Journal of Economics, Finance and Management Studies

ISSN (print): 2644-0490, ISSN (online): 2644-050

Volume 07 Issue 06 June 2024

Article DOI: 10.47191/jefms/v7-i6-18, Impact Factor: 8.044

Page No: 3226-3234

Analysis of Exports, Inflation, Exchange Rates, Interest Rates on Foreign Exchange Reserves: ARDL Approach

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ABSTRACT: The purpose of this study is to describe how inflation, interest rates, exports, and currency exchange rates affect Indonesia's foreign exchange reserves in the short and long run. In order to investigate short-term relationships, this study applies an autoregressive distribution lag (ARDL) model for cointegration for long-term associations. In addition, the error correction model (ECM) is used. Foreign exchange reserves, which are based on annual statistics, are the dependent variable. The four independent variables are interest rates, exchange rates, inflation, and exports. According to the study's findings, exports and exchange rates have a significant positive short- and long-term influence on foreign exchange reserves, whereas interest rates have a negative long-term impact on reserves. Foreign currency reserves have become an increasingly crucial indicator of a country's economic health in the current global economic climate. However, few research have thoroughly examined these traits in both the short and long term. This study attempts to provide fresh insights into how these variables interact and influence Indonesia's foreign

KEYWORDS: Foreign Exchange Reserves, Exports, Inflation, Exchange Rates, Interest Rates

I. INTRODUCTION

One of the developing nations that frequently engages in national development is Indonesia. Indonesia has achieved significant progress in a number of areas, such as natural resources, human resources, and economic development. Development that is carried out evenly can produce prosperity because people in each country can utilize resources more efficiently so that there is no inequality (Marlianda Bolung et al., 2023). Foreign exchange provides the funding for both domestic and global commerce. Foreign currency reserves are a useful evidence of a country's economic health and performance in global trade (Bunga Uli, 2016). Like a lot of other countries, Indonesia does not have the foreign exchange reserves required for international payments and exchange rate stabilization, which causes the balance of payments to be short and the value of the rupiah to decline (Islami & Rizki, 2018). Weak and declining foreign exchange reserves are particularly dangerous as they can lead to an inability to pay foreign debt and interest.

Exchange rates between nations increase a nation's foreign exchange reserves. Trade happens between countries because a nation cannot meet the demand for the production of products and services due to limited and precious resources (both natural and human resources). A nation's foreign exchange reserves may see a rise or fall in value based on its level of spending. A nation need more foreign exchange the more active its trade is. When a nation's imports surpass its exports, it is said to have insufficient foreign exchange reserves (Gandhi, 2006). Here are the latest changes to Indonesia's foreign exchange reserves, which fluctuate annually

