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ARIMA MODELS IN PREDICTING INDONESIAN ISLAMIC BANK PROFITABILITY

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Abstract

This study aims to predict the profitability of Bank Muamalat Indonesia, proxied by the ROA ratio. The data analysis used is ARIMA (Autoregressive Integrated Moving Average), which is an appropriate approach for analyzing time series data such as the profitability of Bank Muamalat Indonesia over the period 2010-2023. The findings indicate that the ARIMA (1,1,12) model is the best in predicting the profitability of Bank Muamalat Indonesia. This is because the ARIMA (1,1,2) model demonstrates white noise characteristics and produces low AIC and SC values as well as significant parameters, thus it is selected for analysis. Using the ARIMA (1,1,2) model, profitability estimation shows RMSE values of 0.39 and MAE values of 0.32, indicating a low error rate. The prediction shows a significant decline in the profitability of Bank Muamalat Indonesia, although fluctuations remain. Therefore, the ARIMA (1,1,2) model proves to be effective in predicting the profitability of Bank Muamalat Indonesia with a low error rate, despite the prediction results showing a downward trend.

Keywords: Autoregressive Integrated Moving Average, Profitability, Return on Assets

1. Introduction

Profitability is a key indicator in assessing the financial performance of a bank, including Islamic commercial banks. Stable and high profitability reflects efficiency in asset management and the bank's ability to generate profit from its main operations (Jigeer & Koroleva, 2023; Nurwulandari et al., 2022; Sobol et al., 2023). Return on Assets (ROA) is one of the most commonly used measures of profitability, indicating how well a bank uses its assets to generate profit (Kamal, 2023; Kristiono, 2024). In Indonesia, Islamic banks face unique challenges in maintaining profitability as they must adhere to strict Sharia principles while competing in a dynamic banking market.

The profitability of Islamic banks in Indonesia has experienced significant fluctuations over time. As one of the largest Islamic banks in Indonesia, Bank Muamalat Indonesia (BMI) shows interesting profitability movements. Based on Return on Assets (ROA) data, BMI recorded substantial fluctuations from the first quarter of 2010 to the fourth quarter of 2023. For instance, in the first quarter of 2010, BMI's ROA was 1.48 and continued to fluctuate until it reached its lowest point in the first quarter of 2019 with an ROA of only 0.02. This movement reflects the challenges BMI faces in maintaining performance stability amid dynamic economic and regulatory conditions.

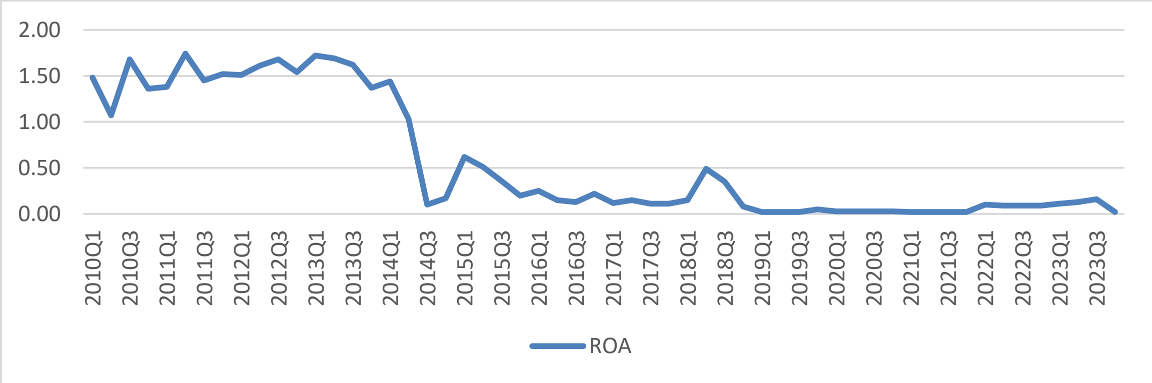


Figure 1: Profitability Development of Bank Muamalat Indonesi

The fluctuation in the profitability of Bank Muamalat Indonesia, even showing a significant decline until 2023, indicates a gap between the expected condition (das sollen) and the actual condition (das sein). Theoretically, Islamic banks are expected to maintain stable profitability through efficient asset management and adherence to Sharia principles. However, the reality shows that the profitability of Islamic banks like BMI faces various challenges causing significant fluctuations. This theoretical gap can be derived from literature studies that state the importance of risk management and operational efficiency in maintaining the financial performance of Islamic banks. Practically, this gap can also be seen from phenomena in the field. The fluctuation in BMI's profitability indicates challenges in operational management and financial strategies. For instance, in the first quarter of 2019 when BMI's ROA reached its lowest point at 0.02, this reflected issues in asset management and operational efficiency. These symptoms indicate the need for further research to understand the factors affecting the profitability of Islamic banks and find appropriate solutions.

