

ANALYSIS OF EXCHANGE RATE DECOMPOSITION IN INDONESIA: A VECM APPROACH

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Abstract

Increased economic openness has brought significant changes to the dynamics of global trade. This study uses the Vector Error Correction Model (VECM) method to analyse the exchange rate relationship with GDP, remittances, investment, and inflation in Indonesia for the period 2011Q1-2023Q4. The study aims to separate the short-run and long-run effects and uses variance decomposition to identify the contribution of each variable to the exchange rate. The analysis shows that investment has a significant effect on the exchange rate in the long run, while GDP, remittances, and inflation have no significant impact. In the short run, investment shows a negative impact on the exchange rate, reflecting its sensitivity to market dynamics. Moreover, variance decomposition reveals that the exchange rate variable itself becomes the dominant factor in exchange rate movements, followed by investment. This study supports the Purchasing Power Parity (PPP) theory by highlighting the importance of investment in maintaining exchange rate stability. The results are expected to serve as a reference for policy makers in designing effective exchange rate management strategies.

Keywords: Exchange Rate, GDP, Remittances, Investment, Inflation, VECM.

INTRODUCTION

The increase in economic openness has brought significant changes to the reach of the global economy. Through freedom of trade and investment, goods and services from various countries can now easily enter the domestic market. (Tamam & Muslikhati, 2019) Developing countries, which generally have persistent current account deficits, often rely on exchange rate policies to manage capital flows and achieve external balance. So that the exchange rate is one of the important components in international trade activities. (Kurnia & Anitasari, 2022) Exchange rates can be divided into real exchange rates and nominal exchange rates, it distinguishes the currency of a country. The real exchange rate is the price between the currencies of two countries. The real exchange rate is the ratio of exchange between goods and services in one country and goods and services in another country after taking into account differences in price levels. For example, in the money market, the real exchange rate is the rate at which economic agents can trade goods in one country for goods in another country (Ginting, 2013).

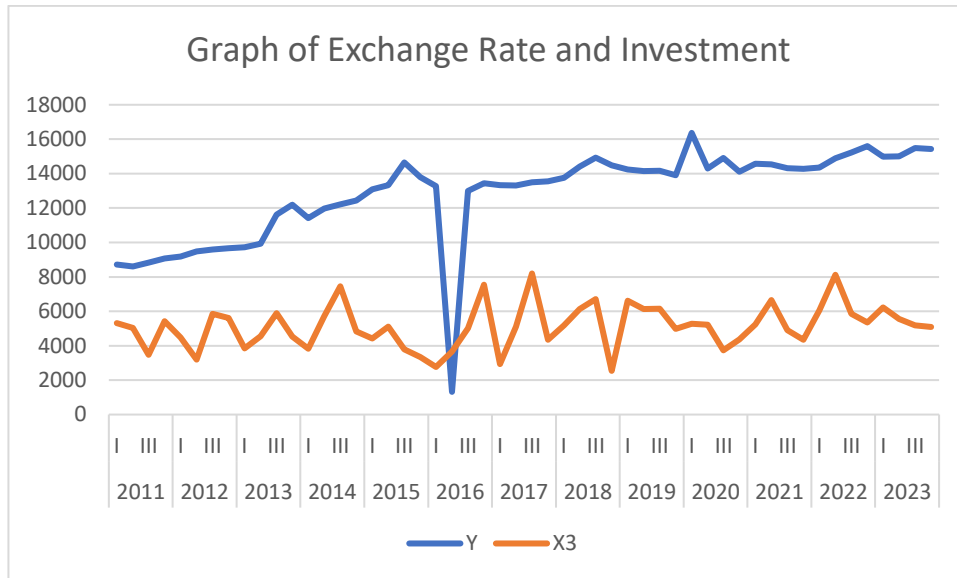
Meanwhile, the Nominal Exchange Rate is the price of a country's currency in relative terms (Mahendra, 2016). In an indirect way, the price of the domestic currency is represented by the foreign currency; for example, the dollar is represented as the domestic currency and the pound is represented as the foreign currency. As a foreign currency, we can show it in the form of the price of pounds in terms of dollars or the price of pounds in terms of dollars. In an exchange rate system, the exchange rate is controlled entirely by the currency market mechanism, such as a free or flexible exchange rate. There are two types of exchange rate changes, namely nominal depreciation, which

indicates that the price of the domestic currency falls against the foreign currency and nominal appreciation, which indicates that the price of the domestic currency increases against the foreign currency (Laksono T.Y., 2017).

