

Vector Autoregressive Modelling of Profitability Sharia Rural Bank in Indonesia

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ABSTRACT

The objective of this study is to investigate the effect of Non-Performing Financing (NPF), Return on Capital (ROE), Capital Adequacy Ratio (CAR), Financing to Deposit Ratio (FDR), Ratio of Operational Costs to Operating Income (BOPO) to Return on Assets (ROA) Sharia rural bank in Indonesia. The data is secondary data sourced from Otoritas Jasa Keuangan (OJK) for the period of January 2013 to August 2019, in addition, it is also related to analytical analysis and forecasting used in this study. The existing variables are not stationary at the level and cointegration testing shows that there is no co-integration so the Vector Autoregressive (VAR) model is used for modeling. The test results show that NPF has a significant and negative effect on ROA, while ROE has a significant and positive effect on ROA. Forecasting results that are used based on the VAR(1) model formed show ROE in the next ten periods will decrease, the results of this forecasting with a MAPE evaluation value of 3.89%.

Keywords: Cointegration, Multivariate Time Series, Profitability, Sharia Bank, Vector Autoregressive.

1. INTRODUCTION

Law Number 10 of 1998 about Banking, banking is everything related to banks, including institutions, business activities, as well as ways and processes in carrying out their business activities. Bank is a business entity that collects funds from the public in the form of deposits and distributes them to the community in the form of credit and or other forms in order to improve the lives of many people. Based on this law, there are two types of banks in Indonesia, namely Commercial Banks and Rural Credit Banks. The two types of banks in conducting their business activities are classified into conventional banks and banks with Sharia principles.

Sharia Bank runs its business activities based on Sharia principles and away from usury practices, to be filled with investment activities on the basis of profit-sharing from trade financing. The Islamic banking industry is part of the national banking system which has an important role in the economy. The role of Sharia banking, in particular, is as a glue for new nationalism, which means being a facilitator of a populist economic business network, empowering the economy of the people, encouraging speculation in the financial markets, encouraging income distribution, and increasing the efficiency of fund mobility [4].

Considering that banks, especially Sharia banks become one of the parties in helping to increase economic growth, the

Islamic banks need to improve their performance in order to create healthy Sharia banks. Profitability or Return of Assets (ROA) is the most appropriate indicator to measure the performance of a bank [1].

ROA of Sharia rural banks from 2013 to mid-2019 is quite volatile, this financing ratio is influenced by many factors, such as Non-Performing Financing (NPF), Return on Equity (ROE), Capital Adequacy Ratio (CAR), Financing to Deposit Ratio (FDR), Ratio of Operational Expenses to Operational Revenue (BOPO) [7].

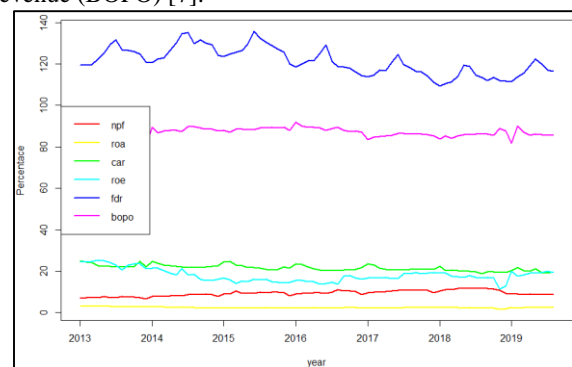


Figure 1. Time Series Plot Each Variables

Based on Figure 1 can be seen that the condition of each variable is different, FDR and BOPO have an upward trend from 2013 to mid-2015, but in the same period ROA

experienced a downward trend or there is negative relationships between these variables, as well as the NPF from time to time shows an upward trend, but the condition of ROA fluctuations, based on these conditions it is necessary to do a deeper study to find out which variables influence the management of Sharia rural banks to increase ROA, as well as forecasting ROA in the coming period so that preparations and actions can be carried and maintain the ROA condition of Sharia rural banks in order to remain healthy

To know the relationship between variables in multivariate time series data and forecasting, you can use several options such as the ARIMAX model, Autoregressive Distribution Lag (ADL), Vector Autoregressive (VAR), or Vector Error Correction Model (VECM). However, in this study, the VAR model is focused on looking at the relationship between exogenous variables in [7] such as NPF, CAR, RPE, FDR, and BOPO on endogenous ROA variable. As well as forecasting the state of ROA in the coming period. The VAR model is used because the data state is not stationary and does not co-integrate.

