International Journal of Economics, Business and Innovation Research
https://e-journal.citakonsultindo.or.id/index.php/IJEBIR
E-ISSN : 2964-0865
IJEBIR

Dynamics Of Indonesia's Foreign Exchange Reserves: The Role Of The External Sector From Short- And Long-Term Perspectives

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Abstract

This study aims to examine the effects of oil and gas exports, external debt, the Indonesian rupiah–US dollar exchange rate, and net inflows of Foreign Direct Investment (FDI) on Indonesia's foreign exchange reserves in both the short and long run. This study employs a quantitative approach using annual secondary data for Indonesia covering the period from 1986 to 2025. The Error Correction Model (ECM) is applied to identify the dynamic relationships among the variables across both time horizons. The long-run estimation results indicate that oil and gas exports, external debt, and the exchange rate have positive and statistically significant effects on foreign exchange reserves, whereas FDI net inflows have a negative but statistically insignificant effect. In the short run, changes in oil and gas exports and external debt have positive and significant effects on changes in foreign exchange reserves. Changes in the exchange rate also have a positive and significant effect at the 10 percent significance level, while changes in FDI net inflows do not have a statistically significant effect. These findings indicate that movements in Indonesia's foreign exchange reserves are primarily associated with foreign currency inflows generated through exports and external financing, while the direct contribution of FDI to foreign exchange reserves remains limited. The findings underscore the importance of strengthening export performance, managing external debt productively, maintaining exchange rate stability, and improving the quality of FDI toward productive and export-oriented activities.

Keywords: foreign exchange reserves, oil and gas exports, external debt, exchange rate, FDI, ECM.

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INTRODUCTION

Foreign exchange reserves are one of the key indicators for assessing the resilience of a country's external sector (Rasyidin et al., 2023). In an economy that is increasingly integrated with international trade and financial markets, foreign exchange reserves serve a strategic function because they can be used to meet international payment needs, support exchange rate stability, and provide protection against external pressures (Siregar et al., 2023; Nasution et al., 2023). Foreign exchange reserves also serve as a buffer when imbalances in external transactions or turbulence in global financial markets occur (Rusydiana et al., 2025). Therefore, the adequacy of foreign exchange reserves is not only related to a country's ability to meet its external obligations but also reflects the economy's capacity to cope with external uncertainties. Indonesia's foreign exchange reserve holdings are influenced by a precautionary motive in the face of external risks, including exchange rate volatility and external liabilities (Kumar et al., 2026). These conditions indicate that the management of foreign exchange reserves is a crucial component of efforts to maintain macroeconomic stability and the resilience of the national economy.

For Indonesia, the need to maintain adequate foreign exchange reserves is becoming increasingly important because national economic activity is strongly linked to external sectors such as international trade, import payments, foreign debt obligations, exchange rate fluctuations, and foreign investment flows—both direct and indirect—which influence the availability of foreign currency in the economy (Santika & Dwiatmoko, 2022; Fortuna et al., 2021). Changes in these factors can lead to shifts in foreign exchange inflows and outflows, which ultimately affect the foreign exchange reserve position. Research by Ruslan et al. (2024) indicates that Indonesia's foreign exchange reserves are linked to several macroeconomic indicators, including exports, external debt, and the exchange rate. Meanwhile, a study by Pebriyanti & Khoirudin (2024) indicates that the determinants of foreign exchange reserves in the ASEAN-5 countries are related to each country's trade characteristics and macroeconomic conditions. Therefore, identifying the factors that determine foreign exchange reserves is crucial, particularly for Indonesia as a developing country facing dynamics in trade, external financing, and international capital flows.

Exports are a key component in generating foreign exchange through international trade. Export activities generate revenue in the form of foreign currency, which has the potential to strengthen a country's external position (Rasyidin et al., 2023; Fortuna et al., 2021). In the Indonesian context, oil and natural gas (O&G) exports have distinct characteristics compared to non-O&G exports, given that their performance is influenced by fluctuations in energy prices on the global market, changes in international demand, and domestic production capacity. Theoretically, an increase in the value of O&G exports

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has the potential to drive an increase in foreign currency receipts, thereby supporting the accumulation of national foreign exchange reserves. In line with this, a study by Prasetyanto et al. (2022) examined the relationship between oil and gas exports, non-oil and gas exports, and Indonesia's foreign exchange reserves. Meanwhile, a study by Setiawati & Harpy (2023) identified the impact of oil and gas commodity export and import activities on Indonesia's foreign exchange reserves. The findings from both studies indicate that oil and gas exports remain a relevant factor in explaining the dynamics of foreign exchange reserves, although the magnitude of their contribution to foreign exchange earnings may fluctuate in line with volatility in international energy prices and shifts in the structure of Indonesia's foreign trade.