Several previous studies have attempted to address the issue of profitability fluctuation in Islamic banks (Apriliani et al., 2023; Astasia et al., 2020; Nasirin, 2020). However, the results still show significant fluctuations. Therefore, this study aims to analyze and predict the profitability of Islamic banks in Indonesia using the Autoregressive Integrated Moving Average (ARIMA) model. The ARIMA model is chosen because it can capture patterns and trends in time series data, providing more accurate predictions regarding the profitability of Islamic banks. The importance of this research is not only limited to the development of knowledge in the field of Islamic banking but also to providing practical recommendations for bank management in managing financial performance. By understanding the dynamics of profitability and the factors affecting it, Islamic banks can develop more effective strategies to enhance financial stability and competitiveness in the market. The results of this research are expected to make a significant contribution to improving the financial performance of Islamic banks in Indonesia, as well as providing new insights into the use of the ARIMA model for profitability analysis and prediction.

2. Theoretical Study

2.1 Profitability

Profitability is an important concept in evaluating the financial performance of a banking institution, including Islamic banks. Generally, profitability refers to the ability of a company or bank to generate profit from its operational activities. In the context of Islamic banks, profitability is assessed using indicators such as Return on Assets (ROA), which measures the efficiency in managing assets to generate profit. ROA is calculated by dividing the net profit obtained by the bank by the total assets it owns, and the result is expressed as a percentage. Conceptually, the higher the ROA of an Islamic bank, the better its financial performance in using assets to generate maximum profit (Al-Homaidi et al., 2020).

A stable and high level of profitability indicates that the bank is capable of meeting its obligations to shareholders by generating optimal profit. This gives confidence to investors and stakeholders that the bank can survive and grow in the long term. Secondly, high profitability enables the bank to more easily obtain funding sources at lower costs, due to its good reputation and financial performance. Thirdly, a profitable Islamic bank can more effectively contribute economically through financing that complies with Sharia principles, which in turn can drive inclusive and sustainable economic growth (Meiryani et al., 2023).

For Islamic banks in Indonesia, the relationship between profitability and Sharia principles is an important aspect that needs attention. Islamic banks must adhere to principles that prohibit usury and transactions that are not in accordance with Islamic law, while maintaining competitive profitability levels in the market. This requires appropriate strategies in risk management, asset allocation, and operational efficiency to maintain or improve ROA amidst economic dynamics and tight competition. Thus, research on the profitability of Islamic banks not only provides insights into financial performance but also about compliance with Sharia values and their impact on the growth of the Islamic financial sector as a whole.

2.2 ARIMA

The Autoregressive Integrated Moving Average (ARIMA) model is one of the approaches in time series data analysis to model and predict patterns in financial data, including bank profitability. ARIMA combines autoregressive (AR), differencing (I for Integrated), and moving average (MA) components to address dependencies in time series data and make more accurate predictions. This approach is very useful in dealing with financial data that tends to be non-stationary or has unexpected trends and fluctuations (Bagshaw, 1986; Ho, 2006; Nasirin, 2020; Nelson, 1998). Using the ARIMA model in the context of bank profitability involves identifying historical patterns and forecasting future financial performance. For instance, by analyzing the ROA data of Islamic banks from previous periods, the ARIMA model can help identify long-term trends, seasonality, or other relevant signals for strategic decision-making. This allows bank management to anticipate market or economic changes that may affect their profitability, enabling them to take appropriate steps to maintain or enhance financial performance.

The main benefit of using the ARIMA model is its ability to provide reliable predictions based on available historical data. By understanding historical patterns and behaviors of ROA, banks can optimize resource allocation and financial strategies more effectively. This aids in long-term financial planning and better investment decision-making, which in turn can enhance the competitiveness and stability of Islamic banks in the market. The relationship between the ARIMA model and the profitability of Islamic banks also highlights the importance of technological adaptation and data analysis in the banking industry. In an increasingly competitive and changing environment, the ability to make decisions based on careful predictive analysis can be a significant competitive advantage. By utilizing the ARIMA model, Islamic banks can optimize risk management, improve operational efficiency, and enhance their profitability sustainably while adhering to the Sharia principles underlying their operations.