The exchange rate acts as a very important policy instrument. Changes or fluctuations in currency values usually indicate changes in these economic activities, the impact of which will directly touch multinational companies, exporters, and importers about the depreciation or appreciation of exchange rate changes. In addition, it anticipates the actions of currency speculators, which sometimes have a major impact on the value of the currency (Noor, 2011). Another opinion also suggests that, exchange rate policy can affect economic performance through channels such as exports, imports, investment, and consumption. Appropriate exchange rate policy can help improve export competitiveness, encourage foreign investment, and reduce inflationary pressures (Atmadja, 2002), Especially Indonesia as one of the developing countries, often relies on exchange rate depreciation to strengthen export competitiveness and attract more foreign investment. Exchange rate depreciation is considered an effective policy instrument to improve export competitiveness, attract foreign direct investment, and ultimately boost economic growth (Usman, 2023).

Because the exchange rate becomes a very important political instrument. Therefore, the Indonesian government decided to replace the managed exchange rate system with a floating exchange rate system where the exchange rate fluctuates depending on the supply and demand forces occurring in the market. The implications of the decision to implement a floating exchange rate are far-reaching, one of which is a fundamental change in Indonesia's existing monetary policy framework (Kartikasari & Dewi, 2017), with different challenges and opportunities, this decision has far-reaching implications, including a fundamental change in the monetary policy framework. However, despite the so-called free floating exchange rate system, a phenomenon known as the fear of floating often occurs. Countries that adopt this system often continue to intervene in the foreign exchange market by keeping large foreign exchange reserves. This shows that the exchange rate is actually not fully allowed to float, but rather indirectly controlled to avoid excessive volatility (Kartikasari & Dewi, 2017).

The decision to adopt a freely floating exchange rate system also creates a new investment environment, which offers both opportunities and challenges. Investments have significant benefits, ranging from improving well-being to being an indicator of economic development and a valuable future asset. In addition, investments can also provide a steady income for its investors. The high individual awareness of the importance of investment is a driving factor, which is influenced by the level of financial literacy, financial behaviour, and the amount of income earned by the community (Burhanudin et al., 2021). According to research by (Lindananty & Angelina, 2021) investment awareness can be seen from the influence of literacy in society, how financial behaviour, and the amount of income earned. However, the uncertainty of exchange rates in a floating system can be a challenge for investors, especially in determining long-term investment decisions. Therefore, improving financial literacy is crucial to maximise investment potential amid market fluctuations.



Source: Bank Indonesia

Figure 1 Graph Comparison test between exchange rate and investment

Based on the graph above, in the range of 2011 to 2013 the conditions of the exchange rate showed a stable change in the graph accompanied by the initial fluctuations, this occurred because 2011 the second quarter occurred and the global economic recovery resulted in an increase in commodity prices that supported the strengthening of the Rupiah. Then in 2014-2015, the Indonesian economy experienced a significant weakening, influenced by the decline in global commodity prices, especially oil and coal, which led to reduced state revenues from the export sector, while domestic political instability, including changes in government and tensions in economic policy, also put great pressure on the rupiah exchange rate, which depreciated further and fuelled economic uncertainty amidst post-global crisis recovery efforts. Indonesia's economy remained relatively stable during 2016-2017, driven by increased foreign direct investment and portfolio capital flows. Improvements in the investment climate and more consistent economic policies also fuelled the strengthening of the rupiah exchange rate.