2. MATERIALS AND METHODS

Multivariate time series data were used in this study. Vector Autoregressive (VAR) is used to identify the short-term relationship of the financial ratio indicators of Sharia finance banks while predicting the condition of ROA for the next ten periods. The VAR model is used if there are variables containing unit roots, and do not co-integrate with one another, variables containing unit roots must be differenced and stationary variables of differentiation results can be used in VAR model.

2.1. Population and Sample

The population in this study is a sharia rural bank in Indonesia which is fully operational from January 2013 to August 2019. While the sample in this study are a Sharia people's financing bank consisting of 164 Sharia banks.

2.2. Data and Operational Variables

The data used in this study are secondary data, which is a multivariate data on timeframe indicators of Islamic finance bank financing in Indonesia, the period of January 2013 to August 2019, sourced from the Otoritas Jasa Keuangan (OJK).

This study uses six variables consisting of 5 exogenous variables and one endogenous variable, endogenous variables in this study are Return of Assets (ROA), while exogenous variables are Non-Performing Financing (NPF), Return on Equity (ROE), Capital Adequacy Ratio (CAR), Financing to

Deposit Ratio (FDR)), Ratio of Operational Expenses to Operational Revenue (BOPO).

Table 1. Definition of Operational Variables

Variables	Measurement	Scale
ROA	Measured by an intermediate ratio profit after tax with total assets.	Ratio
CAR	Measured by an intermediate ratio bank net capital by total asset	Ratio
FDR	Measured by an intermediate ratio of total financing by total third-party funds	Ratio
NPF	Measured by intermediate total financing problems with total financing channelled	Ratio
BOPO	Measured by an intermediate ratio operational expensive with operating income	Ratio
ROE	Measured by an intermediate ratio profit after tax with capital	Ratio

2.3. Unit Root Test

Unit root testing is very important for this VAR modeling, to check the stationarity of the data, the unit root test can be used with the Augmented Dickey-Fuller Test (ADF) test statistics, as follows:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \dots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t \tag{1}$$

With null hypothesis $\gamma = 0$ (there is unit root) and significant level $\alpha = 5\%$. Reject null hypothesis, if ADF statistics < critical value α , or p value lower than $\alpha = 5\%$ [2].

2.4. Determining VAR Order

VAR model selection is based on optimum lag, the most popular method to choose the lag order is to use information criteria, as like Akaike Information Criterion (AIC), Hannan Quin Criterion (HQC), and Schwarz Bayesian Criterion (SC). Which is defined as follows

$$AIC(p) = \log | \hat{\Sigma}_u(p) | + \frac{2pk^2}{T} \tag{2}$$

$$HQC(p) = \log |\hat{\Sigma}_u(p)| + \frac{2 \log(\log(T)) pk^2}{T} \quad (3)$$

$$SC(p) = \log |\hat{\Sigma}_u(p)| + \frac{2 \log(T) pk^2}{T} \quad (4)$$

The p value will be determined based on the smallest AIC, HQC and SC values [6].

2.5. Co-integration Test

If there are K variables with unit roots, there may be a maximum of $(K-1)$ co-integration forms between variables so that there may be as many $(M-1)$ residuals in the VECM equation. In this test using the trace test statistics, as follows [3].

$$LR_r(r | k) = -T \sum_{i=r+1}^k \log(1 - \lambda_i) \quad (5)$$

with null hypotheses there are r , where $r = 0, 1, \dots, k-1$ co-integration equation. If the LR value > critical value is 5%, so reject null hypothesis. If there is no co-integration equation, then the VAR (p) model will be used.