3. Research Method

Research Design. This study uses time series ROA data from Islamic banks in Indonesia over the period 2010-2023. This approach allows for an in-depth analysis of how to predict the profitability of Islamic banks, with the aim of providing better understanding and relevant recommendations for practitioners and regulators. Operational Definition of Variables. The main variable studied is Return on Assets (ROA), operationalized as the ratio between the bank's net profit and its total assets. ROA is measured in percentage terms to compare the relative profitability performance of Islamic banks. ROA data will be collected from Bank Muamalat Indonesia, considering quarterly data from 2010 to 2023. Data Collection Techniques and Data Analysis Methods Secondary ROA data will be collected from the published financial reports of Bank Muamalat Indonesia. The data analysis method to be used is ARIMA (Autoregressive Integrated Moving Average), which is an appropriate approach for analyzing time series data such as ROA.

ARIMA will be used to forecast patterns and trends in Islamic bank ROA, allowing for the identification of important factors affecting their profitability statistically.

4. Result and Discussion

4.1 Stationarity Test

The stationarity test is an initial step to ensure the data used is stationary or not. The following are the results of the stationarity test using Augmented Dickey Fuller (ADF) in this study:

Table 1: Level Stationarity Test

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.442877	0.5544
Test critical values:	1% level	-3.560019	
	5% level	-2.917650	
	10% level	-2.596689	

Sumber: Hasil Olah Data EVIEWS 12

The results of the stationarity test show that the ROA variable is not stationary at the level, so a stationarity test was conducted at the first difference level. The following are the results of the stationarity test at the first difference level:

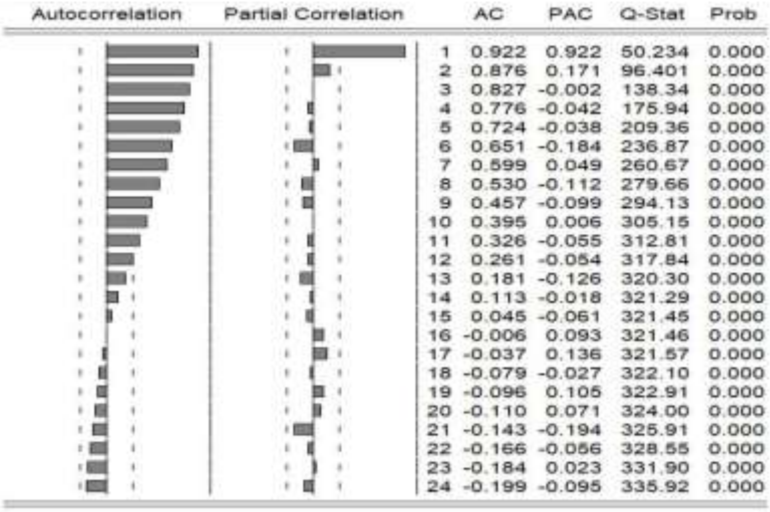
Table 2: Stationarity Test at First Difference Level

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.892950	0.0000
Test critical values:	1% level	-3.560019	
	5% level	-2.917650	
	10% level	-2.596689	

After conducting the stationarity test at the first difference level, it was found that the ROA variable has become stationary as the significance of the ADF has a probability value less than 5%.

4.2 Identification of the Box-Jenkins Model

After the data became stationary, it was necessary to identify the Box-Jenkins model. The identification of the Box-Jenkins model is determined by the AC and PAC plots. The determination of the plots is based on the correlogram output; if there is a violation of the AC bar line, then there is a candidate for MA, and from the PAC bar chart, a candidate for AR is obtained. The following is the correlogram output of the ROA variable:



