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Prediction of Rupiah Currency Value Against Dollar with ARIMA Model

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ABSTRACT

The currency of each country is different, resulting in difficulties in transacting between one country and another. So it takes a currency exchange process to facilitate a transaction process between countries called the Exchange Rate. However, exchange rate volatility can threaten the economy of a country. Therefore, a prediction of the exchange rate is needed so that investors or the public can determine strategies or plans for future economic policies. Therefore, this study aims to find the ARIMA model that has the best performance in predicting the rupiah exchange rate against the dollar. So that this model can be a reference for investors and the public in investing in shares with other countries. The results of this study obtained the best model, namely the ARIMA model (0, 1, 1) to predict the exchange rate for the next 20 periods with the help of *eviews.9 software*.

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1. INTRODUCTION

Money is a legal medium of exchange and is accepted by the community as a means of payment for goods or services. The role of money is very important in the economy of a country. The economic activity that uses and utilizes the function of money is trade. The process of trade economic activity is not only carried out with one region to another, but can be carried out between one country and another. The trading activity of a country with other countries is known as international trade. To facilitate international trade activities, money is used in an open economy by using currency fixed money. Then a country must have the same currency value as the destination country so that it requires a process of exchanging money.

International trade activities will have an impact on changes in currency values due to the uncertainty of the currency exchange rate itself. The uncertainty of currency exchange rates led to an economic crisis. In Indonesia, the currency exchange rate crisis will spread to other sectors, resulting in an economic crisis.

The exchange rate of the Rupiah against the US Dollar is very significant because it causes a wide impact on the Indonesian economy. Therefore, the movement of currency exchange rates requires serious attention by the government to monitor and control it. As a result of the weakening of the Rupiah exchange rate against the US Dollar, the prices of goods and services in Indonesia will experience inflation. The central bank in a country will decide or make a policy on interest rates in order to influence inflation and currency exchange rates.

Seeing the magnitude of the effect of exchange rate instability on the economy, it is therefore necessary to have a good exchange rate management to keep the exchange rate stable. So that exchange rate volatility can be predicted and the economy in Indonesia can run stably. When a policy is taken to maintain the stability of the value of the movement of the Indonesian economy.

To get an idea of the exchange rate of the Rupiah against the US Dollar in the next 20 periods, it is necessary to forecast the exchange rate of the Rupiah against the US Dollar for the next period. Based on the problems above, the author uses the ARIMA model to predict the Rupiah exchange rate against the US Dollar. The reason the author uses this method is because the ARIMA model includes values in the past and also the present to produce accurate short-term forecasts.

2. RESEARCH METHODE

Data Stationarity

Stationarity in time series has two types of data, namely stationary in the mean and stationary in variance. Stationary in the mean is a fluctuation in the data within the scope of a constant mean value, independent of the time and variance of these fluctuations. While stationary in variance is a structure from time to time that has constant fluctuations in data and does not change. Data that is not stationary with respect to variance can be stationary by performing a Box-Cox transformation. Furthermore, if the time series data is not stationary in the mean, then the data can be stationary by differentiating or differencing.

Model *Autoregressive* atau AR (p)

Autoregressive will express predictions as a function of the previous values of a certain time series.
The AR model is defined as:

$$Y_t = \emptyset_0 + \emptyset_1 Y_{t-1} + \emptyset_2 Y_{t-2} + \cdots + \emptyset_p Y_{t-p} + \varepsilon_t$$

Y_t = dependent variable at time t
$\emptyset_0$ = constant
$Y_{t-1}, Y_{t-2}, Y_{t-p}$ = independent variable which is the lag (time difference) of 1,2, dependent variable in one previous period to period p of the previous period
ε_t = residuals at time t.

Model *Moving Average* atau MA (q)

Moving average (MA) is used to explain the phenomenon that an observation at time (t) is expressed as a linear combination of a random number. Although there is a negative sign on the coefficient, the value of the coefficient can be positive or negative.

$$Y_t = \mu + \varepsilon_t + \omega_1 \varepsilon_{t-1} - \omega_2 \varepsilon_{t-2} - \cdots - \omega_q e_{t-q}$$

Y_t = dependent variable at time t
μ = constant
$\omega_1, \omega_2, \omega_q$ = coefficient or model parameter of the model moving average which show weight
ε_t = residuals at time t.
$\varepsilon_{t-1}, \varepsilon_{t-2}, \varepsilon_{t-q}$ = previous residual value (lag)