And the COVID-19 pandemic caused tremendous global economic uncertainty in 2020, leading to a sharp decline in demand for risky assets such as stocks and commodities. On the other hand, as a result of lockdown policies imposed in many countries, the decline in economic activity, and heavy losses in financial markets, financial markets also experienced high volatility. Global economic uncertainty continued in 2021, caused by new strains of the COVID-19 virus, tensions in supply chains around the world, and changes in monetary policy in major economies, impacting capital flows and demand for risky assets. Although there are some signs of economic recovery in 2022-2023, uncertainties remain due to continued geopolitical tensions, the energy crisis in Europe, and tighter monetary policies in many developed countries. This has led to high market fluctuations and investors becoming more cautious in taking risks, resulting in decreased demand for risky assets and exacerbating global economic instability.

Meanwhile, the investment graph shows significant fluctuations from 2011 to 2023. The 2011-2014 period recorded an increase in investment driven by the global economic recovery after the 2008 financial crisis and supportive monetary policies. However, the 2015-2018 period saw sharper fluctuations due to falling commodity prices and global political uncertainty. The peak of this volatility occurred in the 2019-2022 period when the COVID-19 pandemic hit the world. Restrictions on economic activity and high business uncertainty led to a drastic drop in investment. It was not until economic recovery efforts began that investment levels began to show signs of improvement. The

COVID-19 phenomenon was a significant turning point in global investment trends, showing how vulnerable the investment sector is to large external shocks.

The data above shows different influences in each year, however, in this study will discuss how to find out the impact of the Gross Domestic Product (GDP), Foreign Direct Investment (FDI), Inflation, and Remittances variables as a decomposition analysis of the exchange rate. This is in line with an economic term known as Purchasing Power Parity (PPP) theory which explains that it offers a basis for understanding how different levels of investment among countries can affect exchange rates. PPP argues that in the long run, exchange rates will adjust such that the same basket of goods in different countries has the same price when converted into the same currency. In other words, if the inflation rate in one country is higher than the inflation rate in another country, this PPP concept affects the exchange rate, especially in the long run (Rahutami, 2011).

Through the PPP theory, exchange rate fluctuations can influence investment decisions. When a country's exchange rate depreciates, domestic products become more affordable in the international market, which in turn increases export competitiveness and attracts foreign investors to invest. In the context of investment, this study aims to analyse the factors that significantly influence the exchange rate decision in Indonesia, which is influenced by the Purchasing Power Parity (PPP) Theory, then the importance of this study lies in the attempt to uncover the complexity of the factors that influence the exchange rate decision and some of the variables that influence in the country of Indonesia, as well as how the magnitude of the exchange rate by identifying investment as the dominant factor and prove whether PPP is relevant in this context. The research in this paper uses time series data from 2011Q1 - 2023Q2, how the influence between GDP, FDI, and Remittances and Inflation variables on the exchange rate in Indonesia using the VECM method.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

A statement from (Santoso, 2011) states that in assessing the health of an economy, it is important to know the total income generated by all economic activity in the country. One of the most commonly used indicators to measure this is GDP (Gross Domestic Product) which is the total market value of all final goods and services produced within a country in a given period. In other words, GDP is a reflection of a country's total production. Therefore, GDP is often considered a leading indicator of a country's economic health. In a study conducted by (Hakim et al., 2013) using GDP as one of the variables to analyse the factors affecting the Rupiah exchange rate, using multiple linear regression methods, the results showed that the GDP variable had a significant negative effect on the Rupiah exchange rate. That is, when GDP increases, the rupiah exchange rate tends to weaken. However, the current account variable has a partially insignificant effect on the Rupiah exchange rate. Then in the research by (Usman, 2023) stated that the exchange rate is also very sensitive to economic growth, especially in terms of remittances. For example, strengthening the local currency can reduce the flow of incoming remittances, impacting various industries such as trade and agriculture. This shows that exchange rate uncertainty will hamper economic growth by suppressing the balance of payments. Another study from (Wahyuni & Satria, 2024) states that investment is another factor that must be considered, because foreign investors play a central role in the economy of developing countries, especially in the money market. Their investment decisions, which are strongly influenced by the comparison of domestic and global interest rates, have a significant impact on local currency exchange rates. In other words, volatile foreign capital flows in response to changes in interest rates are one of the main factors driving exchange rate fluctuations in developing countries. This is in line with the opinion of (Iavorschi, 2014).