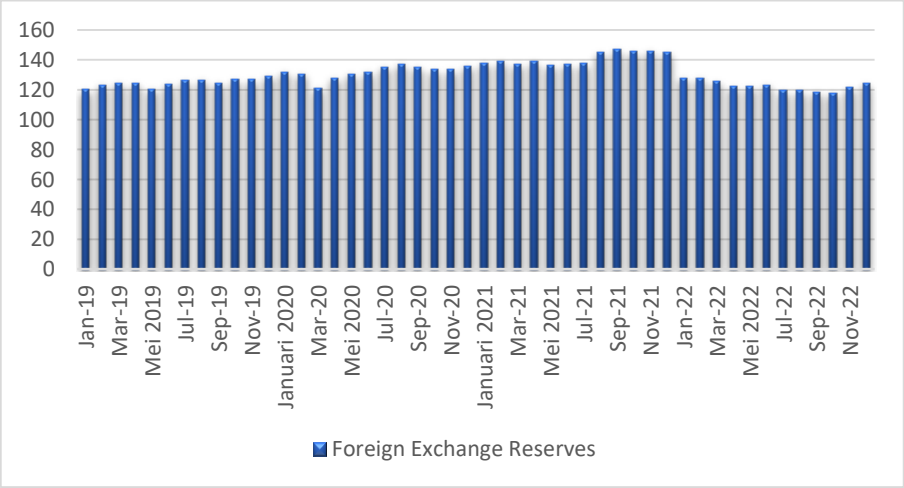

Figure 1. Foreign Exchange Reserves in Indonesia Jan 2019 - Dec 2022

Source: Bank Indonesia, 2023

Between January 2019 and December 2022, numerous domestic and global economic causes caused fluctuations in the foreign exchange reserves of Indonesia. Indonesia has over US$120 billion in reserves of foreign currency at the start of 2019. This was a result of efforts to stabilize the rupiah currency and foreign exchange earnings from exports and tourism, commodity price fluctuations and changes in global economic policy. In 2019 to 2020, foreign exchange reserves experienced many fluctuations, which were partly due to the impact of global trade between the United States and China that affected Indonesia's exports. Nonetheless, Bank Indonesia keeps interfering to maintain currency stability in the foreign exchange market. The COVID-19 pandemic struck Indonesia and the world economy in 2020. Foreign exchange reserves peaked in March 2020 at around US$ 121 billion, but they thereafter fell as a result of pressure on the rupiah and monetary interventions to keep the currency stable. In order to deal with the pandemic's effects, the government also utilized a portion of its foreign exchange reserves to offer monetary and fiscal support. Foreign exchange reserves started to rise in 2021 along with the world economy. In December 2021, Indonesia's foreign exchange reserves reached around US$ 144 billion, demonstrating the strength of the economy and its ability to respond to global uncertainty. Indonesia's foreign exchange reserves were valued at US$ 141.3 billion as of January 2022, although it was down compared to the previous month. however, at the end of December 2022, foreign exchange reserves increased by around US$ 137.2 billion, compared to November 2022. this increase was influenced by tax and service revenues and loan withdrawals. despite positive export performance in 2022, foreign exchange reserves still decreased by 5.31% as of December 2021, due to bank indonesia's intervention throughout the year to maintain the stability of the domestic economy in 2022. Events concerning commodities pricing, imports, exports, Each of these elements significantly affects the foreign exchange reserves' ability to grow over time.

A nation's foreign currency reserves come from trade between nations. Trade arises when a nation is unable to meet its own demands, particularly with regard to the production of products and services. A nation may thus be compelled to participate in trade activity known as imports and exports. One of the ways a nation makes money is through exporting, which produces a particular quantity of foreign exchange or cash. Consequently, a trade balance surplus and increased exports relative to imports will raise foreign currency reserves used for foreign exchange. This is because there are more exports than imports, resulting in net exports. Conversely, when the balance of trade is in deficit, excessive imports will cause foreign exchange reserves to decline (Bunga Uli, 2016).

Domestic inflation can also affect foreign exchange reserves. Growing costs for exporting goods could impede or disturb global trade, which would reduce demand. As a result, foreign exchange decreases, imports rise, and Indonesia's export revenue drops. On the other hand, when inflation is low, exports will rise as a result of lower export goods costs, which will boost foreign exchange and demand. (Islami & Rizki, 2018). This is in line with Agustina & Stie Mikroskil, (2014) that foreign exchange reserves are negatively impacted by inflation. Although some inflation is unavoidable, too much inflation will have an effect on the economy of a nation.

Exchange rates have an impact on foreign exchange reserves. Foreign exchange reserves may be impacted by the exchange rate, or the ratio of one currency to another. Higher exchange rates are a sign of a more stable economy and can be a helpful instrument for international trade (Sahrul et al., 2023). The study by Islami & Rizki, (2018) shows Foreign exchange reserves benefit from the exchange rate. This is due to the fact that the value of the rupiah has a direct impact on a country's

foreign exchange reserves. However, in order to create foreign currency reserves and boost the competitiveness of Indonesian exports, the Indonesian government devalued the Indonesian currency in respect to the US dollar. (Andriyani et al., 2020).