In addition to export activities, foreign debt also serves as a source of external financing that can influence the inflow of foreign currency into the domestic economy (Mahgaraini & Arsita, 2024). The disbursement of foreign loans has the potential to increase the supply of foreign currency and support an increase in foreign exchange reserves, depending on the mechanisms for receiving and using these funds (Pratama & Utomo, 2022). An increase in foreign exchange reserves stemming from debt carries different implications compared to receipts from export activities, as such financing creates obligations to repay principal and interest in subsequent periods (Siregar et al., 2023; Pratama & Utomo, 2022). Thus, the relationship between external debt and foreign exchange reserves is determined not only by the size of the loans received but also by the composition of the debt, its maturity, and the allocation of its use. Research by Bake et al. (2024) found that external debt influences foreign exchange reserves in both the short and long term. Meanwhile, research by Kumar et al. (2026) highlights the relationship between external liabilities—particularly short-term debt—and the need to maintain adequate foreign exchange reserves as a safeguard against external liquidity risks. Both studies show that foreign debt should be analyzed not only as a source of foreign exchange inflows, but also as a factor that can influence the need for foreign exchange reserve management and the resilience of those reserves in the long term.

The exchange rate is one of the macroeconomic variables that can potentially influence the dynamics of foreign exchange reserves through various transmission channels, including international trade, cross-border capital flows, and monetary authority interventions in the foreign exchange market. When measured using the rupiah-to-U.S. dollar exchange rate in terms of rupiah per U.S. dollar, an increase in the exchange rate reflects a depreciation of the rupiah, while a decrease indicates an appreciation of the rupiah. These exchange rate movements may be related to changes in foreign exchange reserves through the revaluation of foreign currency assets, changes in trade competitiveness, and central bank actions to maintain foreign exchange market stability. However, the direction and magnitude of the relationship between the exchange rate and

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foreign exchange reserves are not always consistent, as they depend on economic conditions and the mechanisms at play during the observation period. Research by Bake et al. (2024), for example, found that the exchange rate did not have a significant effect on Indonesia's foreign exchange reserves. Conversely, several other studies indicate a significant relationship between these two variables. Furthermore, a study by Kumar et al. (2026) emphasizes that exchange rate volatility is one of the factors that must be taken into account when determining the adequacy of Indonesia's foreign exchange reserves. These variations in empirical results indicate that the relationship between the exchange rate and foreign exchange reserves still requires further testing, taking into account differences in the study periods, data characteristics, and the econometric approaches used.

In addition to international trade and exchange rate factors, foreign direct investment (FDI) is another component that influences a country's external sector conditions. FDI inflows from abroad can increase the supply of foreign currency and potentially strengthen foreign exchange reserves. From a long-term perspective, foreign investment can also expand production capacity, accelerate technology transfer, improve productivity, and increase export capacity, particularly when investment is directed toward sectors oriented toward international markets. Through these mechanisms, FDI may support the accumulation of foreign exchange reserves through both capital inflows and improved trade performance. Nevertheless, larger foreign investment inflows do not necessarily translate into a net increase in foreign exchange reserves. This is because investment activities may increase imports of capital goods and intermediate inputs, while dividend payments and profit repatriation may generate foreign currency outflows to foreign investors. Alqorni et al. (2026) found that FDI had a positive effect on Indonesia's foreign exchange reserves. In contrast, Candrawinata and Widiana (2025) reported a positive coefficient for FDI, although the effect was not statistically significant. These differing findings suggest that the contribution of FDI to foreign exchange reserve accumulation is not uniform but may depend on investment characteristics, capital flow patterns, and the study period under consideration. Therefore, the effect of FDI on Indonesia's foreign exchange reserves requires further empirical investigation that accounts for economic dynamics across different observation periods.

Various previous studies have examined the factors influencing Indonesia's foreign exchange reserves, but there is still room for further research. Some studies use limited observation periods, so they do not fully capture long-term economic dynamics. In addition, studies that specifically address oil and gas exports remain relevant given the sensitivity of these commodities to changes in the global energy market. Empirical findings regarding the effects of exchange rates and Foreign Direct Investment (FDI) also remain mixed. Furthermore, the differences between short-term and long-term dynamics

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must be taken into account to understand how foreign exchange reserves adjust to changes in external conditions.