In his research on Romania, which also illustrates that the role of investment brings an increase in FDI flows and an increase in the current account of the balance of payments contributes in the long run to the increase in the leu / euro exchange rate. In addition, inflation is a general increase in the price of goods and services in a certain period, the relationship between inflation and exchange rates according to (Zalogo, 2017) In contrast to the general view that links inflation with exchange

rate depreciation, this study shows that the relationship does not apply to the case of exchange rates. This finding highlights the complexity of factors affecting exchange rates and suggests that overly simplistic generalisations can be misleading in analysing exchange rate movements, another opinion also suggests that if the long-term inflation trend is positive and inflation differentials tend to be stable, then it can be expected that inflation rates will move in parallel with relatively consistent differentials, so that in this context, even if there are inflation differentials, their effect on exchange rates becomes smaller (Kano, 2024).

From the many opinions expressed and how the same conditions with the Indonesian economy are very much focused on fluctuations in the rupiah exchange rate. Previous studies have investigated how exchange rate fluctuations affect overall economic growth. However, these studies have not provided a complete picture of Indonesia's unique economic situation. Therefore, this study will thoroughly investigate how GDP, remittances, foreign direct investment (FDI), and inflation in Indonesia relate to the rupiah exchange rate. Therefore, it is expected that this study will provide more relevant empirical contributions for further research.

RESEARCH METHODS

This study uses the vector error correction model (VECM) method to analyse 52 quarterly data from the period 2011-2023. The variables included in the study of the influence on the exchange rate include GDP, remittances, foreign direct investment (FDI), and inflation. The data sources obtained are data from Bank Indonesia and the results of the researchers' own calculations. This research adopts a descriptive quantitative method with a positive economic foundation to analyse quantitative data from the population or sample listed. The Vector Error Method (VECM) is a model designed to control the long-term relationship between variables so that it always leads to an equilibrium. However, the model is also able to capture the short-run dynamics that cause temporary fluctuations in the relationship. The 'Vector Error Mechanism' acts as a counterweight, ensuring that the system always returns to its long-run equilibrium state (Fathurrahman & Rusdi, 2019). Vectors Error Method (VECM) which is one of the analyses developed by Engle and Granger (1987) to reconcile the behaviour of short-term economic variables with long-term economic variables (Hamdani et al., 2020), VECM provides an easy way to separate the long-term and short-term components of the data generation process (Sinay, 2014).

Model In general, the VECM model with a lag length of $p - 1$ can be formulated as follows (Saputra & Sukmawati, 2021):

$$\Delta Y_t = \alpha e_{t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \dots + \beta_{p-1} \Delta Y_{t-p+1} + \varepsilon_t$$

Description:

ΔY = General vector of dependent variables

ΔY_t = First derivative vector of dependent variables

ΔY_{t-1} = First derivative vector of dependent variables with the first lag

$\varepsilon_{(t-1)}$ = error obtained from the regression equation between Y and X at the first lag and also called ECT (Error Correction Term)

e_t = Vektor Residual of time t

α = Cointegration matrix

β_t = Coefficient matrix of dependent variables to -i, where $i = 1, 2, \dots, p$

ε_t = Error term

i = Cross section

RESULTS AND DISCUSSION

The entire observation in this study uses secondary data, which totals 52 derived quarterly data starting from 2011 until 2023 so that it forms a time series. The research results and discussion are included as follows:

Table 1. Descriptive Statistics

Variable	Observation	Min	Max	Mean	St. Deviasi
Exchange Rate	52	1318.000	16367.00	13652.00	2670.748
GDP	52	-5.320000	7.080000	5.065000	2.430090
Remittance	52	3.222196	3.565376	3.363360	0.093884
FDI	52	2539.000	8197.000	5130.962	1283.673
Inflation	52	1.330000	8.400000	4.167885	1.896743