Interest rates are another component that affects foreign exchange reserves. Turmoil in the financial markets will be caused by rising interest rates, according to Soelistyo, (2015). If interest rates rise, foreign capital may withdraw loans. These loans directly lead to a rise in foreign exchange reserves. In the production of export goods, interest rates can serve as working capital that can accelerate production. Mankiw, (2007) states that a decrease in interest rates will encourage people to borrow bank loans and invest, which means an increase in production and exports. The amount of export trade increases the nation's foreign exchange reserves.

Considering the significance of foreign exchange reserves for a nation's economy, all nations strive to preserve their current level of reserves. This study aims to investigate the relationship between Indonesia's foreign exchange reserves and a number of variables, including interest rates, exports, inflation, and currency rates. The short- and long-term effects of foreign currency reserves on interest rates, exports, inflation, and exchange rates have not gotten much attention. Because of its foreign exchange reserves, which are expected to reach a record high of US$ 144.91 billion in 2021 although still being tiny in compared to other ASEAN nations, Indonesia was selected as the recipient nation. This study's primary contribution to the literature is its investigation of the short- and long-term relationships that exist in a nation such as Indonesia between exports, inflation, exchange rates, and interest rates on foreign exchange reserves.

2. RESEARCH METHODOLOGY

This study makes use of secondary data on exports, foreign exchange reserves, interest rates, inflation, and exchange rates. Monthly data from 2019:1 - 2022:12 is used in publications issued by Ceic, Bank Indonesia, and the Central Bureau of Statistics. The research data use the *Lag Distribution Autoregression* method from *Eviews 10* to ascertain whether or not there is a substantial influence among the dependent and independent variable in the short and long terms. The effect can be determined using 5%. Data stationarity test, cointegration test, and model estimation are the first steps in the ARDL model (Basuki, 2014).

After determining the data regression model to be applied in the data stationarity test with *Augmented Dicky Fuller* (ADF). Then the optimum lag is determined, which will be used in the research at the next stage. Before the *Autoregression Distribution Lag (ARDL)* test is conducted, each variable is tested with a cointegration test and a bound test. Finding out if there is cointegration between the investigated variables is the aim of this test. During the model estimation procedure, both the short-term and long-term elasticities are estimated using the ARDL and ECM models. After the ARDL test, classical assumption testing is required so that the resulting regression model can be used as a good predictive tool. The econometric equation for the model to be estimated is the same ECM model, where the ARDL equation is usually as follows

$$CD_t = \beta_0 + \beta_1 EKS_t + \beta_2 INF_t + \beta_3 NTR_t + \beta_4 SK_t + \varepsilon_t \quad (1)$$

Description

CD = Foreign Exchange Reserves

EKS = Export

INF = Inflation

NTR = Currency of country i in year t

SK = Interest Rate

β_0 = Intercept or Constant

$\beta_1\beta_2\beta_3$ = Regression Coefficient

ε_t = Error Term

Using the ARDL model equation, which can be described as follows, to determine whether exports, inflation, exchange rates, and interest rates have a linear connection

$$\Delta CD_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta CD_{t=i} + \sum_{i=1}^{n} \alpha_{2i} \Delta EKS_{t=i} + \sum_{i=1}^{n} \alpha_{3i} \Delta NTR_{t=i} + \sum_{i=1}^{n} \alpha_{4i} \Delta SK_{t=i} + \beta_1 CD_{t=1} + \beta_2 EKS_{t=1} + \beta_3 NTR_{t=1} + \beta_4 SK_{t=1} \quad (2)$$

where Δ describes the *first difference*. The coefficients (β1-β4) represent the long-term relationship while the coefficients (α1-α5) represent the short-term dynamics of the model. The *error correction* model based on the previous ARDL equation can be explained as follows:

$$\Delta CD_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta CD_{t=i} + \sum_{i=1}^{n} \alpha_{2i} \Delta EKS_{t=i} + \sum_{i=1}^{n} \alpha_{3i} \Delta NTR_{t=i} + \sum_{i=1}^{n} \alpha_{4i} \Delta SK_{t=i} + \gamma ECT_{t=1} + \epsilon_t \quad (3)$$

where Ɣ is the parameter for speed adjustment, while ECT is the residual that results from calculating equation's cointegration model (2).