Based on this gap, this study analyzes the effects of oil and gas exports, foreign debt, the rupiah's exchange rate against the U.S. dollar, and net FDI inflows on Indonesia's foreign exchange reserves during the period 1986–2025. This long time span is expected to provide a more comprehensive picture of the dynamics of Indonesia's external sector. This study uses the Error Correction Model (ECM) to identify the relationships between variables in the short and long term, as well as the adjustment mechanisms leading to equilibrium. The results of this study are expected to enrich the empirical evidence regarding the determinants of foreign exchange reserves and serve as a basis for policy formulation aimed at strengthening the resilience of Indonesia's external sector.

METHODOLOGY

This study is a quantitative study that uses secondary data in the form of annual time series sourced from Bank Indonesia, the Central Statistics Agency (BPS), and the World Bank for the period 1986–2025, with Indonesia as the subject of the study. This study aims to analyze the effects of oil and gas exports, the rupiah exchange rate against the U.S. dollar, external debt, and net Foreign Direct Investment (FDI) inflows on Indonesia's foreign exchange reserves. To analyze the relationships among these variables in both the short and long term, this study employs the Error Correction Model (ECM). The ECM method is used to identify long-run equilibrium relationships while also analyzing short-run dynamics among the variables when cointegration exists. Before the ECM estimation was conducted, the study began with a stationarity test to determine the level of integration of each variable, followed by a cointegration test to confirm the existence of a long-run relationship among the study variables. The entire process of econometric data processing, estimation, and testing was performed using Stata software. The long-run relationship model in this study is formulated as follows:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \varepsilon_t$$

Next, the Error Correction Model (ECM) for identifying short-run relationships and adjustment mechanisms toward long-run equilibrium is formulated as follows:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta X_{1t} + \beta_2 \Delta X_{2t} + \beta_3 \Delta X_{3t} + \beta_4 \Delta X_{4t} \quad EC_{t-1} + u_t$$

Description:

Y_t	= Dependent variable
$X_{1t} - X_{4t}$	= Independent variable
β_0	= Constant

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$\beta_1 - \beta_4$ = Coefficient variable
Δ = First difference
EC_{t-1} = Prior-period imbalance error
ε_t, u_t = Error term

RESULTS AND DISCUSSION

Descriptive Statistics

This study first presents descriptive statistics to provide an overview of the characteristics of the data used during the research period of 1986–2025. Descriptive statistics include the mean, standard deviation, minimum value, and maximum value for each research variable, namely foreign exchange reserves, oil and gas exports, foreign debt, the rupiah exchange rate against the U.S. dollar, and foreign direct investment (FDI).

Table 1. Descriptive Statistics Test

Variable	Obs	Mean	Std. Dev.	Min	Max
Foreign exchange reserves	40	10.62342	1.077585	8.730852	11.95581
Oil and gas exports	40	9.575769	.449333	8.894396	10.63289
Foreign debt	40	11.94899	.7513643	10.34981	12.97064
Exchange rate	40	8.757115	.8611635	6.933423	9.709721
FDI	40	1.239183	1.237979	-2.75744	2.916115

Source: Data processed in 2026.

Based on the results of descriptive statistics for 40 observations during the 1986–2025 period, the characteristics and degree of variation of each research variable can be determined. Foreign exchange reserves have a mean value of 10.52322 with a standard deviation of 1.977583, as well as a minimum value of 6.733685 and a maximum value of 11.995681. Oil and gas exports have a mean of 9.575769 with a standard deviation of 0.409334, while the minimum and maximum values are 8.809396 and 10.632890, respectively. Furthermore, foreign debt had a mean of 11.94899 with a standard deviation of 0.751364, as well as a minimum value of 10.30981 and a maximum value of 12.976064. The exchange rate of the rupiah against the U.S. dollar had a mean of 8.757115, a standard deviation of 0.861170, a minimum value of 6.935923, and a maximum value of 9.769721. Meanwhile, net FDI inflows had a mean of 1.239183 with a standard deviation of 1.237979, as well as a minimum value of −2.757440 and a maximum value of 2.916115.

Overall, the descriptive statistics indicate that all variables underwent changes during the observation period. Foreign exchange reserves exhibited the relatively highest

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level of variation, as reflected by a standard deviation higher than that of most other variables. Conversely, oil and gas exports exhibited a relatively lower level of variation, as indicated by the smallest standard deviation. Fluctuations in foreign exchange reserves, external debt, exchange rates, and FDI reflect the dynamics of external conditions and the Indonesian economy during the study period. These descriptive findings provide an initial overview of the data characteristics, which must be further examined through tests of stationarity and cointegration, as well as through the estimation of an Error Correction Model (ECM).