Source: Data Processed

In the table above, it can be seen that the exchange rate variable (Y) has a lowest value of 1,318, a highest value of 16,367, an average (mean) of 12,818.63, and a standard deviation of 2,670.748. This shows that the exchange rate has a large spread of data. The high standard deviation reflects that the exchange rate is highly volatile, influenced by changes in monetary policy, global market movements, and foreign capital flows. Therefore, this data can be said to be heterogeneous. The GDP variable has a low value of -5.32, a high value of 7.08, a mean of 4.606538, and a standard deviation of 2.430090. The spread of GDP data is quite large, with negative values indicating a possible period of economic contraction. The high standard deviation indicates that GDP varies significantly, depending on the economic cycle and changes in investment. Therefore, the GDP data is heterogeneous. This is in line with research conducted by (Hakim et al., 2013) which similarly states that there is an insignificant negative relationship between GDP and exchange rates.

The remittance variable (X2) has a low value of 3.222196, a high value of 3.565376, an average (mean) of 3.363360, and a standard deviation of 0.093884. The spread of remittance data is very small, indicating the stability of the flow of funds from migrant workers. The low standard deviation value indicates that the data does not experience a large difference between one observation and another, so this data can be said to be homogeneous. The investment variable (X3) has the lowest value of 2,539, the highest value of 8,197, an average (mean) of 5,130.962, and a standard deviation of 1,283.673. The spread of investment data is quite large, which is due to the sensitivity of investment to domestic and global economic conditions. Factors such as interest rates, investor confidence, and government policies strongly influence investment. Therefore, investment data is heterogeneous. And the inflation variable (X4) has a low value of 1.33, a high value of 8.4, an average (mean) of 4.167885, and a standard deviation of 1.896743. The distribution of inflation data is moderate, although there are fluctuations due to monetary policy and external factors such as changes in energy or food prices. With a significant standard deviation compared to the mean, the inflation data can be categorised as heterogeneous.

It can be concluded that high data variability is found in variables Y, X1, and X3 because their standard deviation values are much larger than the mean. The standard deviation value of variable Y is 2670.748, while the mean is 12818.673. In contrast, the variables Remittances (X2) and iflation (X4) have relatively smaller data variability. The standard deviation value for X2 is only 0.093884, indicating that the data for this variable is quite concentrated around its mean. The high volatility of Y, X1 and X3 is due to the dynamic nature of these variables and their sensitivity to domestic and

global macroeconomic factors. In contrast, variables such as remittances and inflation are more stable due to the consistency of monetary policy efforts to control remittance flows and inflation.

For stationarity testing, the Augmented Dickey Fuller (ADF) approach is used. Unit root is done to check whether there is a unit root problem in the variable data used. A non-stationary data is characterised by the presence of a unit root problem, this can lead to spurious regression. If the data is not stationary (if there is a unit root problem), spurious regressions or relationships between economic variables that seem important but are actually not important can occur.

Table 2 Panel data estimation model

Variable	Level ADF Statistic		First difference ADF Statistic	
	Intercept	Trend	Intercept	Trend
Y (Exchange Rate)	-6.327993***	-3.431390*	-11.29166***	11.18462***
X1 (GDP)	-3.535144	-3.431390*	-9.241158***	-9.164562***
X2 (Remittance)	0.602684	-2.026728*	-6.462688***	-6.422218***
X3 (Investment)	-6.666858***	-7.113204***	-7.927366***	-7.837229***
X4 (Inflation)	-2.376313	-2.764901	-5.126107***	-5.052095*

Source: Data Processed

Table 2 shows the results of the unit root test using the ADF approach at the level, showing that only investment (X3) and exchange rate (Y) variables do not have unit root problems. Meanwhile, at the first difference, all variables such as remittances (X2), GDP (X1), inflation (X4), investment (X3), and exchange rate (Y) show ADF-statistic values that are smaller than the critical value at the α significance level of 5% or 0.05. Thus, all variables can be considered stationary at first difference.