3. RESULTS AND DISCUSSION

3.1. RESULT

Root Test

The degree chosen was 95%, or the real level (alpha 5%), According to the results of the Augmented-Dickey-Fuller (ADF) exam. If the p value is less than the MacKinnon critical value, the data used in this model may be stationary. The unit root will be examined at both the level and early disparity levels. The results from the table below show that all variables at the level level have p values that are lower than the critical value α. Therefore, under various conditions, the variables CK, EKS, INF, NTR, and SK are stationary at the level level.

Table 1. Root Test

Variables	Level		Result
	Stat.ADF	P Value	
CD	-6.700375	0.0000	Stasioner
EKS	-6.958738	0.0000	Stasioner
INF	-5.924240	0.0001	Stasioner
NTR	-6181430	0.0000	Stasioner
SK	-5.475406	0.0002	Stasioner

Source: Eviews 10, 2023

Determination of the optimum lag

The number of lags to be employed in the following phase can be ascertained using the lag optimal method. Before starting the estimation process, determining the ideal number of lags is very important to achieve good results. In this study, VAR *lag length criteria* will be used to determine the best lag. By considering the largest number of stars and based on the information criteria used, the optimum lag will be determined. The information *criterion* used is the *Akaike Information Criterion* (AIC). The AIC value is ARDL (2, 3, 3, 2, 2), which indicates that the significant models are CD in the previous two years, exports in the previous three years, inflation in the previous three years, exchange rates in the previous two years, and interest rates in the previous two years. The variable with the *minimum* lag is lag 2 and the *maximum lag* is lag 3.

Cointegration Test

In this study, the percentage of confidence that can be used for the research variables is determined through a cointegration test conducted using the *Bounds test* method. By comparing the calculated F-statistic value and the critical value, a diagnosis can be made. The F-statistic value is always less than the lower bound, indicating that the conclusion does not result in cointegration between the two variables; however, if the F-statistic value remains more than the upper bound, the conclusion does result in cointegration between the two variables. then the conclusion may result in cointegration between the two variables. As long as the statistical F value remains in between, the results obtained are inconclusive.

Table 2. Cointegration Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	10.37435	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Eviews 10, 2023

With a value of 10.37435, and a degree of *freedom level* of 3, the F statistic value is quite substantial, The Bounds test results demonstrate that it is bigger than the bottom limit of the I(0) and I(1) values. Thus, at a significance level of α = 5%, the

predicted ARDL model can be applied in this investigation. These findings suggest a relationship between long-run cointegration between the variables, indicating that ARDL should be the next approach to be employed.

Long-term Test

Table 3. Long-term Test

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EKS)	0.240934	0.074662	3.226983	0.0033
D(INF)	-0.091193	0.049675	-1.835814	0.0774
D(NTR)	-0.480953	0.124213	-3.872017	0.0006
D(SK)	0.205855	0.099700	2.064749	0.0487
C	-0.000803	0.001788	-0.449263	0.6568

EC = D(CD) - (0.2409*D(EKS) -0.0912*D(INF) -0.4810*D(NTR) + 0.2059 *D(SK) -0.0008)

Source: Eviews 10, 2023

The ARDL estimation results produced using the *Long Run Form* and *Bound Test* found in the levels equation are the basis for the above table. The Export, Exchange Rate, and Interest Rate variables have a p-value that is less than α = 5% (0.05), which indicates that the Export, Exchange Rate, and Interest Rate variables have a long-run relationship to foreign exchange reserves. Alternatively, the Inflation variable shows no long-term link with foreign exchange reserves, with a p-value greater than α = 5%.

