Thailand Statistician
October 2024; 22(4): 953-962
http://statassoc.or.th
Contributed paper

Comparison of ARIMAX and Feedforward Neural Network in Forecasting Cash Outflow Inflow at Bank Indonesia East Java Region

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Received: 9 November 2021
Revised: 8 September 2022
Accepted: 22 September 2022

Abstract

Money management, which includes planning, expenditure (outflow), circulation to withdrawal (inflow) in Indonesia, is the duty and authority of the central bank, namely, Bank Indonesia. The amount of money going out and going in needs to be modeled and forecasted to estimate people's money needs in the next period. The effects of calendar variations often affect cash outflows and inflows. Therefore, the method used is ARIMAX with the effect of calendar variations. On the other hand, cash outflow and inflow data allow nonlinear patterns so that the forecasting method used is FFNN. The purpose of this study is to compare the best model between ARIMAX and FFNN in forecasting cash outflow and inflows in the East Java region. There are three Bank Indonesia Representative Offices that are the focus of the research, namely, in the City of Kediri, the City of Jember, and the City of Malang. Not all places can use the ARIMAX and FFNN methods because they adjust the actual data conditions. If the ARIMAX or FFNN criteria do not meet, the modeling continues with ARIMA/SARIMA/Time Series Regression. The criteria for selecting the best model are based on the MSE and RMSE values in the testing data. FFNN modeling is better than ARIMAX on cash inflow data for the city of Kediri and the city of Jember. As for the cash outflow of Jember, ARIMAX is better than FFNN. The rest, compared to ARIMA/SARIMA/Time Series Regression adjusts the actual data pattern. In general, the FFNN model is better than ARIMAX, provided that the data has a nonlinear pattern.

Keywords: Time series, forecasting, machine learning, cashflow

1. Introduction

Indonesia consists of 34 provinces, one of which is East Java province. The country’s economy is also related to the economy of each province. In everyday life, the economy cannot be separated from the need for money. The central bank of Indonesia has the duty and authority to regulate and maintain the payment system (Bank Indonesia 2021). Each region has a Bank Indonesia Representative Office, abbreviated as KPW BI, which oversees the regulation of the money needs of each region. For example, in East Java province, there are several BI representative offices such as in Jember City, Malang City, and Kediri City. In carrying out the task of regulating and maintaining the smooth running of the payment system, Bank Indonesia is authorized to manage money, which includes planning, spending (outflow), circulation, revocation, and withdrawal (inflow) of money (Bank Indonesia, 2012). Therefore, forecasting is needed to estimate cash outflows and cash inflows.

Bank Indonesia uses the Autoregressive Integrated Moving Average (ARIMA) method in estimating cash outflows and cash inflows. However, not all data are compatible with this method. Non-linear data patterns cannot use these methods for modelling and forecasting. One of the methods that can be used for this problem is the Feedforward Neural Network (FFNN). On the other hand, there are time series modelling methods such as time series regression, Seasonal Autoregressive Integrated Moving Average (SARIMA), Autoregressive Integrated Moving Average with Explanatory (ARIMAX), etc. Its use is adjusted to the actual data conditions.

Several previous studies have used these methods. Elena et al. (2012) which predicts tourist arrivals in Bali; Fransiska et al. (2019) monthly rainfall modelling; Borhan and Arsad (2014) predict international tourism demand from the US, Japan, and South Korea to Malaysia; all three use the SARIMA method. On the other hand, Suharsono and Monica (2020) estimated inflation using ARIMAX; Lee and Hamzah (2010) predicted sales with Ramadan effect using ARIMAX; Monica and Suharsono (2021) predicted outflow inflow using ARIMAX; etc. Machmudin and Ulama (2012) showed that the ARIMA and ANN methods with the FFNN approach provide a good model compared to ARIMA to predict air temperature in the city of Surabaya. Based on these results, this study uses basic methods such as ARIMA, which is echoed by the development method, namely, FFNN, so that nonlinear patterns in the data can be resolved. Based on these studies, this study wants to know which one is better between the ARIMAX and FFNN methods in forecasting cash outflows and inflows in the East Java region. These results can serve as further information for the Bank Indonesia Representative Office and related parties in determining monetary policy.