2.6. Vector Autoregressive Model

The VAR model is actually a combination of several autoregressive (AR) models, where this model forms a vector in which the variables influence each other [8]. With the VAR model as follows [6]

$$y_t = \alpha + \gamma t + \delta_1 y_{t-1} + \dots + \delta_p y_{t-p} + \beta_1 y_{t-1} + \dots + \beta_p y_{t-p} + \varepsilon_t \quad (6)$$

2.7. Diagnostik Checking

In this test, we will see whether there is a serial correlation in VAR model residuals or not by using portmenteau test statistics. With null hypothesis is there is no serial correlation. Reject null hypothesis if p value < $\alpha = 5\%$.

2.8. Forecasting and Structural Analysis

VAR modeling, structural analysis can use the impulse response function analysis aimed at looking at the effects of impulse or shocks given by exogenous variables on endogenous variables in this ROA. In addition to the impulse response function, another structural analysis is the variance decomposition. This structural analysis aims to see the contribution of each exogenous variable to endogenous variables.

Forecasting can also be done to find out the picture of ROA that will occur in the coming months. In measuring the goodness of forecasting can use the Mean Absolute Percentage Error (MAPE), as follows [3]

$$MAPE = \frac{\sum_{t=1}^n \left| \frac{\hat{y}_t - y_t}{y_t} \right|}{n} \times 100\% \quad (7)$$

3. RESULTS

3.1. Unit Root Test

Unit root test uses the ADF test for each variables, in the fitting model procedure, the unit root test is important to check the stationary of each variable, because if the data is not stationary, this time series data will produce a spurious or false regression [5]. Because the time series of data is at the trend level, interception and time trend will occur later in model.

Table 2. Unit Root Test

Variables	Significant Level	Level		First Difference	
		<i>P value</i>	Decision	<i>P value</i>	Decision
ROA	5%	0.4598	Not Stationary	2.12×10^{-13}	Stationary
CAR	5%	0.3489	Not Stationary	6.72×10^{-10}	Stationary
ROE	5%	0.416	Not Stationary	3.89×10^{-13}	Stationary
NPF	5%	0.939	Not Stationary	3.23×10^{-10}	Stationary
FDR	5%	0.818	Not Stationary	5.16×10^{-8}	Stationary
BOPO	5%	0.61505	Not Stationary	2.73×10^{-14}	Stationary

Unit root test in Table 1 shows that all variables contain unit roots, so it is necessary to do differencing and re-unit root testing. First differencing all variables have $p \text{ value} < \alpha = 5\%$, so it can be concluded that null hypothesis is the root of the unit rejected or the data stationary.

3.2. Determining Lag Order

Determination of the optimal lag is one of the contradictions that occur in stationary tests. Stationary test will cause residuals from regression will not display white noise process, if the residual regression does not show the white noise process, the model cannot accurately estimate the actual error. The optimal lag-length of the lagged differences of the tested variable is determined by minimizing the Akaike Information Criteria (AIC), Hannan Quin Criterion (HQC), and Schwarz Bayesian Criterion (SC). Table 2 shows that lag 1 is the lag with the smallest AIC, HQ, and SC values.

Table 2. VAR Lag Order Selection by Different Selection Criteria

Metrics	Lags				
	1	2	3	4	5
AIC	-4.196	-4.097	-4.154	-4.113	-4.171
HQC	-3.678	-3.135	-2.747	-2.262	-1.876
SC	-2.898	-1.687	-0.631	0.522	1.576

3.3. Co-Integration Test

Co-integration testing is conducted to determine the long-term relationship of ROA, CAR, ROE, NPF, FDR, and BOPO variables in this study, besides discussing cointegration between research variables, the Vector Error Correction Model can be used to model the profitability of Sharia banks in Indonesia

Table 3. Co-Integration Rank Test

Co-Integration	Trace statistics	0.05 Critical Value
$r \leq 5$	3.35	8.18
$r \leq 4$	4.99	14.90
$r \leq 3$	8.97	21.07
$r \leq 2$	12.55	27.14
$r \leq 1$	26.46	33.32
$r \leq 0$	28.40	39.43

The test results in Table 3 can be seen that trace statistics < critical value 5%, meaning that there is no cointegration that is able to explain the whole of each model. It means that there is no long-term relationship between the development of Islamic bank ROA in Indonesia with the determining factors, namely CAR, ROE, NPF, FDR, and BOPO, so the model used is Vector Autoregressive (VAR) or VAR (1).