Table 3. Shows Before proceeding with further analysis, the first step that needs to be done is to check the stability of the model that has been given the first difference treatment and lag 4 (four). If the output results from the AR Roots Table show a stable model, which is characterised by a modulus value smaller than 1 (one). After the model is confirmed to be stable, the next step is to conduct a cointegration test. The Johansen Cointegration Test is used to test the existence of a long-term relationship between these variables (Ristianti & Purwadi, 2019).

Table 3 Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.558116	80.99810	69.81889	0.0049
At most 1	0.330572	40.97941	47.85613	0.1893
At most 2	0.262515	21.31418	29.79707	0.3383
At most 3	0.112446	6.393230	15.49471	0.6490
At most 4	0.011125	0.548197	3.841466	0.4591
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**

None *	0.558116	40.01869	33.87687	0.0082
At most 1	0.330572	19.66524	27.58434	0.3647
At most 2	0.262515	14.92095	21.13162	0.2945
At most 3	0.112446	5.845033	14.26460	0.6332
At most 4	0.011125	0.548197	3.841466	0.4591

Source: Data Processed

Based on the table of cointegration test results above, it can be seen that there is a long-term relationship between the variables analyzed, namely the exchange rate (LOG(Y)) as the dependent variable, and GDP (X1), remittances (X2), investment (LOG(X3)), and inflation (X4) as independent variables. The Trace test results show that at a significance level of 5%, there is at least one cointegration relationship. This is indicated by the Trace value for "None" (80.99810) which exceeds the critical value (69.81889) with a very small probability (0.0049). Thus, although these variables may not be stationary in the short term, they move together in the long term.

In addition, the results of the Maximum Eigenvalue test strengthen this finding. The Max-Eigen value for "None" (40.01869) is also greater than the critical value (33.87687) at a significance level of 5% with a probability of 0.0082. This indicates the presence of at least one significant cointegration relationship. The presence of this cointegration relationship indicates that when there is a deviation from the long-run relationship, the VECM model can be used to correct the imbalance. In this context, the exchange rate is affected by changes in GDP, remittances, investment, and inflation in the short run, but remains controlled within the framework of a stable long-run relationship.

Table 4 shows that in the VECM estimation, most variables do not have a significant effect in the short term. This reflects that the relationship between the exchange rate and GDP, remittances, investment, and inflation requires time or lag to interact fully, this can be seen from In the short term, the relationship between variables is explained by the movement of each variable in the previous period (lag) CointEq1 has a negative coefficient (-1.135982) and is significant (T-statistic = -5.14055), which indicates that there is a correction mechanism for long-term imbalances. Variables with a significant effect in the short term are LOG(X3(-1)) (investment with a coefficient of -1.176068, T-statistic = -3.74279) and LOG(X3(-2)) (-0.557262, T-statistic = -2.59601). This shows that investment has a significant impact on moving the exchange rate in the short term, although with a negative relationship. Other variables such as GDP, remittances, and inflation do not have a significant impact in the short run (based on low T-statistics).

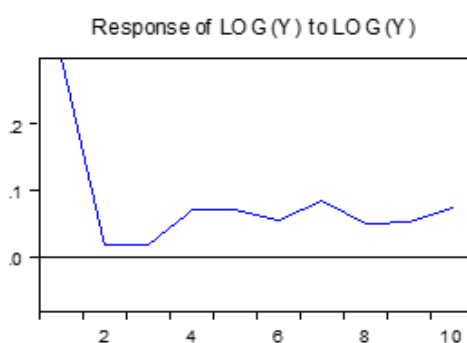
Table 4 Short-term and Long-term Estimates

SHORT TERM		
Variabel	Coefficient	T – statistic
CointEq1	-1.135982	-5.14055
D(LOG(Y(-1)))	0.040925	-0.26366
D(LOG(Y(-2)))	-0.171696	-1.56185
D(X1(-1))	0.030179	1.32986
D(X1(-2))	0.021102	0.94294
D(X2(-1))	0.130526	0.08440
D(X2(-2))	-0.773254	-0.50562
D(LOG(X3(-1)))	-1.176068	-3.74279
D(LOG(X3(-2)))	-0.557262	-2.59601
D(X4(-1))	-0.055848	-0.061601
D(X4(-2))	0.061601	1.50542
C	0.021025	0.46596
LONG TERM		

