:

1. Determine the range

$$R = (Y_{max} + D_2) - (Y_{min} - D_1)$$

$$\begin{aligned}
 &= (2960 + 46) - (1100 - 41) \\
 &= 3006 - 1059 \\
 &= 1947
 \end{aligned}$$

2. Determine the number of class intervals

$$\begin{aligned}
 K &= 1 + 3,322 \times \text{Log}(n) \\
 &= 1 + 3,322 \times \text{Log}(481) \\
 &= 9,91 \approx 10
 \end{aligned}$$

3. Specifies the width of the interval

$$\begin{aligned}
 I &= \frac{R}{K} \\
 &= \frac{1947}{10} \\
 &= 194,7
 \end{aligned}$$

Based on the calculation of the number of fuzzy sets, the results obtained were 10 fuzzy sets with an interval width of 194.7. U in each fuzzy set is partitioned into 10 sets. So, the set of fuzzy intervals formed is presented in Table 1 as follows.

Table 1. Fuzzy Set Intervals

Fuzzy set i -th	Interval Fuzzy Sets
u_1	[1059; 1253,7]
u_2	(1253,7 ; 1448,4]
u_3	(1448,4 ; 1643,1]
\vdots	\vdots
u_{10}	(2811,3 ; 3006]

4. Calculation of the mean value of the fuzzy set

The results of the fuzzy set calculation are presented in Table 2 below.

Table 2. Middle Value of Fuzzy Sets

Fuzzy set i -th	median (m_i)
u_1	1156,35
u_2	1351,05
u_3	1545,75
\cdot	\cdot
u_{10}	2908,65

Defining the Degree of Fuzzy Set Membership on A_i and Fuzzyfication

Determining the degree of fuzzy set membership to A_i is based on the fuzzy set that is formed. The following is the definition of a fuzzy set for A_i .

$$\begin{aligned}
 \mu_{A_1(u_1)} &= 1/u_1 + 0,5/u_2 + 0/u_3 + \dots + 0/u_{10} \\
 \mu_{A_2(u_2)} &= 0,5/u_1 + 1/u_2 + 0,5/u_3 + \dots + 0/u_{10} \\
 \mu_{A_3(u_3)} &= 0/u_1 + 0,5/u_2 + 1/u_3 + \dots + 0/u_{10} \\
 \vdots &= \vdots + \vdots + \vdots + \dots + \vdots \\
 \mu_{A_{10}(u_{10})} &= 0/u_1 + 0/u_2 + 0/u_3 + \dots + 1/u_{10}
 \end{aligned} \tag{1}$$

Based on defining the degree of fuzzy set membership to A_i , the following fuzzyfication results are obtained

Table 3. Fuzzyfication results

Fuzzyfication	Linguistic Values
A ₁	Level 1
A ₂	Level 2
A ₃	Level 3
⋮	⋮
A ₁₀	Level 10

Note: The naming of linguistic value levels is done in the order that the smaller the fuzzy set interval value, the smaller the linguistic value level, which means the more drastic the decline in BSI share price data.

Based on the fuzzyfication results in Table 3, the fuzzyfication process for BSI share price data from February 1 2021 to January 11 2023 is presented in Table 4.

Table 4. Fuzzification of BSI Share Price Data

Period	BSI Share Price (Million)	Fuzzyfication	Levels
1 Feb 2021	Rp 2800	A ₉	Level 9
2 Feb 2021	Rp 2610	A ₈	Level 8
3 Feb 2021	Rp 2750	A ₉	Level 9
⋮	⋮	⋮	⋮
11 Jan 2023	Rp 1335	A ₂	Level 2

Determination of Fuzzy Logical Relationship (FLR)

Determining Fuzzy Logical Relationship (FLR) involves 1 historical data symbolized by $Y_{t-1} \rightarrow Y_t$. The FLR results of BSI share price data are presented in Table 5.

Table 5. FLR BSI Share Price Data

Period	FLR	Levels
1 Feb 2021	-	-
2 Feb 2021	A ₉ → A ₈	Level 9 → Level 8
3 Feb 2021	A ₈ → A ₉	Level 8 → Level 9
⋮	⋮	⋮
11 Jan 2023	A ₂ → A ₂	Level 2 → Level 2

Formation of Fuzzy Logical Relationship Group (FLRG) and Weighting

The formation of a fuzzy logical relationship group (FLRG) has the same steps as the FLR formation stage on BSI share price data. Fuzzyfication groups that have the same current state are then grouped into one next state group. The FLRG results of BSI share price data are presented in Table 6.