2. Literature Review

2.1. Cash outflow and inflow

Money is objected that they are approved by the community as an intermediary tool to exchange (Endriani, 2015). Cash outflow is money that comes out of Bank Indonesia through withdrawals by the public and commercial banks, either directly, mobile cash, or cash deposit (Bank Indonesia, 2019). Meanwhile, cash inflow is the money that enters Bank Indonesia through deposits by the public and commercial banks, either directly mobile cash or cash deposit.

2.2. Seasonal Autoregressive Integrated Moving Average Exogenous (ARIMAX) with calendar variation effects

ARIMAX modelling is a modification of ARIMA modelling with additional explanatory variables that have a significant effect. Most of the East Java's population is Muslim, so the celebration of Eid al-Fitr is thought to affect cash outflow and inflows. Model identification can be done by identifying Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) graphs. In general, the ARIMAX model with a stochastic trend can be written in equation (1) (Lee et al. 2010).

$$Y_t = \beta_1 V_{1,t} + \beta_2 V_{2,t} + \ldots + \beta_p V_{\text{p},t} + \gamma_1 M_{1,t} + \gamma_2 M_{2,t} + \ldots + \gamma_s M_{\text{s,t}} + \frac{\theta_q(B)}{\phi_p(B)(1-B)^d} a_t, \tag{1}$$

where $\beta_1, \beta_2, ..., \beta_p$ are the Eid al-Fitr dummy variable parameter, $V_{1,t}, V_{2,t}, ..., V_{p,t}$ are the Eid al-Fitr dummy variable, $\gamma_1, \gamma_2, ..., \gamma_s$ are the seasonal pattern dummy variable parameter, $M_{1,t}, M_{2,t}, ..., M_{s,t}$ are the seasonal pattern dummy variable, and δ is the coefficient for trend.

2.3. Feedforward Neural Network (FFNN)

Feedforward Neural Network (FFNN) is one of the artificial neural network models that is often used to predict time series data. Neurons in FFNN are generally grouped in layers. This method is also a type of method where the process goes forward from the input layer to the output with a directed acyclic graph (Fine 1999). Figure 1 shows the FFNN network architecture which consists of an input layer, a hidden layer, and an output layer.

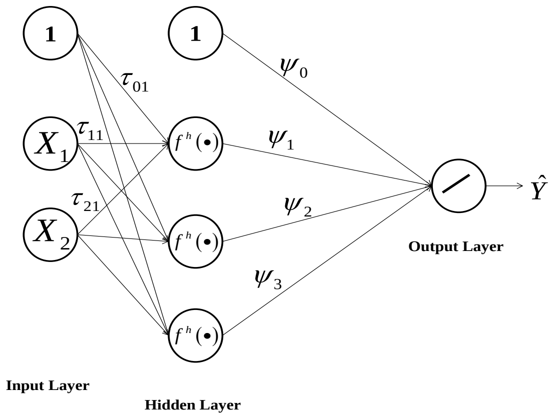

Figure 1 FFNN Network Architecture

In general, the equation of the FFNN model can be seen in (2).

$$Y_t = \psi_0 + \sum_{j=1}^{J} \psi_j f(\tau_{oj} + \sum_{k=1}^{K} \tau_{kj} X_{kt}) + a_t, \tag{2}$$

where K is the number of input nodes, J is the number of hidden nodes, $\{\psi_j, j = 0,1,...,J\}$ is the weight vector from hidden layer to output, $\{\tau_{ij}, k = 0,1,...,K; j = 0,1,...,J\}$ is the weight vector from the input layer to the hidden layer.

2.4. Terasvirta non-linearity test

Non-linearity testing methods include the Terasvirta test, White test, and Ramsey test. Based on Prabowo et al. (2020), the Terasvirta test is the best non-linearity test compared to the white test and Ramsey test. The study said that Terasvirta was more sensitive to outliers than the two tests. The steps for testing using the Terasvirta test are as follows.