3.4. Vector Autoregressive Model Estimation

Based on the results of the co-integrated examination it was found that there was no co-integrated between ROA Sharia banks in Indonesia with the determining factors, namely CAR, ROE, NPF, FDR, and BOPO. Thus, the ROA modeling of Sharia banks in Indonesia follows the model VAR(1). The obtained model can be written when it is distributed:

$$\begin{aligned} RO\hat{A}_t = & 3.4028 - 0.0031 + 0.0004BOPO_{T-1} - 0.0246CAR_{T-1} - 0.0079FDR_{T-1} - 0.0450NPF_{T-1} \\ & - 0.0314ROA_{T-1} + 0.0619ROE_{T-1} \end{aligned} \tag{8}$$

From the model that has been formed, parameter estimation will be carried out, as follows

Table 4. Parameter Estimate

Lags of Variable	Coefficient	SE (Coefficient)	t-value
BOPO _{t-1}	0.000356	0.0094	0.038
CAR _{t-1}	-0.024594	0.0195	-1.259
FDR _{t-1}	-0.007897	0.0043	-1.846
NPF _{t-1}	-0.044986	0.0194	-2.322
ROA _{t-1}	-0.031405	0.3086	-0.102
ROE _{t-1}	0.061939	0.0270	2.086
Intercept	3.402779	1.0842	3.138
Trend	-0.003093	0.0019	0.1014

The absolute value of t statistics will be compared with the value of $t_{(a/2, 80-6-1)} = 1.99$, NPF_{t-1}, and ROE_{t-1} has an absolute value of t value > 1.99, it can be concluded that the NPF (Non Performing Financing) variable gives significant and negative influence on ROA of Sharia banks in Indonesia, so that if NPF experiences an increase of 1%, then ROA will decrease by 0.0479% assuming other variables are constant. The results of this test are the same as the results of tests conducted by Yusuf and Mahriana, who concluded that the NPF had a negative influence on ROE [9].

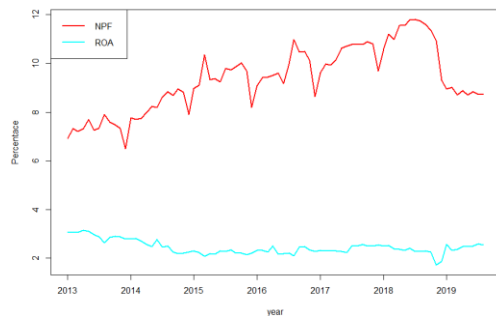


Figure 2. Time Series Plot between NPF and ROA

Conditions like this can be explained that the NPF does not affect the management of Sharia rural banks to increase the amount of financing so that the increase in NPF does not directly affect ROA directly. This is reasonable because when viewed from the plot, it can be concluded that the NPF has increased, but ROA has a declining trend, indicating that the NPF level is not directly responded to by the ROA level. This shows that the income of Sharia banks is not solely influenced by the NPF.

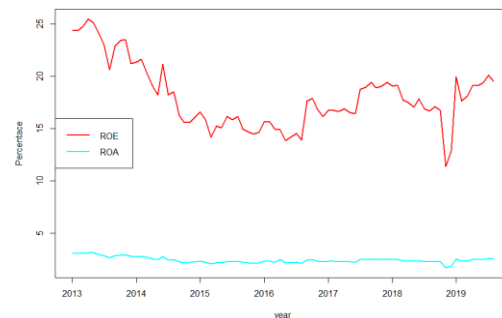


Figure 3. Time Series Plot between ROE and ROA

ROE or Return on Equity gives a significant and positive influence on ROA of Sharia banks in Indonesia, every 1% increase of ROE will increase ROA by 0.06518%. Return on Equity (ROE) is very important for bank owners because they will measure the skills and abilities of managers of Sharia banks in manipulating available capital to get a reasonable net income. Every increase of this ratio means an increase in net profit, so that every increase means that it will raise the stock price in the capital market. This ratio is attractive for shareholders as well as investors in the capital market who want to buy shares (if it has gone public). In the period 2012 to 2013 ROE experienced an upward trend and was followed by an increase in ROE, after 2013 to mid-2016 ROE experienced a decline and the same thing happened to ROA. Overall the picture of ROE is the same as ROA. So it can be concluded that the management of Sharia banks are able to process and obtain net profits to increase ROE.