Short Term Test

Table 4. Short Term Test

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CD(-1), 2)	0.530831	0.156415	3.393723	0.0021
D(EKS, 2)	0.087352	0.020094	4.347117	0.0002
D(EKS(-1), 2)	-0.249541	0.045799	-5.448677	0.0000
D(EKS(-2), 2)	-0.094133	0.022391	-4.204044	0.0003
D(INF, 2)	-0.142504	0.025387	-5.613243	0.0000
D(INF(-1), 2)	-0.029578	0.035835	-0.825378	0.4164
D(INF(-2), 2)	-0.070921	0.028275	-2.508310	0.0184
D(NTR, 2)	-0.484851	0.067479	-7.185231	0.0000
D(NTR(-1), 2)	0.287708	0.114569	2.511208	0.0183
D(SK, 2)	0.099439	0.041637	2.388231	0.0242
D(SK(-1), 2)	-0.144076	0.045274	-3.182284	0.0037
CointEq(-1)*	-2.151220	0.250458	-8.589131	0.0000

R-squared	0.921123	Mean dependent var	0.000198
Adjusted R-squared	0.894009	S.D. dependent var	0.069337
S.E. of regression	0.022574	Akaike info criterion	-4.517078
Sum squared resid	0.016306	Schwarz criterion	-4.030481
Log likelihood	111.3757	Hannan-Quinn criter.	-4.336624
Durbin-Watson stat	2.146338		

* p-value incompatible with t-Bounds distribution.

Source: Eviews 10, 2023

Analysis of Exports, Inflation, Exchange Rates, Interest Rates on Foreign Exchange Reserves: ARDL Approach

Using the ECM method, Short-term model estimation was performed. The short-term estimation test findings show that exports have a substantial impact on Indonesia's foreign exchange reserves (-1), 2, Exchange Rate (-1), 2, and Interest Rate (-1), 2. With a value of 0.087352, the export variable shows that the foreign exchange reserves of Indonesia have risen. If interest rates increase from where they were two years ago to now, Indonesia's foreign currency reserves will decline, while reserves will increase if the exchange rate rises during that period, according to the coefficients of 0.144076 and 0.287708 for the interest rate and exchange rate variables, respectively. The CointEq probability value, which is significant at the 5% confidence level, indicates the validity of the short-term model. If pressure builds up on foreign exchange reserves, the independent factors will modify the long-term connection. Therefore, this analysis of the short-term model can be referred to (Basuki, 2014). The study's additional variables have an impact on the remaining coefficient of 7.89%, which is determined by R^2 (0.921123), or 92.11%.

Stability Test

Table 5. Stability Test

	Value	df	Probability
t-statistic	1.005700	26	0.3238
F-statistic	1.011433	(1, 26)	0.3238

Source: Eviews 10, 2023

In this table, the *Stability Diagnostic Test* using the *Ramsey Reset Test* produces a p-value with an F-statistic probability of 0.3238 (*Likelihood Ratio*), which indicates that the data results are greater than α = 5% (0.05), This demonstrates the linear relationship between the independent and dependent variables.