Stationarity Test

A stationarity test was conducted to determine the degree of stationarity of each variable used in the study. The test was performed using the Augmented Dickey-Fuller (ADF) test at the original and first-difference levels by comparing the t-statistic and p-value. The results of the stationarity test for the study variables over the 1986–2025 period are as follows:

Table 2. Stationarity Test

No	Variable	Level		1st Difference	
		T-statistik	P-Value	T-statistik	P-Value
1.	lncadev	-1.171	0.9163	-5.662	0.0000
2.	lnekspor	-1.919	0.6447	-6.111	0.0000
3.	lnuln	-2.188	0.4967	-4.232	0.0040
4.	lnkurs	-3.239	0.0768	-6.187	0.0000
5.	fdi	-2.805	0.1951	-4.396	0.0022

Source: Data processed in 2026.

Based on Table 2, none of the research variables are stationary at the level, as indicated by the p-values for each variable being greater than the 5 percent significance level. After testing at the first-difference level, all variables showed p-values less than 5 percent, so the null hypothesis stating the presence of a unit root was rejected. Thus, all research variables were found to be stationary at the first-difference level or integrated of order one, I(1). These results indicate that the data meet one of the requirements for proceeding with the analysis of long-run and short-run relationships using the Error Correction Model (ECM).

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Optimal Lag Test

The optimal lag was determined to identify the most appropriate lag length for capturing the dynamics of the relationships among the study variables. The test results, based on several information criteria, are presented in Table 3.

Table 3. Optimal Lag Test

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-97.1232	-	-	-	0.0002	5.67351	5.75027	5.89344
1	44.8707	283.99	25	0.000	3.1e-07*	-0.826148*	-0.365572*	0.493451*
2	60.9878	32.234	25	0.151	5.5e-07	-0.332657	0.511731	2.08661
3	80.5047	39.034	25	0.037	9.3e-07	-0.028041	1.20016	3.49089
4	111.329	61.648*	25	0.000	1.1e-06	-0.351585	1.26043	4.26701

Source: Data processed in 2026.

The results of the lag length test indicate that lag 1 is the most optimal specification based on the information criteria used. At that lag, the Final Prediction Error (FPE) value is 3.1e-07, while the Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC) values were -0.826148, -0.365572, and 0.493451, respectively. These values indicate that using a one-lag model provides the most efficient specification for capturing the dynamics of the relationship between variables while still accounting for model complexity. Selecting a shorter lag is also consistent with the characteristics of this study, which uses annual data over 40 observation periods, as adding too many lags can reduce the degrees of freedom and potentially lower estimation efficiency. Based on these results, a lag of one was determined to be the optimal lag length and was used in subsequent stages of the analysis.

Cointegration Test

The cointegration approach used in this study is the Engle-Granger method, which is conducted in two stages: estimating the long-run equation and testing the stationarity of the residuals from that equation using the Augmented Dickey-Fuller (ADF) test. This test aims to determine whether there is a long-run equilibrium relationship among the study variables.

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Table 4. Estimation Results for the Long-Run Equation

Variable	Coeffisient
lnekspor	0.3880***
	(0.0732)
lnuln	1.1338***
	(0.0745)
lnkurs	0.1709**
	(0.0654)
fdi	-0.0254
	(0.0246)
Constant	-8.1041***
	(0.7450)
Observation	40
R-squared	0.9786
Adjusted R-squared	0.9761
Prob > f	0.0000

Source: Data processed in 2026.

The results of the long-run estimation show that oil and gas exports have a coefficient of 0.38795 with a probability of 0.000, indicating a positive and significant effect on foreign exchange reserves. Foreign debt has a coefficient of 1.13377 with a probability of 0.000, indicating a positive and significant effect. The exchange rate has a coefficient of 0.17091 with a p-value of 0.013, indicating a positive and significant effect. Net FDI inflows have a coefficient of -0.02535 with a p-value of 0.310, thus showing no significant effect on foreign exchange reserves in the long run.

A Prob > F value of 0.0000 indicates that the variables of oil and gas exports, foreign debt, the exchange rate, and FDI are simultaneously and significantly related to foreign exchange reserves. An R-squared value of 0.9786 indicates that 97.86 percent of the variation in foreign exchange reserves can be explained by the variables in the long-run equation, while the remaining 2.14 percent is explained by other factors outside the model. The residuals obtained from the estimation of the long-run equation were subsequently used to conduct an Engle-Granger cointegration test.