Lag	AC	PAC	Q-Stat	Prob
1	0.922	0.922	50.234	0.000
2	0.876	0.171	96.401	0.000
3	0.827	-0.002	138.34	0.000
4	0.776	-0.042	175.94	0.000
5	0.724	-0.038	209.36	0.000
6	0.651	-0.184	236.87	0.000
7	0.599	0.049	260.67	0.000
8	0.530	-0.112	279.66	0.000
9	0.457	-0.099	294.13	0.000
10	0.395	0.006	305.15	0.000
11	0.326	-0.055	312.81	0.000
12	0.261	-0.054	317.84	0.000
13	0.181	-0.126	320.30	0.000
14	0.113	-0.018	321.29	0.000
15	0.045	-0.061	321.45	0.000
16	-0.006	0.093	321.46	0.000
17	-0.037	0.136	321.57	0.000
18	-0.079	-0.027	322.10	0.000
19	-0.096	0.105	322.91	0.000
20	-0.110	0.071	324.00	0.000
21	-0.143	-0.194	325.91	0.000
22	-0.166	-0.056	328.55	0.000
23	-0.184	0.023	331.90	0.000
24	-0.199	-0.095	335.92	0.000

Figure 1: Correlogram Output

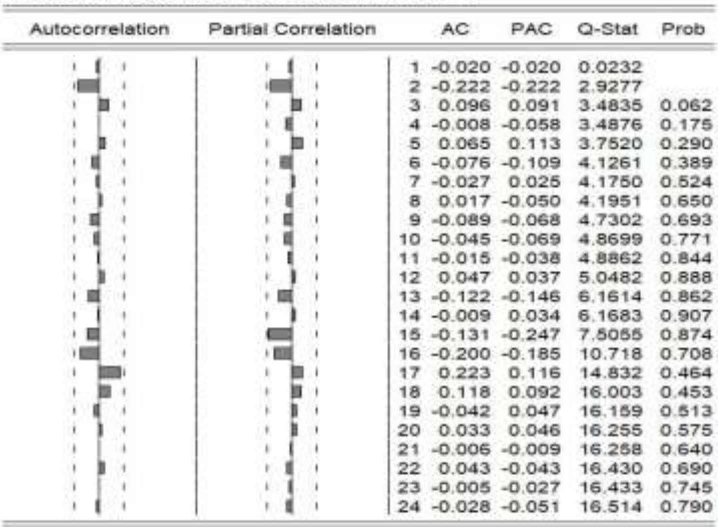
Source: EVIEWS 12 Data Processing Results

The results of the correlogram output violate the AC bar line from lag 1 to 12, so the MA component is worth between 1 and 12. Then, there is a violation of the PAC bar line at lag 1, so the AR component is worth 1. Furthermore, the data is stationary at the first difference level, so the I component is worth 1. Thus the model formed is ARIMA (1,1,1); ARIMA (1,1,2); ARIMA (1,1,3); ARIMA (1,1,4); ARIMA (1,1,5); ARIMA (1,1,6); ARIMA (1,1,7); ARIMA (1,1,8); ARIMA (1,1,9); ARIMA (1,1,10); ARIMA (1,1,11); ARIMA (1,1,12).

4.3 Parameter Estimation

After obtaining 12 ARIMA models, it is necessary to estimate the parameters of the model, to obtain the best model, by displaying the correlogram of the residuals to determine whether the residuals are random (white noise). After testing that only the ARIMA (1,1,2) model is white noise.

Figure 2 ARIMA (1,1,2) Model Estimation



Date: 06/21/24 Time: 00:22
Sample (adjusted): 2010Q2 2023Q4
Q-statistic probabilities adjusted for 2 ARMA terms

Lag	AC	PAC	Q-Stat	Prob
1	-0.020	-0.020	0.0232	
2	-0.222	-0.222	2.9277	
3	0.096	0.091	3.4835	0.062
4	-0.008	-0.058	3.4876	0.175
5	0.065	0.113	3.7520	0.290
6	-0.076	-0.109	4.1261	0.389
7	-0.027	0.025	4.1750	0.524
8	0.017	-0.050	4.1951	0.650
9	-0.089	-0.068	4.7302	0.693
10	-0.045	-0.069	4.8699	0.771
11	-0.015	-0.038	4.8862	0.844
12	0.047	0.037	5.0482	0.888
13	-0.122	-0.146	6.1614	0.862
14	-0.009	0.034	6.1683	0.907
15	-0.131	-0.247	7.5055	0.874
16	-0.200	-0.185	10.718	0.708
17	0.223	0.116	14.832	0.464
18	0.118	0.092	16.003	0.453
19	-0.042	0.047	16.159	0.513
20	0.033	0.046	16.255	0.575
21	-0.006	-0.009	16.258	0.640
22	0.043	-0.043	16.430	0.690
23	-0.005	-0.027	16.433	0.745
24	-0.028	-0.051	16.514	0.790

Source: EVIEWS 12 Data Processing Results

The estimation of ARIMA (1,1,2) is already white noise, indicated by the bars on the random autocorrelation graph and there are no bars that come out of the Bartlett line on the AC and PAC graphs and the probability value is greater than α by 5 per cent. Therefore, the ROA variable data with ARIMA (1,1,2) model is suitable for data analysis.