1. Regressing Y_t on $Y_{t-1}, Y_{t-2}, \ldots, Y_{t-p}$ with constant 1 and calculate residual value $\hat{u}_t$.

2. Regressing $\hat{u}_t$ on $Y_{t-1}, Y_{t-2}, \ldots, Y_{t-p}$ with constant 1 and v additional predictors of quadratic and cubic terms which are approximations of the Taylor series.

3. Calculate the coefficient of determination (R^2) from the regression in the previous step.

4. Calculating test statistics $\chi^2 = nR^2 \sim \chi^2_{\alpha,v}$ where n is the number of observations. The hypothesis used is a linear model as the null hypothesis and a non-linear model as the opposite hypothesis. If the p-value is less than then rejecting the null hypothesis.

3. Methodology

The data used in this study are cash outflows and inflows from Kediri City, Jember City, Malang City in East Java Province, Indonesia. The data period for each city is different due to the granting of permission to collect data from the relevant agencies. However, all three are monthly data. Cash inflows and outflows for Malang City from January 2016 to July 2020, for Jember City from January 2015 to June 2020, and for Kediri City from January 2016 to February 2021. Training testing was applied to each data. Table 1 are the research response variables.

Table 1 Research response variable*

Variable	Description
$Y_{1,t}$	Cash Inflow Kediri
$Y_{2,t}$	Cash Outflow Kediri
$Y_{3,t}$	Cash Inflow Malang
$Y_{4,t}$	Cash Outflow Malang
$Y_{5,t}$	Cash Inflow Jember
$Y_{6,t}$	Cash Outflow Jember

*Source: Bank Indonesia Representative Office, 2021

This study also used dummy variables in modelling. An explanation of the dummy variables used is in Table 2.

Table 2 Dummy variable

Trend	Variable
	t, with $t = 1, 2, ..., n$
Seasonal	$M_{1,t} = \begin{cases} 1, \text{for January} \\ 0, \text{other months} \end{cases}$ $M_{2,t} = \begin{cases} 1, \text{for February} \\ 0, \text{other months} \end{cases}$ $\vdots$ $M_{12,t} = \begin{cases} 1, \text{for December} \\ 0, \text{other months} \end{cases}$
Calendar Variation	$V_{1,t} = \begin{cases} 1, \text{one month before Eid} \\ 0, \text{other months} \end{cases}$ $V_{2,t} = \begin{cases} 1, \text{month of Eid} \\ 0, \text{other months} \end{cases}$ $V_{3,t} = \begin{cases} 1, \text{one month after Eid} \\ 0, \text{other months} \end{cases}$

4. Results and Discussion

4.1. Characteristics of cash outflow and inflow

Table 3 Descriptive statistics

		Malang City	Kediri City	Jember City
Cash Inflow	Mean (Trillion Rupiah)	1.488	1.453	1.317
	Standard deviation	0.871	0.662	0.453
	Minimum	0.267	0.587	0.728
	Maximum	5.476	3.623	3.057
Cash Outflow	Mean (Trillion Rupiah)	1.051	1.561	1.006
	Standard deviation	0.848	1.012	0.618
	Minimum	0.187	0.199	0.061
	Maximum	3.753	5.746	3.353

Based on Table 3, the City of Jember has the smallest average compared to the other two cities, which is 1.317 trillion Rupiah, as well as a cash outflow of 1.006 trillion Rupiah. In terms of data diversity, Malang City's cash inflow is more diverse than the other two cities. As for cash outflow data, the city of Kediri is more diverse than the other two cities. The highest cash inflow in Jember City was 3.0571 trillion Rupiah in June 2019, at which time there was deflation; in the City of Kediri of 3.623 trillion Rupiah in June 2019 coinciding with Eid al-Fitr in that month; and in Malang City of 5.476 trillion Rupiah in April 2019. On the other hand, the highest cash outflow was in Jember City of 3.353 trillion Rupiah in May 2019, which was due to inflation and a month approaching Eid Al-Fitr; in the City of Kediri 5.746 trillion Rupiah in June 2017 to coincide with Eid al-Fitr in that month; and in Malang city of 3.753 trillion Rupiah in May 2019 which was caused a month before Eid al-Fitr. In general, the cash outflows and inflows of the three cities are related to Eid al-Fitr because most of the people in the three cities are Muslim. This holiday calendar effect is used as exogenous in ARIMAX modeling. Based on Figure 2, the cash outflow and inflow variables in the three cities fluctuated variously and tended to increase in certain months. These months coincide with the occurrence of Eid al-Fitr and before and after Eid al-Fitr. This is one of the reasons for using Eid al-Fitr as the effect of calendar variations.