Based on the estimation results, there is a positive and significant effect on Indonesia's foreign exchange reserves in the long term, as indicated by a coefficient value of 0.38795 with a probability of 0.000. These results suggest that an increase in the value of oil and gas exports tends to be followed by an increase in Indonesia's foreign exchange reserves. Economically, export transactions generate revenue in the form of foreign currency, thereby increasing the availability of foreign exchange and ultimately

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strengthening the national foreign exchange reserve position. This finding is consistent with the research by Bake et al., 2024; Santika & Dwiatmoko, 2022; and Fortuna et al., 2021, which demonstrated a significant long-term impact of exports on Indonesia's foreign exchange reserves. According to Ramadhan et al. (2026), developments in international trade activities—particularly exports—are linked to changes in Indonesia's foreign exchange reserves. Therefore, the findings of this study suggest that improved performance in oil and gas exports could serve as a key driver supporting the accumulation of foreign exchange reserves in the long term. Nevertheless, the contribution of oil and gas exports to foreign exchange reserves must take into account the characteristics of Indonesia's exports, which remain dependent on primary commodities. This situation means that export revenues are susceptible to changes due to fluctuations in commodity prices and developments in the global economy.

Foreign debt has a coefficient of 1.13377 with a probability value of 0.000, indicating a positive and statistically significant effect on foreign exchange reserves in the long run. This positive relationship can be explained by the mechanism of external capital flows, whereby the disbursement or receipt of foreign loans generates additional foreign currency inflows into the economy and, under certain conditions, increases the availability of foreign exchange reserves. This finding is consistent with Bake et al. (2024), Nasution and Nasution (2026), Fortuna et al. (202), and Maesyaroh and Kundhani (2024), who found that foreign debt has a significant effect on Indonesia's foreign exchange reserves. External financing can serve as a source of foreign currency in the long run. Nevertheless, the positive coefficient should not be interpreted as evidence that an increase in foreign debt always improves Indonesia's external position. Foreign debt constitutes an obligation that may generate future principal and interest payments in foreign currencies. Kumar et al. (2026) demonstrate that debt-related factors, particularly short-term external debt, are important determinants of Indonesia's foreign exchange reserve holdings because reserves serve as a buffer against external obligations and liquidity risks. Therefore, the findings of this study are more appropriately interpreted as indicating that foreign debt disbursements can increase foreign exchange reserves in the long run, while their implications for external resilience continue to depend on the productivity of debt utilization and the capacity to meet external obligations.

The exchange rate has a positive and statistically significant effect on Indonesia's foreign exchange reserves in the long run, as indicated by a coefficient of 0.17091 and a probability value of 0.013. In this study, the exchange rate is measured in Indonesian rupiah per US dollar (IDR/USD), such that an increase in the IDR/USD exchange rate reflects a depreciation of the rupiah against the US dollar. Accordingly, the positive coefficient indicates that rupiah depreciation is associated with an increase in foreign exchange reserves in the long run. One possible mechanism underlying this relationship

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is the valuation effect, given that a substantial proportion of foreign exchange reserves is held in foreign currency-denominated assets or currencies. Exchange rate movements can change the rupiah value of these foreign currency assets when converted into the domestic currency, thereby affecting the reported value of foreign exchange reserves. This finding is consistent with Ruslan et al. (2024), who identified the exchange rate as one of the factors explaining changes in Indonesia's foreign exchange reserves. The findings of Zulfikar and Syafira (2024), Pratama and Utomo (2022), Safitri et al. (2023), and Budi et al. (2024) also indicate a positive relationship between the exchange rate and foreign exchange reserves in dynamic analyses. Nevertheless, previous research has not established a uniform pattern regarding the relationship between these two variables. Differences in findings may be attributable to variations in exchange rate measurement, research periods, estimation techniques, and changes in domestic and global economic conditions during the observation period. The findings of this study indicate that exchange rate movements are associated with developments in Indonesia's foreign exchange reserves in the long run. This relationship cannot be explained solely by changes in trade competitiveness but may also be associated with changes in the value of foreign currency-denominated assets and the dynamics of Indonesia's external transactions.