Table 6. FLRG BSI Share Price Data

Group	FLRG
1	A ₁ → 13(A ₁), 3(A ₂)
2	A ₂ → 3(A ₁), 79(A ₂), 4(A ₃)
3	A ₃ → 5(A ₂), 109(A ₃), 5(A ₄)
⋮	⋮
10	A ₁₀ → 3(A ₉), 9(A ₁₀)

After establishing the FLRG, the next stage in obtaining forecasting values using Cheng's fuzzy time series method is entering the FLRG weights into the weighting matrix. The FLRG weighting matrix is presented in Table 7.

Table 7. Weighting Matrix

FLRG	A ₁	A ₂	A ₃	...	A ₁₀
A ₁	13	3	0	...	0
A ₂	3	79	4	...	0
A ₃	0	5	109	...	0
⋮	⋮	⋮	⋮	⋮	⋮
A ₁₀	0	0	0	...	0

The next step is to convert the FLRG weights into a standardized weighting matrix (W^*) using the following equation.

$$W_{ij}^* = \frac{w_{ij}}{\sum_{j=1}^n w_{ij}} \tag{2}$$

The standardized weighting matrix is presented in Table 8.

Table 8. Standardized Weighting Matrix

FLRG	A ₁	A ₂	A ₃	...	A ₁₀
A ₁	0,81	0,19	0	...	0
A ₂	0,03	0,92	0,05	...	0
A ₃	0	0,04	0,92	...	0
⋮	⋮	⋮	⋮	⋮	⋮
A ₁₀	0	0	0	...	0,75

Defuzzification

In the defuzzification process the calculation process uses a standardized weighting matrix (W^*) and the middle value (m_i) in the interval u_i . Thus, the results of the defuzzification of forecasting values from the 10 groups formed are presented in Table 9.

Table 9. Results of Defuzzification of Forecast Values

Group	FLRG	Defuzzification
1	A ₁ → 13(A ₁), 3(A ₂)	1193,34
2	A ₂ → 3(A ₁), 79(A ₂), 4(A ₃)	1354,94
3	A ₃ → 5(A ₂), 109(A ₃), 5(A ₄)	1545,75
⋮	⋮	⋮
10	A ₁₀ → 3(A ₉), 9(A ₁₀)	2859,98

Evaluate Prediction Results and Perform Forecasting

The predicted value for Bank Syariah Indonesia (BSI) share price data from 1 February 2021 to 11 January 2023 using active days Monday to Friday was obtained from the defuzzification results of the FLRG group. The previous data Y_{t-1} has obtained a fuzzyfication value which will be used to obtain a prediction value for the t -time data period (Y_t) Prediction results are presented in Table 10

Table 10. BSI Share Price Prediction Results

Number	Fuzzyfication	BSI Share Price (Million)	Prediction
1	A ₁	Rp 2800	-
2	A ₂	Rp 2610	Rp 2692,53
3	A ₃	Rp 2750	Rp 2494,06
⋮	⋮	⋮	⋮
481	A ₁₀	Rp 1335	Rp 1354,34

The next step is to see the accuracy of the prediction results by calculating the MAPE value predicted by FTS Cheng. The calculation of the MAPE value from FTS Cheng's prediction results can be seen in Table 11.

Table 11. Calculation of MAPE Values from Prediction Results

Number	Period	Fuzzyfication	Y_t	\hat{Y}_t	$\frac{ Y_t - \hat{Y}_t }{Y_t}$
1	1 Feb 2021	A ₁	Rp 2800	-	-
2	2 Feb 2021	A ₂	Rp 2610	Rp 2692,53	0,032
3	3 Feb 2021	A ₃	Rp 2750	Rp 2494,06	0,093
481	11 Jan 2023	A ₁₀	Rp 1335	Rp 1354,34	0,015
$\sum_{t=2}^{481} \frac{ Y_t - \hat{Y}_t }{Y_t}$				=	14,83
$MAPE = \left(\frac{1}{N} \sum_{i=1}^N \frac{ Y_t - \hat{Y}_t }{Y_t} \times 100\% \right)$				=	3,09%

Based on Table 11, the MAPE value obtained from BSI share price data is 3.09%. The MAPE value shows that the BSI share price prediction results are in the very good category because it is less than 10%. Then forecast BSI share prices for the next 14 periods, namely January 16 2023 to January 31 2023, the forecasting results are presented in Table 12.