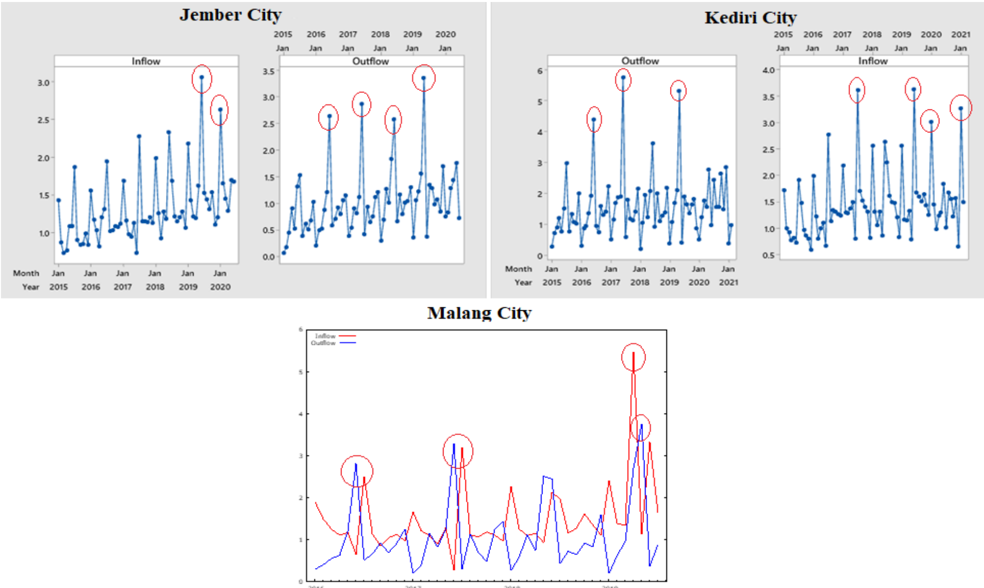

Figure 2 Time series plot

4.2. Cash outflow and inflow with ARIMAX modelling

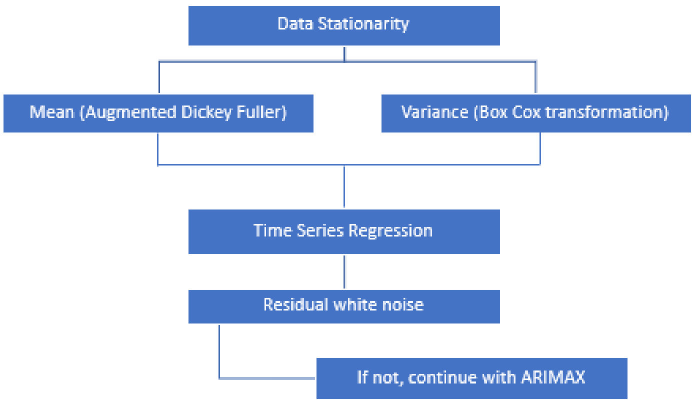

Figure 3 Step by step summary for ARIMAX modelling

The stationarity of the data needs to be tested first before further time series analysis is carried out. Data is said to be stationary if the mean and variance of the data do not change systematically over time. Two things need to be tested in the stationarity of the data, namely, the variance and the average. Stationarity of variance was tested using the Box-Cox transformation, while the average stationarity was tested using the Augmented Dickey-Fuller Test. The data is said to be stationary with respect to a variance if the rounded value of the Box-Cox Transformation is 1. After the three data are stationary with respect to variance and average, it is followed by Time Series Regression (TSR). ARIMAX is performed when the testing assumption of white noise on the TSR is not met. The remainder of the TSR is modelled by ARIMA first. Then, choose the best model with the smallest AIC value. TSR modelling is intended to determine which exogenous variables have an influence.