Based on the long-run estimation results, FDI net inflows have a coefficient of −0.02535 and a probability value of 0.310. These results indicate that net inflows of foreign direct investment (FDI) do not have a statistically significant effect on Indonesia's foreign exchange reserves in the long run. Thus, within the observation period and model specification employed, changes in FDI net inflows cannot be established as a factor that directly affects changes in foreign exchange reserves. This result may be explained by the characteristics of foreign direct investment, which does not necessarily translate into a net increase in foreign exchange reserves. Foreign capital inflows may be accompanied by increased import demand, particularly for machinery, production equipment, and raw materials sourced from abroad. Furthermore, dividend payments and the repatriation of profits to foreign investors may generate capital outflows that reduce the positive impact of investment on foreign currency availability. This finding is consistent with Fiddien et al. (2023), Holifah and Laut (2022), Jaya and Widanta (2023), Bintoro (2022), and Sukoco (2023), who found that FDI did not have a statistically significant long-run effect on Indonesia's foreign exchange reserves over the 1992–2022 period. The contribution of FDI to foreign exchange reserve accumulation depends substantially on the characteristics and orientation of incoming investments. Export-oriented investments may generate greater foreign currency earnings, whereas investments that rely heavily on imported goods or involve substantial profit repatriation may reduce their contribution to foreign exchange reserves. Therefore, the statistically insignificant effect of FDI net

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inflows in this study should not be interpreted as evidence that FDI plays no role in Indonesia's economy. Rather, the findings indicate that net FDI inflows have not been demonstrated to exert a direct and statistically significant effect on foreign exchange reserves in the long run, given the observation period and model specification employed in this study.

Test for Stationarity of Residuals

Once the long-run equation has been estimated, the next step is to test whether the resulting residuals are stationary at the level. The test is conducted using the Augmented Dickey-Fuller (ADF) test.

Table 5. Results of the Residual Stationarity Test

Description	Value
ADF Z(t)	-4.211
1% critical value	-3.662
5% critical value	-2.964
10% critical value	-2.614
P-value	0.0006
Number of observations	38

Source: Data processed in 2026.

The test results in Table 5 show that the residuals from the long-run equation are stationary at the level. The ADF statistic of -4.211 is smaller than the critical value at the 1 percent significance level of -3.662. The p-value of 0.0006 is less than 1 percent; therefore, the null hypothesis stating that the residuals contain a unit root is rejected. These results indicate that the residuals of the long-run equation are stationary at the level, suggesting the existence of a cointegration relationship among foreign exchange reserves, oil and gas exports, external debt, the exchange rate, and FDI in the long run. The presence of this cointegration indicates that the study variables have a long-run equilibrium relationship, allowing the analysis to proceed using the Error Correction Model (ECM) to identify short-run relationships and the adjustment process toward long-run equilibrium.

Error Correction Model (ECM)

The results of the cointegration test indicate the existence of a long-run equilibrium relationship among the study variables. This condition allows for the estimation of an Error Correction Model (ECM) to identify short-run changes in the variables and long-run adjustment processes when imbalances occur in previous periods. The ECM estimation includes changes in oil and gas exports, foreign debt, the exchange rate, and FDI as explanatory variables for changes in foreign exchange reserves.

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Table 6. Results of the Error Correction Model Estimation

Variable	Value
D.lnekspor	0.1853**
	(0.0781)
D.lnuln	0.5169**
	(0.2243)
D.lnkurs	0.0671*
	(0.0346)
D.fdi	-0.0191
	(0.0197)
Ect	-0.5420***
	(0.1210)
Constant	0.0353
	(0.0234)
Observation	39
R-squared	0.4133
Adjusted R-squared	0.3244
Prob > f	0.0025

Source: Data processed in 2026.

The ECM estimation results indicate that changes in oil and gas exports have a coefficient of 0.1853 with a probability value of 0.024, indicating a positive and statistically significant effect on changes in foreign exchange reserves in the short run. Changes in foreign debt have a coefficient of 0.5169 with a probability value of 0.028, indicating a positive and statistically significant effect. Changes in the exchange rate have a coefficient of 0.0671 with a probability value of 0.061, indicating a positive and statistically significant effect at the 10% significance level. Changes in FDI have a coefficient of −0.0191 with a probability value of 0.339, indicating no statistically significant effect on changes in foreign exchange reserves in the short run.

The error correction term (ECT) coefficient of −0.5420, with a probability value of 0.000, indicates the presence of an adjustment mechanism toward the long-run equilibrium. This value suggests that approximately 54.20% of the disequilibrium from the preceding period is corrected within one year. The Prob > F value of 0.0025 indicates that the explanatory variables are jointly statistically significant in explaining changes in foreign exchange reserves. The R-squared value of 0.4133 indicates that 41.33% of the variation in changes in foreign exchange reserves can be explained by the variables included in the model, while the remaining 58.67% is explained by factors outside the model.