4.4 Model Verification

The next step is to verify the ARIMA (1,1,2) model, to ensure that the ARIMA (1,1,2) model is good enough. The model with smaller AIC and SC values has good quality and that model should be selected for further analysis. The following are the results of the ARIMA (1,1,2) model verification.

Table 3 Verification of ARIMA (1,1,2) Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027243	0.024070	-1.131802	0.2630
AR(1)	-0.074552	0.107922	-0.690792	0.4928
MA(2)	-0.342160	0.153317	-2.231714	0.0301
SIGMASQ	0.042195	0.005357	7.876659	0.0000
R-squared	0.086191	Mean dependent var		-0.026545
Adjusted R-squared	0.032438	S.D. dependent var		0.216865
S.E. of regression	0.213319	Akaike info criterion		-0.177552
Sum squared resid	2.320748	Schwarz criterion		-0.031564
Log likelihood	8.882681	Hannan-Quinn criter.		-0.121097
F-statistic	1.603457	Durbin-Watson stat		1.999644
Prob(F-statistic)	0.200036			
Inverted AR Roots	-.07			
Inverted MA Roots	.58	-.58		

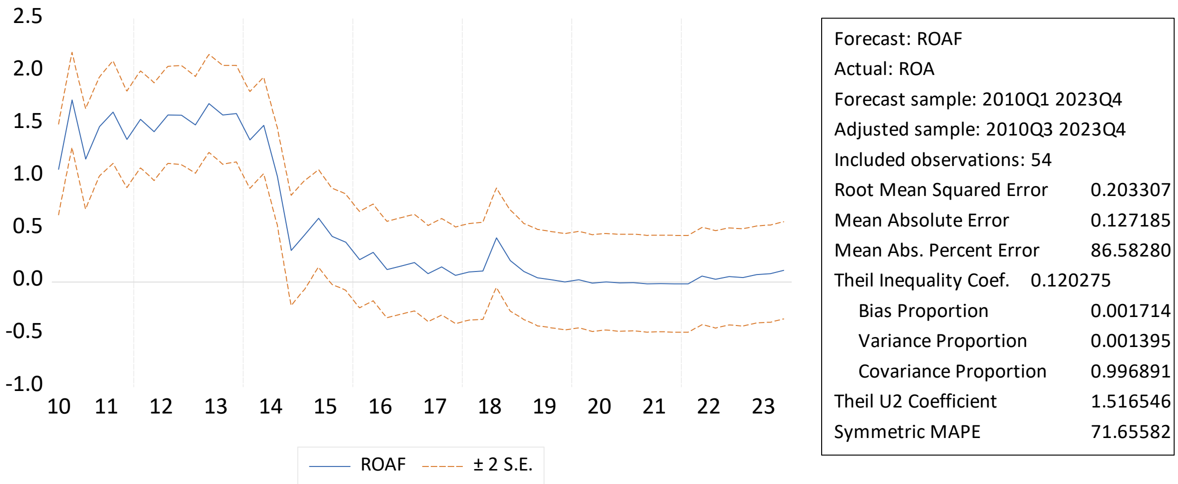
Source: EVIEWS 12 Data Processing Results

Based on the results of the AIC and SC values, the ARIMA (1,1,2) model is suitable for predicting the profitability of Bank Muamalat Indonesia.