3.5. Diagnostic Checking

The purpose of this test is to see whether there is a serial autocorrelation in the residual. for serial correlation testing,

the statistical portmanteau test can be used or can be seen in autocorrelation function (ACF) residual plot to conclude, there is serial autocorrelation or not.

ACF of Residuals

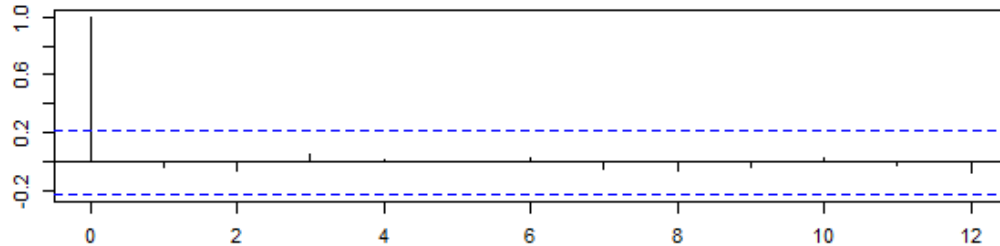


Figure 4. Autocorrelation Function Residual Plot

serial correlation can be detected by looking at the length of each first lag until 12 does not exceed the significance line, if it passes it indicates there are the presence of serial correlation in residuals. Figure 4 shows that there is no lag passes the significant line, we can conclude that there is no presence of serial correlation in residual, while based on testing the hypothesis with a portmanteau test obtained p value = 0.1998 > $\alpha = 5\%$, so it fails to reject null hypothesis. Then it can be concluded that no presence of serial correlation. But according to [4], residual normality can be ignored not as important as serial correlation and no heteroscedasticity assumption.

3.6. VAR Stability Test

Stability test is used to calculate the roots of polynomial functions or known roots of characteristic polynomials. A VAR system is said to be stationary if all its roots have a modulus smaller than one and are located within the range of the CUSUM line, which means the VAR system can be controlled or stable.

OLS-CUSUM of equation ROA

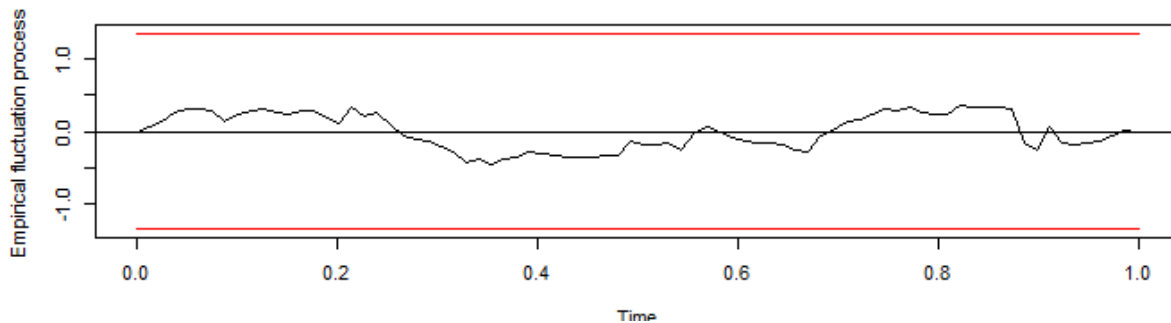


Figure 5. Stability CUSUM of ROA

Figure 5 shows that the VAR (1) model used is stable in the long run, so that an impulse response and variance decomposition test can be performed

3.7. Impulse Response Function (IRF)

The y-axis in the figure illustrates the standard deviation used to measure how much response will be given by CAR, ROE, NPF, FDR, and BOPO in the event of a shock to ROA. While the x-axis shows the length of time the response is given if there is a shock to the ROA.