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Based on the estimation results using the Error Correction Model (ECM) approach, changes in oil and gas exports have a coefficient of 0.1853 with a probability value of 0.024. These results indicate that changes in oil and gas exports have a positive and statistically significant effect on changes in Indonesia's foreign exchange reserves in the short run. An increase in the value of oil and gas exports in the current period tends to be accompanied by an increase in available foreign exchange reserves. This relationship can be explained by the foreign currency earnings generated through export activities. As exports increase, foreign currency receipts entering the economy may also rise, thereby increasing the availability of foreign exchange in the short run. This effect may become apparent relatively quickly because export transactions directly generate foreign currency inflows from international trade. This finding is consistent with Basuki and Mulyani (2024), who found that exports have a significant effect on Indonesia's foreign exchange reserves in the short run using the Vector Error Correction Model (VECM) approach. Similar findings were reported by Ramadhan et al. (2026), Sukoco (2023), and Waruwu et al. (2023), who demonstrated that changes in international trade activities, including exports, can influence foreign exchange reserve movements, particularly in the short run, before adjustments toward equilibrium occur. Therefore, the findings of this study indicate that oil and gas exports continue to play a role in supporting the accumulation of Indonesia's foreign exchange reserves in the short run. Nevertheless, the magnitude of this contribution depends on global energy commodity market conditions, export volume developments, and import requirements arising from production processes and supporting activities in the oil and gas sector.

The ECM estimation results indicate that changes in foreign debt have a coefficient of 0.5169 with a probability value of 0.028, suggesting that foreign debt has a positive and statistically significant effect on changes in Indonesia's foreign exchange reserves in the short run. This finding indicates that an increase in foreign loan disbursements during the current period tends to be accompanied by an increase in foreign exchange reserves. Economically, the inflow of funds from foreign borrowing can increase the supply of foreign currency in the domestic economy. These inflows may enhance foreign currency availability and be reflected in the level of foreign exchange reserves during the same period. This finding is consistent with Nasution and Nasution (2026), who employed the Error Correction Model (ECM) approach using Indonesian data for the 2005–2024 period. Their study found that foreign debt has a positive and statistically significant effect on foreign exchange reserves in both the short run and the long run. Similar findings were reported by Rahmawati and Suriani (2022), Sukoco (2023), and Davis and Akbar (2022), who identified a positive relationship between foreign debt and Indonesia's foreign exchange reserves and highlighted the adjustment process from short-run conditions toward long-run equilibrium. However, an increase in foreign exchange reserves resulting

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from loan inflows does not automatically indicate a sustainable improvement in external capacity. This is because foreign borrowing creates future obligations to repay principal and interest. Therefore, the longer-term implications of foreign debt for foreign exchange reserves depend substantially on the effectiveness of loan utilization and the economy's capacity to generate foreign currency earnings to meet these external obligations.

Based on the ECM estimation results, changes in the exchange rate have a coefficient of 0.0671 with a probability value of 0.061. These results indicate that changes in the exchange rate have a positive and statistically significant effect on changes in Indonesia's foreign exchange reserves in the short run at the 10% significance level. The positive coefficient indicates that rupiah depreciation is associated with an increase in foreign exchange reserves in the short run. One possible explanation for this relationship is the change in the domestic currency value of foreign currency-denominated assets when converted into rupiah. In addition to this valuation mechanism, exchange rate movements may also affect various external transactions, which can subsequently influence the level of foreign exchange reserves. This finding is consistent with Kumar et al. (2026), Loyola et al. (2024), and Yusuf and Nugroho (2022), who demonstrated that exchange rate dynamics and volatility are relevant to precautionary considerations in determining the appropriate level of foreign exchange reserves. When exchange rate pressures intensify or uncertainty in the foreign exchange market increases, monetary authorities may require adequate foreign exchange reserves as an instrument for maintaining external stability and meeting international transaction needs. These conditions indicate that exchange rate movements are associated not only with changes in the value of foreign currency-denominated assets but also with broader external economic dynamics that may influence demand for foreign exchange reserves. Thus, the findings of this study indicate an association between exchange rate movements and changes in foreign exchange reserves in the short run, although this relationship should be interpreted in the context of foreign exchange market conditions and developments in Indonesia's external transactions.