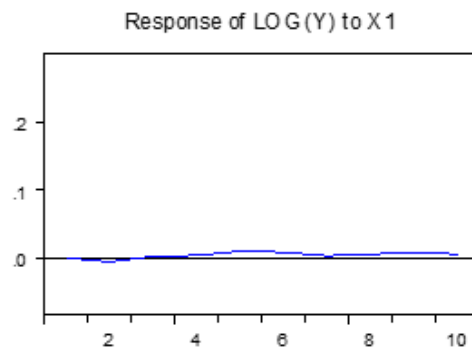
Variabel	Coefficient	T – statistic
X1(-1)	0.028164	1.82320
X2(-1)	0.185698	0.42431
LOG(X3(-1))	1.751349	-6.33873
X4(-1)	0.011002	0.57597

Table 4. Also shows that in the long-term VECM estimation, there is one variable that significantly affects the exchange rate, namely investment (LOG (X3 (-1))). This is indicated by a coefficient of 1.751349 and a t-statistic value of -6.33873, which exceeds the t-table. A positive coefficient value indicates that increased investment contributes significantly to the strengthening of the exchange rate in the long run.

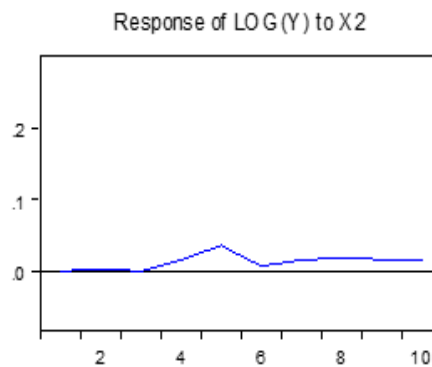
Meanwhile, other variables, such as GDP (X1), remittances (X2), and inflation (X4), have t-statistic values that are smaller than the t-table, indicating that these variables do not have a significant effect on the exchange rate in the long run. In this remittance, it proves that there is a misalignment of the theory (Usman, 2023) about being very sensitive to economic growth. The three variables that show small t-statistic values, although there are fluctuations in the short term, the correction mechanism through CointEq ensures that the long-term equilibrium relationship is maintained, with investment being the main factor in the relationship. This is in line with the research (Wahyuni & Satria, 2024) obtained which analyzed the rupiah exchange rate found that foreign investment had a significant negative impact on the rupiah in the short term. On the other hand, the long-term impact is that an increase in foreign capital inflows, especially investment in Indonesia, will affect the appreciation of the rupiah exchange rate, while foreign capital outflows, such as overseas portfolios and other investments, will affect the appreciation of the rupiah exchange rate.



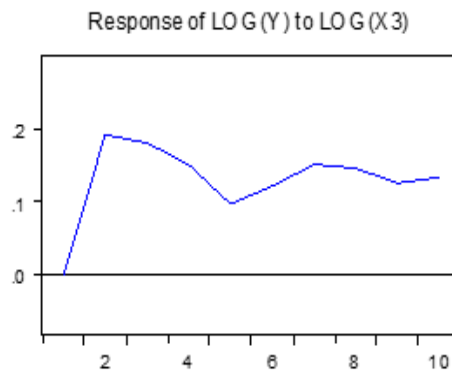
Y response (Exchange rate) with actual conditions the exchange rate in Indonesia, based on processed data and graphs generated on quarterly data from 2011 to 2023, shows that, The graph shows the exchange rate response (LOG(Y)) to shocks to itself during the period 2011-2023 using the VECM method. In the early period, namely periods 1 and 2 (2011-2013), there was a sharp decline in response from 0.25 to 0.05. This was due to the high current account deficit, as well as global uncertainty after the 2008 financial crisis. During this period, high volatility in the rupiah exchange rate was triggered by capital outflows, reflecting market sensitivity to external and internal factors. However, policy interventions such as increases in the benchmark interest rate by Bank Indonesia helped suppress this volatility. In the following periods, years 3 and 4 (2014-2023), the exchange rate response tended to be stable with small fluctuations. This stability reflects the success of economic policies, including fiscal reforms and foreign exchange reserve management, which strengthen the rupiah's resilience to global shocks such as the COVID-19 pandemic and the Fed's interest rate hike (2022). The graph shows that in the long run, market mechanisms work effectively to return the exchange rate to equilibrium, with a smaller long-term impact compared to the initial period. This stability confirms the role of effective monetary and fiscal policies in maintaining Indonesia's economic fundamentals.