The method of selecting variables that are included in the model or not uses backward elimination. After that, combine the TSR and ARIMA results to become an ARIMAX model. In general, the ARIMAX modelling steps can be seen in Figure 3. Table 4 shows the results of ARIMAX modelling of cash outflow and inflow data in each city. In the table, Malang City's cash outflow is not continued with the ARIMAX model because it already meets the white noise assumption in the TSR. Therefore, the modelling and forecasting continued using time series regression.

Table 4 ARIMAX model

City	Data	ARIMAX Model
Kediri	Cash Inflow	ARIMAX(1,0,[13])
	Cash Outflow	ARIMAX(1,0,0)
Malang	Cash Inflow	ARIMAX(0,0,[2])
	Cash Outflow	-
Jember	Cash Inflow	ARIMAX([1][6],0,[6])
	Cash Outflow	ARIMAX([5],0)

4.3. Cash Outflow and Inflow with FFNN modelling

ARIMA/SARIMA modelling is carried out first according to the actual conditions related to seasonality or not. The results of the ARIMA modelling are used as input for the FFNN model. The nonlinear detection test was carried out first with the Terasvirta test. This test is conducted to determine whether the relationship between and the input variable is nonlinear or not. The alternative hypothesis, namely, a nonlinear model. If the test results show nonlinearity, then continue with FFNN modelling. Table 5 is the result of ARIMA/SARIMA modelling which is used as input and then continued with the Terasvirta test.

Table 5 Input FFNN

City	Data	ARIMA/SARIMA Model	p-Value (Terasvirta Test)
Kediri	Cash Inflow	SARIMA (0,0,0) $(1,0,0)_{12}$	0.00035
	Cash Outflow	SARIMA (0,0,0) $(1,0,0)_{12}$	0.10770
Malang	Cash Inflow	ARIMA (1,1,1)	0.09680
	Cash Outflow	ARIMA (2,1,0)	2.20E-16
Jember	Cash Inflow	SARIMA (1,0,1) $(1,0,0)_{12}$	2.20E-16
	Cash Outflow	SARIMA (10,0,1) $(1,0,1)_{12}$	0.04113

*Column marked in yellow are selected input FFNN

Based on Table 5, cash outflows from Kediri City and cash inflows from Malang City cannot be continued with the FFNN model because the p-value is more than the real level or significance level (5%) or can be concluded to follow a linear pattern. In FFNN modelling, it is necessary to first identify many hidden layers that are used for the learning algorithm process. In this study, the number of hidden layers is limited to 10 neurons with the selection of many hidden layers based on the smallest Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE) values. The hidden layer with the smallest RMSE and MAPE is used as the selected hidden layer for FFNN modelling. The general form of the FFNN model for the variables can be seen in Table 6. In short, the FFNN model cannot be interpreted but is used for forecasting.