4.5 Forecasting

The next step is to estimate using the selected model, namely the ARIMA (1,1,2) model. The following are the forecasting results of this study:

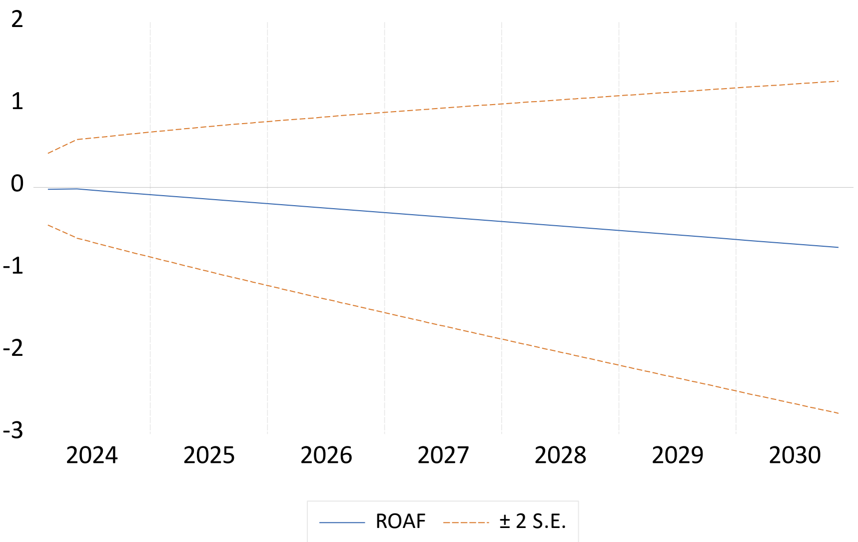
Figure 3 Forecasting ARIMA Model (1,1,2)



Source: EVIEWS 12 Data Processing Results

It can be seen that the forecasting accuracy measure shows the Root Mean Squared Error (RMSE) value has a value of 0.203; and the Mean Absolute Error (MAE) has a value of 0.127. This indicates that the ARIMA (1,1,2) model has a relatively low error rate and can predict actual values. So, the prediction results of Bank Muamalat Indonesia's profitability show a significant decrease, although there are still fluctuations. The results of the ARIMA (1,1,2) model show a predictive forecasting accuracy measure and a decline is indicated. The prediction results of profitability from the first quarter of 2024 to the fourth quarter of 2030 can be seen in the following figure:

Gambar 4 Hasil *Forecasting* Profitabilitas dari Tahun 2024-2030



Source: EVIEWS 12 Data Processing Results

The prediction results show a decline until 2030. Details can be seen in the following table:

Table 4 Profitability Forecasting Results from 2024-2030

Periode	Hasil Forecasting
2024Q1	-0.02822330991464326
2024Q2	-0.02445037527127998
2024Q3	-0.05400519410215887
2024Q4	-0.0810753686094203
2025Q1	-0.108330777846639
2025Q2	-0.1355723774995819
2025Q3	-0.1628150066820193
2025Q4	-0.1900575591111699
2026Q1	-0.2173001172624171
2026Q2	-0.2445426749870715
2026Q3	-0.2717852327435292
2026Q4	-0.299027790497616
2027Q1	-0.3262703482518794
2027Q2	-0.3535129060061297
2027Q3	-0.380755463760381
2027Q4	-0.4079980215146322
2028Q1	-0.4352405792688834
2028Q2	-0.4624831370231346
2028Q3	-0.4897256947773858
2028Q4	-0.516968252531637
2029Q1	-0.5442108102858883
2029Q2	-0.5714533680401395
2029Q3	-0.5986959257943906
2029Q4	-0.6259384835486419
2030Q1	-0.6531810413028931
2030Q2	-0.6804235990571444
2030Q3	-0.7076661568113955
2030Q4	-0.7349087145656468

5. Conclusion

The test results of this study show that the stationarity test with Augmented Dickey Fuller (ADF) shows that the ROA variable is not stationary at the level level, but becomes stationary at the first difference level with an ADF probability value smaller than 5%. Once the data is stationary, the Box-Jenkins model is identified based on the correlogram output, resulting in potential ARIMA models from ARIMA (1,1,2) to ARIMA (1,1,12). Residual testing shows that only the ARIMA (1,1,2) model shows white noise properties. Estimation and verification of the ARIMA (1,1,2) model resulted in low AIC and SC values and significant parameters, so this model was selected for analysis. Using the ARIMA (1,1,2) model, the profitability estimation showed an RMSE value of 0.39 and MAE of 0.32, indicating a low error rate. The prediction shows a significant decrease in the profitability of Bank Muamalat Indonesia, although fluctuations remain.

In conclusion, the ARIMA (1,1,2) model proved effective in predicting the profitability of Bank Muamalat Indonesia with a low error rate, although the prediction results showed a downward trend.

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