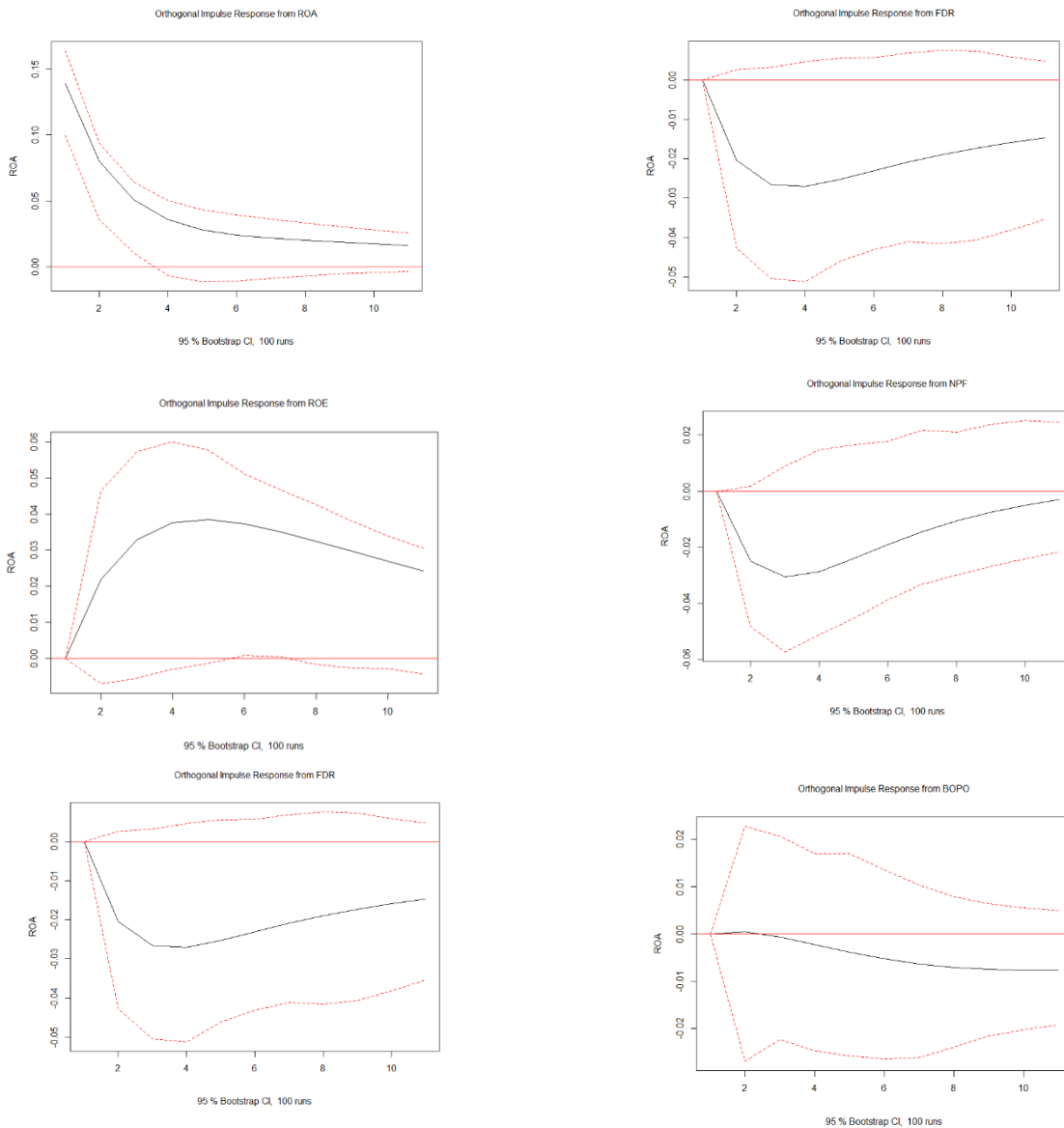


Figure. 6. Impulse Response Function

The results of the IRF analysis show that ROE in the next 10 periods the highest response is the ROA response to the shock of ROE. ROA in the first period of 0% until the fifth period ROA responded positively to ROE shocks and will increase to 3.84% and decrease in the sixth period of 3.73% until the tenth period of 2.69%.