Autoregressive Moving Average atau ARMA (p,q)

The ARMA model is an amalgamation of the AR and MA models. The ARMA model is obtained by entering the AR and MA models at once. The ARMA model can be written as follows.

$$Y_t = \emptyset_0 + \emptyset_1 Y_{t-1} + \emptyset_2 Y_{t-2} + \cdots + \emptyset_p Y_{t-p} + \varepsilon_t - \omega_1 \epsilon_{t-1} - \omega_2 \varepsilon_{t-2} - \cdots - \omega_q e_{t-q}$$

Where :
Y_t = dependent variable at time t
$\emptyset_0$ = constant
$Y_{t-1}, Y_{t-2}, Y_{t-p}$ = independent variable from the previous dependent variable
$\varepsilon_{t-1}, \varepsilon_{t-2}, \varepsilon_{t-q}$ = previous residual value (lag)
ε_t = residual
$\emptyset_1, \emptyset_2, \emptyset_p, \omega_1, \omega_2, \omega_q$ = model coefficient

Autoregressive Integrated Moving Average atau ARIMA (p,d,q)

By using these two models, past values, present values and errors that exist in past values can be known

$$Y_t = \emptyset_0 + \emptyset_1 Y_{t-1} + \emptyset_2 Y_{t-2} + \cdots + \emptyset_p Y_{t-p} - \omega_1 \epsilon_{t-1} - \cdots - \omega_q e_{t-q} + \varepsilon_t$$

Where :

Y_t = dependent variable at time t
$\emptyset_0$ = constant
$Y_{t-1},, Y_{t-p}$ = independent variable from the previous dependent variable
$\varepsilon_{t-1},, \varepsilon_{t-q}$ = previous residual value (lag)
ε_t = residual
$\emptyset_1, \emptyset_p, \omega_1, \omega_q$ = model coefficient

Metode Maximum Likelihood

One way to get a good estimator is to use the maximum likelihood method introduced by RA Fisher. Maximum Likelihood is a way to get an estimator a for the unknown parameter b from the population by maximizing the probability function. The maximum probability estimator for obtained by maximizing the function *likelihood*

$$L(\theta) = \log\big(f(y_1|Y_0;\theta) f(y_2|Y_1;\theta) \dots f(y_T|Y_{T-1};\theta)\big)$$
$$= \sum_{t=1}^{T} \log f(y_t|Y_{t-1};\theta)$$

Where Y_t is field -σ complete and built by $Y_1, Y_2, Y_3, \dots, Y_t$ and

$$f(y_t|Y_{t-1};\theta) = P(X_t = 1|Y_{t-1};\theta)\frac{1}{\sqrt{2\pi\sigma}} exp\left\{\frac{-(x_t - c_1 - \emptyset_2 y_{t-1})^2}{2\sigma^2}\right\}$$
$$+P(X_t = 2|Y_{t-1};\theta)\frac{1}{\sqrt{2\pi\sigma}} exp\left\{\frac{-(x_t - c_1 - \emptyset_2 y_{t-1})^2}{2\sigma^2}\right\}$$

Types and Sources of Data

The type of data used in this study is secondary data that is quantitative in nature, namely data that is already available in the form of numbers. While the data used in this study includes time series data per month starting from January 4, 2021 - December 14, 2021. Sources of data https://www.bi.go.id/id/statistik/information-kurs/transaksi-bi/default.aspx.

Data Analysis Techniques

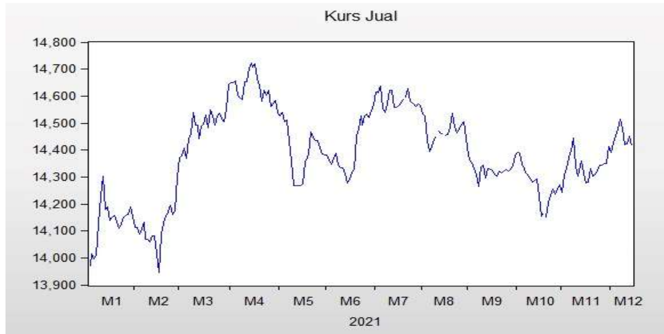
Data analysis was performed using the ARIMA method. Before calculating using the ARIMA method, a series of tests such as data stationarity, differentiation process and correlogram testing were conducted to determine the autoregression coefficient.