FDI net inflows have a coefficient of −0.0191 with a probability value of 0.339, which is greater than 0.05. Accordingly, changes in net foreign direct investment inflows are not found to have a statistically significant effect on changes in Indonesia's foreign exchange reserves in the short run. Although the coefficient indicates a negative relationship, this result does not provide sufficient evidence to conclude that an increase in FDI causes a decline in foreign exchange reserves, given that the estimated relationship is not statistically significant. This finding may be associated with the characteristics of foreign direct investment, which generally requires time to affect production and trade activities. Capital inflows through FDI do not necessarily translate immediately into higher foreign currency receipts because some investments may be

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allocated to the purchase of imported machinery, equipment, raw materials, and other production inputs. Consequently, an increase in foreign capital inflows during the current period does not necessarily generate a net increase in foreign exchange reserves in the same period. This finding is consistent with Holifah and Laut (2022), who employed the Vector Error Correction Model (VECM) approach and found that FDI does not have a statistically significant effect on foreign exchange reserves in the short run, although its effect becomes significant in the long run. Similar results were reported by Harahap and Usman (2026), Fitriyanto (2021), and Monasterios (2022), who employed the ARDL approach and found that FDI does not have a statistically significant effect on Indonesia's foreign exchange reserves in either the short run or the long run. Therefore, the findings of this study suggest that FDI inflows have not yet generated a significant immediate change in foreign exchange reserves in the short run. The effects of FDI on foreign exchange reserves are more likely to materialize gradually, particularly when these investments begin to expand production capacity, promote export activities, and generate foreign currency earnings in subsequent periods.

Classical Assumption Tests

Classical assumption tests are conducted to ensure that the research model meets econometric requirements and produces estimates that can be accurately interpreted. The tests include normality, multicollinearity, heteroscedasticity, autocorrelation, and linearity.

Table 7. Results of Classical Assumption Tests

Test of Classical Assumptions	Probability Value	Description
Normality	0,1321	Fulfilled
Multicollinearity	1.55	Fulfilled
Heteroscedasticity	0.8908	Fulfilled
Autocorrelation	0.4803	Fulfilled
Linearity	0.3465	Fulfilled

Source: Data processed in 2026.

The test results in Table 7 show that the model satisfies all tested assumptions at a 5 percent significance level (α = 0.05). The normality test yielded a value of 0.1321 > 0.05, indicating that the residuals are normally distributed. The heteroscedasticity test yielded a value of 0.8908 > 0.05, indicating no evidence of heteroscedasticity. The autocorrelation test yielded a value of 0.4803 > 0.05, indicating no autocorrelation issues. The linearity test yielded a value of 0.3465 > 0.05, indicating that the relationship in the model satisfies the assumption of linearity. Meanwhile, a VIF value of 1.55 < 10 indicates

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that the model does not suffer from multicollinearity. Based on these results, the research model is deemed to satisfy the econometric assumptions required for further analysis.

CONCLUSION AND RECOMMENDATIONS

Based on the Error Correction Model (ECM) estimation results, this study finds that, in the long run, oil and gas exports, foreign debt, and the exchange rate have positive and statistically significant effects on Indonesia's foreign exchange reserves, whereas FDI net inflows have a negative but statistically insignificant effect. In the short run, changes in oil and gas exports and foreign debt have positive and statistically significant effects on changes in foreign exchange reserves, while changes in the exchange rate have a positive and statistically significant effect at the 10% significance level. Changes in FDI net inflows do not have a statistically significant effect on changes in foreign exchange reserves. These findings indicate that the accumulation of Indonesia's foreign exchange reserves remains closely associated with the capacity to generate foreign currency earnings through export activities and external financing inflows, while the contribution of FDI to foreign exchange reserves has not demonstrated a strong direct effect during the study period.

Based on these findings, the government should strengthen export performance, particularly by increasing the value added and competitiveness of export products, so that growth in foreign exchange earnings does not depend solely on primary commodities. Foreign debt should also be managed prudently, with its utilization directed toward productive activities that enhance economic capacity and generate foreign currency earnings. This approach would help ensure that increases in foreign exchange reserves do not rely solely on the accumulation of external liabilities. In addition, exchange rate stability should be maintained through policies that support equilibrium in the foreign exchange market and strengthen external sector resilience. The government should also improve the quality and orientation of FDI by directing foreign investment toward export-oriented sectors with strong linkages to domestic industries, greater use of local inputs, and the capacity to generate foreign exchange earnings sustainably. Future research could extend the analysis by incorporating other relevant variables, accounting for structural breaks during periods of economic crisis, and employing alternative estimation methods as robustness checks to assess the reliability of the findings.

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