Besides that, the highest response is ROA to the shock on ROA. In the first period was the highest response throughout the ten periods of 13.87% and decreased exponentially to the tenth period of 1.75%. In contrast to ROA and ROE, ROA responds negatively to shocks provided by CAR, and FDR. At the beginning of the month the ROA has not yet responded to CAR and FDR, the response of ROA to shake from the CAR

in the second month was negative by 1.72% and increased until the fifth period of 2.10%, this negative response then decreased until it was predicted to respond positively after the tenth period. As is the case with FDR, ROA responds negatively to shocks from FDR in the second period of 2.05% and this negative response continues to increase until the fourth period of 2.70% and decreases again in the sixth period until the end of this study period, and it is estimated that ROA will respond positively after the tenth period.

In addition to CAR and FDR, ROA also provides the same response to shocks from BOPO and NPF. However, at the beginning of the second period ROA responded positively but was quite small to the shock of BOPO of 0.05%, ROA again

responded negatively in the third period of 0.064% and continued to experience negative responses until the end of the tenth period. Whereas when NPF experienced a shock, ROA has not experienced a response, but in the second period ROA responded negatively to NPF shocks by 2.59% and increased in the third period by 3.06% and negative responses decreased in the fourth period until the end of the study period by 0.49% and are expected to be stable after the tenth period.

3.8. Forecast Error Variance Decomposition (FEVD)

Variance Decomposition aims to determine the contribution of each variable to changes in ROA in the coming periods. The following table shows that the variable that is expected to have the greatest contribution to ROA in the next ten months is ROA itself, in the first period ROA is affected by shocks to itself then decreases but is still dominant compared to other variables. Whereas in the second period 93.40% of ROA fluctuations were influenced by themselves then 2.26% were influenced by NPF and 1.74% were affected by ROE. Whereas FDR, CAR, and BOPO each had an influence on ROA of 1.53%, 1.08% and 8.78×10^{-6} . In the next period until the end of the period after ROA, ROE which gives the second largest influence on the fluctuation of ROA, is followed by the NPF.

Table 5. Variance Decomposition

ROA	CAR	ROE	NPF	FDR	BOPO
1.000	0.000	0.000	0.000	0.000	0.000
0.934	0.011	0.017	0.023	0.015	8.78×10^{-6}
0.849	0.024	0.047	0.046	0.034	1.95×10^{-5}
0.776	0.034	0.078	0.062	0.049	1.55×10^{-4}
0.722	0.041	0.106	0.070	0.060	5.04×10^{-4}
0.683	0.046	0.129	0.0731	0.067	1.08×10^{-3}
0.655	0.050	0.148	0.0734	0.072	1.85×10^{-3}
0.634	0.052	0.162	0.072	0.076	2.75×10^{-3}
0.619	0.053	0.174	0.071	0.080	3.73×10^{-3}
0.608	0.0537	0.183	0.070	0.082	4.73×10^{-3}
0.599	0.0542	0.189	0.068	0.084	5.71×10^{-3}
0.592	0.0544	0.194	0.067	0.086	6.66×10^{-3}

Can be seen that the average variable that has the greatest influence on ROA fluctuations is ROE, followed by NPF, FDR, CAR and finally BOPO. These results are the same as the results of the previous parameter estimation that NPF and ROE significantly influence ROA. The low contribution of BOPO to ROA shows that the management of Islamic banks does not pay much attention to the amount of BOPO to determine policies with the aim of increasing ROA. On the other hand ROE, NPF, FDR and CAR are the amount of contribution that is considered by Sharia bank management to determine the amount of revenue to increase ROA. Judging from these results, in the first period 100% of ROA fluctuations are influenced by ROA, and decreases until the end of the period. It can be concluded that the current ROA is influenced by the level of ROA in the past.