The steps used in this research are:

1. Model identification by testing the stationary data.
2. Estimated AR and MA parameters according to the model using the Maximum Likelihood Method.

3. RESULT AND ANALYSIS

Our first step is to see at the time series plot of data from the Rupiah Exchange Rate against the US Dollar whether it is stationary with respect to the mean or variance on January 4, 2021 to December 14, 2021.



Gambar 4.1 *Time Series* Plot of Rupiah Exchange Rate against US Dollar

Based on Figure 4.1, it can be seen that some of the data tend to increase and some of them tend to be low so that this data is not stationary. Therefore, a differentiation process is needed (*differencing*) so that the data becomes stationary.

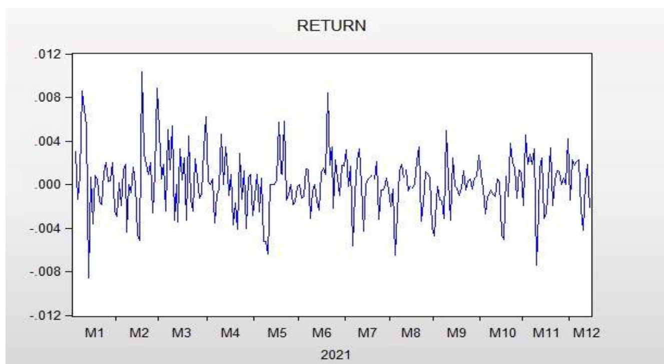
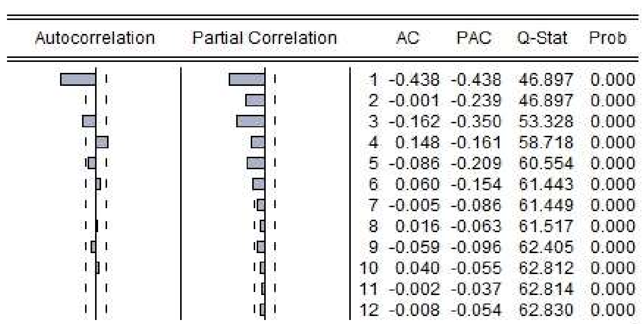


Figure 4.2 Graph of Rupiah exchange rate against US Dollar after differencing

Based on Figure 4.2, the data on the Rupiah exchange rate against the US Dollar after experiencing differencing is already stationary. Judging from the graph with an average or variance that is close to zero and does not show a trend. Next, perform a time series analysis using ARIMA modeling.
If the data is stationary in the mean and variance, then the assumptions of the ARIMA model have been met. The next step is to create an ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function) to identify the ARIMA model that is suitable for use. The following are the results of calculating the autocorrelation function and from the stationary data and the correlogram diagram..



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.438	-0.438	46.897	0.000
		2	-0.001	-0.239	46.897	0.000
		3	-0.162	-0.350	53.328	0.000
		4	0.148	-0.161	58.718	0.000
		5	-0.086	-0.209	60.554	0.000
		6	0.060	-0.154	61.443	0.000
		7	-0.005	-0.086	61.449	0.000
		8	0.016	-0.063	61.517	0.000
		9	-0.059	-0.096	62.405	0.000
		10	0.040	-0.055	62.812	0.000
		11	-0.002	-0.037	62.814	0.000
		12	-0.008	-0.054	62.830	0.000

Figure 4.3 ACF and PACF Exchange Rate against US Dollar *differencing* 1

From the ACF and PACF correlograms in the Figure above, the results of differencing show that ACF is not significant at the 1st and 3rd time lags, so it is assumed that the data is generated by MA (1) and MA (3). From the PACF plot, it can be seen that the partial autocorrelation value is not significant at the 1st and 3rd time lags so that the initial ARIMA models (1,1,1) and (3,1,3) are obtained. However, there are other ARIMA models that can be formed. The possible ARIMA models are as follows:

a. Model 1 : ARIMA (1, 1, 1)
b. Model 2 : ARIMA (3, 1, 3)
c. Model 3 : ARIMA (1, 1, 3)
d. Model 4 : ARIMA (3, 1, 1)
e. Model 5 : ARIMA (0, 1, 1)
f. Model 6 : ARIMA (0, 1, 3)
g. Model 7 : ARIMA (1, 1, 0)
h. Model 8 : ARIMA (3, 1, 0)

After obtaining the possible models, then estimating these models using the *likelihood* method with the help of the application *eviews9.* From the estimated models 1 to 8 we can get some of the best models by looking at the probabilities. H_0 accepted if the probability value is > 0.5. And H_0 rejected if the probability value < 0.5. The model is selected if the probability value of the model H_0 rejected.