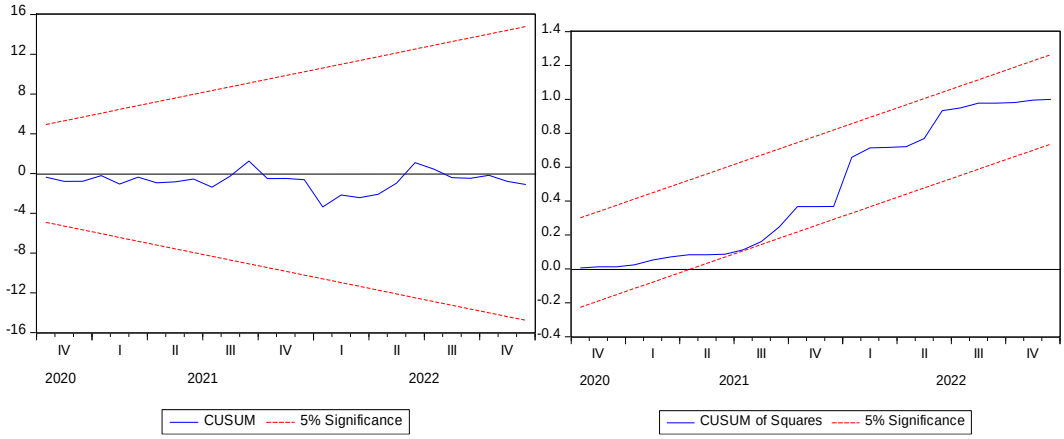

Figure 2. Cusum Test and Cusum Square Test

Source: Eviews 10, 2023

The iterative approximations of the CUSUM and CUSUMQ tests in this picture display the Stability Diagnostics Test findings. It can be seen that the CUSUM and CUSUMQ test lines remain between the 5% (0.05) significant lines, indicating that both models are still in the threshold state.

Classical Assumption Test

1) Autocorrelation Test

Table 6.Autocorrelation Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.600489	Prob. F(2,25)	0.5563
Obs*R-squared	2.016833	Prob. Chi-Square(2)	0.3648

Source: Eviews 10, 2023

Based on the table, the autocorrelation test results reveal a Chi-Square probability value of 0.3648 greater than 5% alpha, which means Ho cannot be rejected, it can be deduced from the table that the data does not demonstrate autocorrelation.

2) Heterocedacity Test

Table 7. Heterocedacity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.678306	Prob. F(16,27)	0.7896
Obs*R-squared	12.61534	Prob. Chi-Square(16)	0.7006
Scaled explained SS	11.51351	Prob. Chi-Square(16)	0.7767

Source: Eviews 10, 2023

Using the Breusch-Pagan Godfrey method, an assumption heteroscedasticity test has been performed on the data processing results. The p-value is 0.7896, which is greater than the threshold of 5% (0.05).

3.2 DISCUSSION

The Effect of Exports on Foreign Exchange Reserves

The export variable has a significant and favorable long-term impact on foreign exchange reserves. This variable has a probability value of 0.0002 and a coefficient value of 0.087352 in the short run. The other independent variables are taken to be constant for this. One of the main ways to generate foreign currency is through exports. Foreign exchange revenues from the export of products and services will rise if Indonesia is successful in growing the volume and value of its exports. This growth will immediately boost Indonesia's foreign exchange reserves. High exports demonstrate market potential and draw foreign investment to Indonesia. In the end, more foreign exchange revenues from these overseas investments will result in higher foreign exchange reserves. High exports help Indonesia maintain a balanced balance of payments.

The payments balance is in surplus when exports are greater than imports and when the amount of foreign exchange earned from exports is greater than what is spent on imports, this adds to foreign exchange reserves (Agustina & Stie Mikroskil, 2014). The study's findings are consistent with those of Suwarno et al., (2021), Marlianda Bolung et al., (2023), Bunga Uli, (2016) Resdianto et al., (2022), Andriyani et al., (2020), Simamora & Widanta, (2021), and other studies that assert that exports of goods to other countries generate foreign exchange for the country of purchase; consequently, Indonesia will receive more foreign exchange the more commodities it exports. This implies that exports have a significant and beneficial effect on Indonesia's foreign exchange reserves.