Table 12. BSI Share Price Forecasting Results

Period	Fuzzyfication	Forecasting (Million)
12 Jan 2023	A ₂	Rp 1354,94
13 Jan 2023	A ₂	Rp 1354,94
16 Jan 2023	A ₂	Rp 1354,94
:	:	:
31 Jan 2023	A ₂	Rp 1354,94

Interpretation of Forecasting Results

Based on the prediction and forecasting results obtained, a time series plot can be made comparing the prediction results and actual data as well as the forecasting results and actual data on Bank Syariah Indonesia (BSI) share prices. The time series plot image of actual data and BSI share price prediction data is presented in Figure 2.

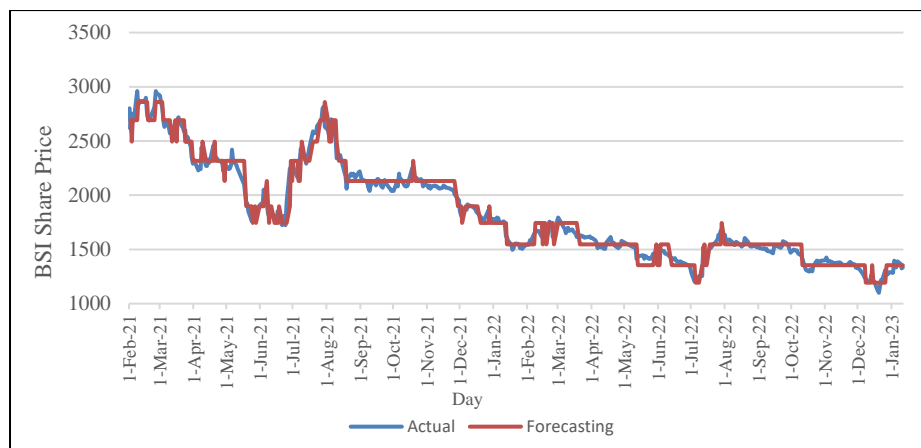


Figure 2. Time Series Plot Comparison of Prediction Results and BSI Stock Price Data

Based on Figure 2, it can be seen that the time series plot of FTS Cheng's prediction results tends to be close to the time series plot of actual BSI share price data. This indicates that the FTS Cheng method is very good for predicting BSI share prices. The time series plot of actual data and BSI stock price forecasting data is presented in Figure 3.

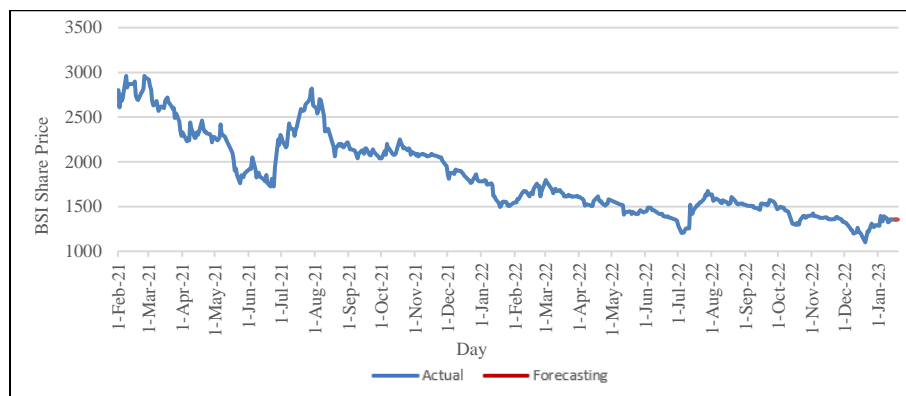


Figure 3. Time Series Plot of Forecasting Results with BSI Stock Price Data

Based on Figure 3, the forecast results obtained show that BSI's share price is at level 2, namely IDR 1354.94 million. The downward trend in BSI share prices can have a negative impact on investors investing in BSI. Continuous decline is a loss for investors. Apart from that, declining share prices have an impact on company value which will also fall. As a result, if the company wants to increase capital, the company can sell some of its shares back at a lower price. Of course, the funds obtained from selling shares will be smaller.

CONCLUSION

Based on the results and discussions that have been carried out previously, it can be concluded that the results of forecasting BSI share prices from January 12, to January 31, 2023, using the Cheng fuzzy time series method are constantly worth IDR 1354.94 million with an accuracy level of forecasting results using MAPE of 3.09% .

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