After getting the possible ARIMA models, then select the best model by looking at the smallest value of the probability or the AIC value (*Aike info criterion*) and SC (*Schwarcz Criterion*) is calculated with the help of *eviews9*.

Tabel 4.3 ARIMA Model Parameter Comparison Results

Parameter	AIC	SC
ARIMA (3, 1, 3)	-8.394255	-8.350876
ARIMA (1, 1, 3)	-8.585158	-8.541778
ARIMA (3, 1, 1)	-8.909940	-8.866561
ARIMA (0, 1, 1)	-8.908323	-8.879403
ARIMA (0, 1, 3)	-8.380051	-8.351132
ARIMA (1, 1, 0)	-8.570262	-8.541343
ARIMA (3, 1, 0)	-8.382214	-8.353295

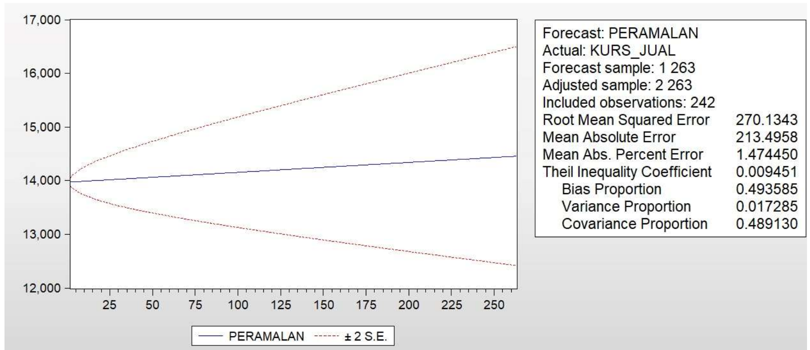
From some of these assumptions, the ARIMA model (0, 1, 1) is used because it has an SC value (Schwarcz Criterion) which is the smallest compared to the other models. The ARIMA model equation (0, 1, 1) above is generally written as follows:

$$Y_t = Y_{t-1} + \mu + e_t - 0{,}102367 e_{t-1}$$

Where :

Y_t = Observation in period t
Y_{t-1} = Error value in one period before period t
μ = constant
e_t = Error value in period t
e_{t-1} = previous residual value (lag)

Then the last step is to predict or predict the next period in the time series analysis. In this discussion, we will predict the exchange rate or the Rupiah exchange rate against the US Dollar in the next 1 month starting on December 15, 2021 - January 17, 2022. The following is a graph of forecasting the Rupiah exchange rate against the US Dollar using the help of *eviews9.*



From the graph above, it can be seen descriptively that the Rupiah exchange rate against the US Dollar for the next 20 periods has increased. In addition, there are several forecasting error values such as MSE = 270.1343, MAE = 213.4958, MAPE = 1.474450. Then the forecasting results for 15 December 2021 – 17 January 2021 are as follows:.

Tabel 4.4 Forecast Results of the Exchange Rate (Exchange) against the US Dollar

Tanggal	Ramalan	Tanggal	Ramalan	Tanggal	Ramalan
15-Des-21	14420,18	29-Des-21	14433,08	10-Jan-21	14445,98
16-Des-21	14422,03	30-Des-21	14434,92	11-Jan-21	14447,82
17-Des-21	14423,87	03-Jan-21	14436,77	12-Jan-21	14449,66
20-Des-21	14425,71	04-Jan-21	14438,61	13-Jan-21	14451,5
21-Des-21	14427,55	05-Jan-21	14440,45	14-Jan-21	14453,35
23-Des-21	14429,4	06-Jan-21	14442,29	17-Jan-21	14455,19
28-Des-21	14431,24	07-Jan-21	14444,13		

4. CONCLUSION

1.Compile Based on the results and discussion in this study, the best model in forecasting is the (0, 1, 1) model. The ARIMA model equation (0, 1, 1) above is generally written as follows:

$$Y_t = Y_{t-1} + \mu + e_t - 0{,}102367 e_{t-1}$$

The prediction results of the Rupiah exchange rate against the US Dollar on December 15, 2021 to January 17, 2022 have increased every period so that investors or the public who will invest can take advantage of this model to predict exchange rates. However, this model can only be used to predict in the short term.

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