Table 6 FFNN model

City	Data	FFNN Model
Kediri	Cash Inflow	$\widehat{Y}_{1,t} = f^{0}((-1.693 f_1^h(-1.074\widehat{Y}_{1,t-12} + 0.224a_{1,t} - 0.021) + 2.540 f_2^h(1.341\widehat{Y}_{1,t-12} - 0.725a_{1,t} - 0.157) + 1.613 f_3^h(1.191\widehat{Y}_{1,t-12} - 1.109a_{1,t} - 0.631) - 1.925 f_4^h(-0.490\widehat{Y}_{1,t-12} - 7.702a_{1,t} + 1.109) + 4.235 f_5^h(0.620\widehat{Y}_{1,t-12} + 6.487a_{1,t} - 0.899) + 4.235)$
Malang	Cash Outflow	$\hat{Y}_{4,t} = f^{0}((-15.696 f_1^h(0.836\hat{Y}_{4,t-1} + 3.081\hat{Y}_{4,t-2} - 0.8771a_{4,t} - 1.881) + 3.634 f_2^h(-0.108\hat{Y}_{4,t-1} - 1.869\hat{Y}_{4,t-2} + 2.411a_{4,t} - 0.043) + 2.279 f_3^h(-0.560\hat{Y}_{4,t-1} + 0.264\hat{Y}_{4,t-2} + 1.498a_{4,t} - 1.551) + 0.893 f_4^h(0.502\hat{Y}_{4,t-1} - 1.003\hat{Y}_{4,t-2} + 2.223a_{4,t} - 0.357) - 1.285 f_5^h(-0.451\hat{Y}_{4,t-1} + 0.666\hat{Y}_{4,t-2} - 0.017a_{4,t} + 1.544) - 1.214 f_6^h(0.672\hat{Y}_{4,t-1} - 0.513\hat{Y}_{4,t-2} - 1.534a_{4,t} + 1.653) - 4.061 f_7^h(0.048\hat{Y}_{4,t-1} + 1.121\hat{Y}_{4,t-2} - 2.852a_{4,t} + 0.164) + 13.033 f_8^h(-0.252\hat{Y}_{4,t-1} + 0.431\hat{Y}_{4,t-2} + 2.743a_{4,t} - 5.764) - 0.046)$
Jember	Cash Inflow	$\widehat{Y}_{5,t} = f^{0}((4.728 f_1^h(1.678\widehat{Y}_{5,t-12} - 0.356\widehat{Y}_{5,t-1} - 1.099\widehat{Y}_{5,t-13} + 8.257a_{5,t} - 1.044a_{5,t-1} - 1.521) - 1.688 f_2^h\left(-2.605\widehat{Y}_{5,t-12} + 0.518\widehat{Y}_{5,t-1} + 0.174\widehat{Y}_{5,t-13} + 1.547a_{5,t} - 1.708a_{5,t-1} - 0.658\right) + 1.962 f_3^h\left(3.468\widehat{Y}_{5,t-12} + 0.491\widehat{Y}_{5,t-1} - 1.288\widehat{Y}_{5,t-13} + 0.724a_{5,t} - 2.565a_{5,t-1} - 1.554\right) - 2.537 f_4^h\left(1.021\widehat{Y}_{5,t-12} - 1.355\widehat{Y}_{5,t-1} - 1.704\widehat{Y}_{5,t-13} + 0.088a_{5,t} - 2.126a_{5,t-1} - 0.288\right) - 2.029 f_5^h\left(-2.754\widehat{Y}_{5,t-12} + 0.739\widehat{Y}_{5,t-1} + 1.082\widehat{Y}_{5,t-13} - 2.777a_{5,t} - 1.133a_{5,t-1} + 0.453\right) + 1.455)$
	Cash Outflow	$\widehat{Y}_{6,t} = f^{0}((6.979 f_1^h(3.237\widehat{Y}_{6,t-12} + 3.418a_{6,t} - 4.097a_{6,t-12} - 0.367) - 4.750 f_2^h(-3.081\widehat{Y}_{6,t-12} - 2.915a_{6,t} + 5.043a_{6,t-12} + 0.361) + 2.006)$

4.4. Comparison between ARIMAX and FFNN modelling

Comparison between the two can only be done with a few variables because not all variables have a nonlinear pattern and there are also variables that cannot be modelled using ARIMAX, namely, cash outflow in Malang City. Table 7 is a summary of the comparison of MSE and RMSE between the two models. The best models have a minimum MSE and RMSE. In the table, the FFNN model is better than ARIMAX. This is in line with the theory that has been mentioned regarding the use of FFNN on nonlinear data.

Table 7 Comparison forecast accuracy between ARIMAX and FFNN

City	Data	MSE		RMSE	
		ARIMAX	FFNN	ARIMAX	FFNN
Kediri	Cash Inflow	0.176	0.015	0.420	0.121
Jember	Cash Inflow	0.100	0.067	0.316	0.259
	Cash Outflow	0.383	0.416	0.619	0.645

*Column marked in yellow are the best model

While the modelling for cash outflow variables in Kediri City and cash inflow in Malang City is adjusted to the actual data conditions. If the available data is detected as seasonal, SARIMA will be used, if not, then ARIMA will be used. Then, both are compared with ARIMAX as shown in Table 8. In addition, because Malang City's cash outflow has met the white noise assumption when modelled using Time Series Regression, the variables are compared with the FFNN model as shown in Table 8. The results of MSE and RMSE in Table 8 are obtained from data testing forecasting to compare with the actual data. That way, it can be easily which model is more accurate to be used as a basis for forecasting in the next period.