3.9. Forecasting

After the VAR model has been estimated and passed diagnostic tests, the model can be used to predict. So in addition to the main purpose of this VAR mode is to detect dynamic interactions between variables, this model can also be used to predict based on the obtained model and utilize past values to predict future values, and also provide confidence intervals around the forecast value. By utilizing the VAR model formed in equation 7, forecasting results can be made as follows

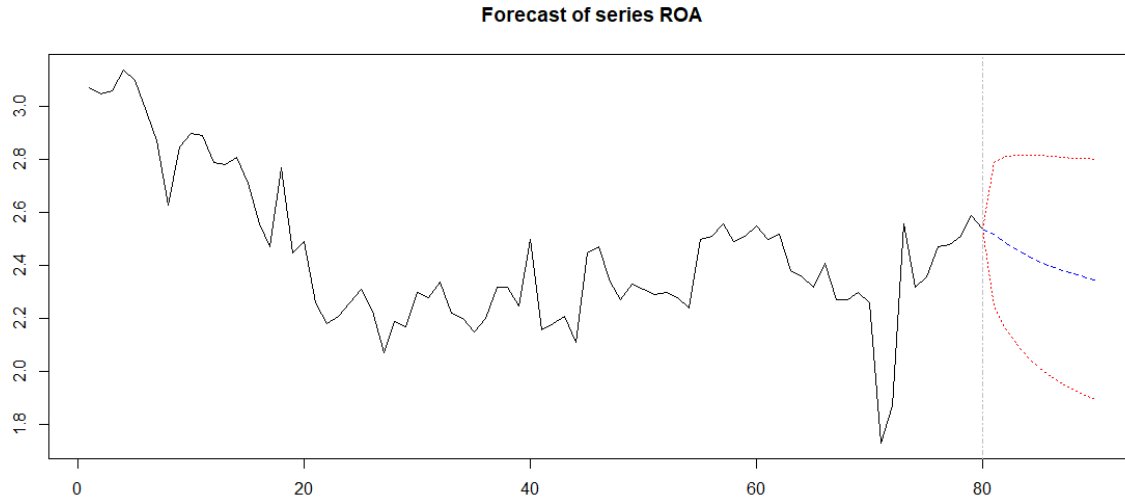


Figure 7. Forecasting of Series ROA

Figure 7 illustrates the forecast results for ten periods, the figure indicates that ROA will decrease after August 2019 until June 2020. Forecasting results are presented in Table 6.

Table 6. Forecasting Results

Month and Years	Forecast	Lower	Upper	MAPE
September 2019	2.52	2.46	2.79	3.89%
Oktober 2019	2.49	2.16	2.81	
November 2019	2.46	2.10	2.82	
December 2019	2.44	2.05	2.82	
Januari 2020	2.41	2.01	2.82	
Februari 2020	2.40	1.98	2.81	
March 2020	2.38	1.95	2.81	
April 2020	2.36	1.93	2.81	
May 2020	2.36	1.91	2.80	
June 2020	2.35	1.90	2.80	

To measure the goodness of the model used for this forecasting, the researchers used the mean square of error (MAPE) based on historical data from January 2013 to August 2019 was 3.89%, the MAPE of the VAR (1) model is below 10%, meaning the model is very well used to do forecasting.

4. CONCLUSION

The purpose of this study is to examine the relationship between the exogenous variables NPF, ROE, CAR, FDR, and BOPO on the ROA of Islamic banks in Indonesia. Testing is done by comparing Johnson and the results show there is no long-term relationship between exogenous variables and ROA of Sharia banks in Indonesia. The VAR model concludes that NPF has a significant and negative effect on ROA while ROE has a positive effect on ROA in Indonesia.

Overall exogenous variables were able to explain the variation in ROA of Islamic banks in Indonesia amounting to 74.1%. Empirical results from the impulse response function show that ROE gives the highest positive response to ROA. While ROE also gives a fairly high positive response if there is a shock to the ROA itself, meaning that the current ROA is very much influenced by the ROA of the previous period. Whereas ROA responds negatively if shocks occur on NPF, ROE, FDR and BOPO.

The results of the variance decomposition show that ROA is very influential on itself in the first period, overall in addition to ROA, the other variable that gives the greatest effect on ROA is ROE, followed by NPF, FDR, CAR. Whereas BOPO contributed very little in influencing ROA.

Forecasting results for the next ten periods indicate that the ROA situation will decrease every month, with the error rate of forecasting using MAPE of 3.89% below 10%, which means the model is very good for forecasting.

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