The Effect of Inflation on Foreign Exchange Reserves

Over the long run, the inflation variable has a slight negative influence on reserves of foreign currency. However, the short-term analysis's findings, which show a coefficient value of 0.142504 and a probability value of 0.0000, demonstrate that the inflation variable has a considerable and negative impact on foreign exchange reserves. Elevated inflation drives up labor costs, raw materials, and production, which in turn raises the price of goods and services inside a nation. Consequently, the cost of the nation's exported goods will rise, lowering its competitiveness on the international market. This can reduce export demand and volume, which in turn impacts the foreign exchange reserves of the nation. As a consequence, the government must maintain price stability and implement appropriate monetary policies to control inflation so that foreign exchange reserves can be maintained and economic growth can continue. The study's findings support those of Suwarno et al., (2021), Khusnatun & Hutajulu, (2021), Simamora & Widanta, (2021), Inflation, according to study, has a major negative influence on Indonesia's foreign exchange reserves.

The Effect of Exchange Rate on Foreign Exchange Reserves

The dollar to rupiah exchange rate variable has a positive and large long-term impact on foreign exchange reserves. The short-term investigation revealed a strong and positive influence on foreign exchange reserves. A high exchange rate can support a nation's foreign exchange reserves, which can assist in combating inflation, lower import prices, and increase the foreign exchange value of the country's currency. As a result, the exchange rate has minimal long-term beneficial influence. Outsider investors may want to invest in Indonesia because of the favorable exchange rate. Foreign exchange inflows into the nation may rise when they convert their cash into rupiah for investment purposes. Factors such as international trade conditions, political stability, and a nation's foreign exchange reserves can also be impacted by its monetary policy. Foreign exchange reserves may benefit from changes in exchange rates, but this effect is not always significant. The study's findings are consistent with those of Suwarno et al., (2021), Herlina et al., (2021), Simamora & Widanta, (2021), which contend that foreign exchange reserves will rise in response to an increase in the value of the rupiah as investor interest in the domestic banking sector develops.

The Effect of Interest Rates on Foreign Exchange Reserves

In the long run, the interest rate variable has a significant and positive impact on foreign currency reserves. The likelihood value of 0.0037 and coefficient value of 0.144076 in the short-term research, on the other hand, indicate a significant and negative effect on foreign exchange reserves. In theory, high interest rates should attract foreign capital, boosting the native currency while depleting a country's foreign exchange reserves. A rise in exchange rates could make imported items more affordable, leading to a rise in imports and a fall in exports. The nation's foreign exchange reserves may therefore decline. reserves of foreign currency at the national level. The study's findings are consistent with those of Adiyadnya, (2017)**,** Juliansyah et al., (2020)**,** Khusnatun & Hutajulu, (2021), They assert that Indonesia's diminishing An increase in interest rates has an effect on foreign exchange reserves.

4. CONCLUSIONS AND SUGGESTIONS

Based on the results of the ARDL and ECM assessments of the effects of inflation, interest rates, currency rates, and exports on Indonesia's foreign exchange reserves, it is reasonable to believe that exports have a significant and positive impact on those reserves. This is because increased foreign exchange profits, which are one of the state's primary revenue sources, represent the country's development. Furthermore, inflation has a considerable and positive effect on Indonesia's foreign exchange reserves. This will invariably lead to a trade imbalance. As a result, both now and in the future, the exchange rate boosts Indonesia's foreign exchange reserves. This is done in order to create a current account surplus by using the exchange rate to entice investors to participate in the local financial sector. Lastly, because the interest rate may draw in foreign capital inflows that could enhance the value of the currency, It has a significant and long-term detrimental impact on Indonesia's foreign currency reserves. Foreign exchange reserves are influenced, albeit not necessarily considerably, by a variety of different variables. Global trade conditions, political stability, and monetary policy all affect the reserves of foreign currency. The ARDL-ECM model estimation results from this work can already be utilized as a trustworthy prediction tool because they satisfy the conditions of the Bound Test using cointegration and the Classical Assumption Test. Furthermore, in line with the outcomes of the short-term ARDL model estimation, The CointEq (-1) variable, which represents error correction and takes into account the existence of errors from the previous period, was found to be negatively and significantly significant. As a result, the ARDL-ECM model employed in this investigation is reliable and illustrates the connection between the variables.

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