Table 8 Comparison forecast accuracy between ARIMAX/TSR and ARIMA/SARIMA/FFNN

City	Data	MSE		RMSE	
		ARIMAX[1] / TSR[2]	ARIMA[1]/ SARIMA[2]/FFNN[3]	ARIMAX[1] / TSR[2]	ARIMA[1]/ SARIMA[2]/FFNN[3]
Kediri	Cash Outflow	0.465[1]	0.164[2]	0.682[1]	0.405[2]
Malang	Cash Inflow	2.029[1]	0.205[1]	1.424[1]	0.452[1]
	Cash Outflow	2.576[2]	0.650[3]	1.605[2]	0.806[3]

*Column marked in yellow are best model

The best models have a minimum MSE and RMSE. Based on Table 8, the best model for forecasting cash outflow in Kediri City is SARIMA(0,0,0)(1,0,0)$_{12}$ compared to ARIMAX. While the best model for forecasting cash inflow in Malang is ARIMA(1,1,1) compared to ARIMAX and the best model for forecasting cash outflow in Malang is FFNN compared to Time Series Regression (TSR).

5. Conclusion

In general, the best model for forecasting cash outflow and inflows in East Java is using FFNN (with a note of nonlinear data patterns). However, not all data meet the nonlinear requirements so that the modelling must also be adjusted to the actual data conditions. Other time series methods that can be used are ARIMA or SARIMA. The model formed can serve as additional information for Bank Indonesia Representative Offices in each city in forecasting the next period and determining the appropriate monetary policy together with the government or related agencies.

References

Bank Indonesia. Functions of Bank Indonesia [Internet]. 2021. Available from: http://www.bi.go.id/id/tentang-bi/fungsi-bi/tujuan/Contents/Default.aspx.

Bank Indonesia. Bank Indonesia Regulation concerning Rupiah Money Management; 2012.

Bank Indonesia. Bank Indonesia Regulation concerning Rupiah Money Management. Bank Indonesia; 2019.

Borhan N, Arsad Z. Forecasting international tourism demand from the US, Japan and South Korea to Malaysia: A SARIMA approach. In: AIP Conference Proceedings. American Institute of Physics; 2014: 955-960.

Elena M, Lee MH, Suhartono H, Hossein I, Abd Rahman NH, Bazilah NA. Fuzzy time series and SARIMA model for forecasting tourist arrivals to Bali. J Teknol. 2012; 57(1): 69-81.

Endriani S. The concept of money: Islamic economics vs conventional economics. Anterior J. 2015; 15(1): 70-75.

Fransiska H, Novianti P, Agustina D. Monthly rainfall modeling in Bengkulu City with Seasonal Autoregressive Integrated Moving Average (SARIMA). In: Seminar Nasional Official Statistics. 2019; 390-395.

Fine TL. Algorithms for designing feedforward networks. New York: Springer; 1999.

Lee MH, Hamzah N. Calendar variation model based on ARIMAX for forecasting sales data with Ramadhan effect. In: Proceedings of the Regional Conference on Statistical Sciences. 2010: 30-41.

Lee MH, Suhartono, Hamzah N. Calendar variation model based on time series regression for sales forecasts: The Ramadhan effects. In: Proceedings of the Regional Conference on Statistical Sciences (RCSS' 10). Malaysia: Universiti Teknologi MARA (UiTM); 2010: 349-361.

Machmudin A, Ulama BSS. Forecasting air temperature in Surabaya City using ARIMA and artificial neural network. J Sains dan Seni ITS. 2012; 1(1): D118-D123.

Monica M, Suharsono A. Forecasting cash outflow and inflow in Jember with ARIMAX calendar variation effect. AIP Conf. Proc. 2021; 2326: 020014.

Prabowo H, Suhartono S, Prastyo DD. The performance of Ramsey test, white test and Terasvirta Test in detecting nonlinearity. Inferensi. 2020; 3(1): 1-12.

Suharsono A, Monica M. Forecasting inflation in Malang City using autoregressive integrated moving average exogenous with calendar variation effect. J Technol Reports Kansai Univ. 2020; 62(8): TRKU-02-09-2020-11065.