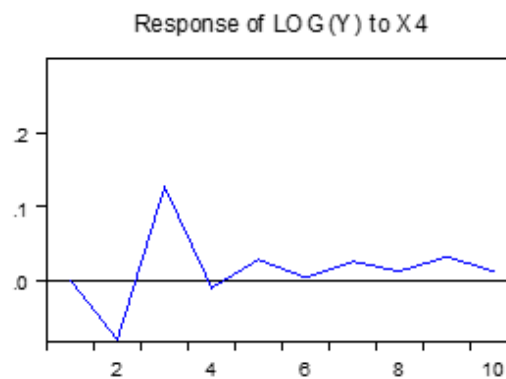
The response graph of Y (Exchange Rate) to X1 (GDP) based on processed data and the graph produced in the quarters from 2011 to 2023, illustrates the response of the rupiah exchange rate (LOG(Y)) to changes in Indonesia's GDP (X1), it can be seen that the response of the exchange rate to shocks to Indonesia's GDP is very small and tends to approach zero throughout the period. This shows that changes in Indonesia's GDP do not have a significant effect on the movement of the rupiah exchange rate in the short to medium term, and strengthens the opinion in previous literature from (Hakim et al., 2013).



Response graph of Y (Exchange Rate) to X2 (Remittance) based on processed data and graphs generated in quarters from 2011 to 2023, where in quarters In the 3rd to 4th period, the graph shows an increase in response to approaching 0.08. This reflects the contribution of remittances to the exchange rate that is starting to be felt, although the influence is not large. In the Indonesian context, this may occur during times of high remittance flows, for example during big celebrations such as Eid al-Fitr, where remittances from abroad increase. After the exchange rate peaked around period 4 or period 5, the exchange rate response to remittances declined again and stabilized at around 0.02 from period 6 to period 10 (2016 to 2023). This decline is because the impact of remittances tends to be short-term and is replaced by other external factors such as foreign capital flows and global monetary policy, so that remittances can temporarily contribute to exchange rate stability indicating that it only has a negative impact.



Response graph of Y (Exchange Rate) to X3 (Investment) based on processed data and the graph produced in the quarters from 2011 to 2023, shows the response of the rupiah exchange rate (Y) to changes in investment in Indonesia (X3). In period 0-period 2 the exchange rate reaction increased significantly to around 0.2. This reflects the positive impact of investment inflows, especially foreign direct investment (FDI) and portfolios, which encouraged the strengthening of the exchange rate. However, this period was also marked by the high sensitivity of the exchange rate to capital flows, which were influenced by global uncertainty and domestic conditions such as the current account deficit, while in the 3rd to 10th periods the exchange rate response to investment decreased to around 0.12 and showed stable fluctuations in that range. This decline indicates that the initial effect of investment is starting to fade, while external pressures, such as rising global interest rates, and internal pressures continue to affect exchange rate stability.



The graph shows the relationship between the inflation rate (X4) and the Rupiah exchange rate (Y) using the quarterly VECM method in 2011 to 2023. The graph shows that the exchange rate response to inflation began in Period I with a negative value of around -0.02. This decline may reflect the direct impact of rising inflation on exchange rate depreciation, as rising inflation often reduces export competitiveness and causes capital flight. However, in periods 2 to 3, the exchange rate response increased sharply to around 0.12. This reflects the government or central bank's policy in controlling inflation through monetary adjustments. then, in the 3rd period and beyond, the exchange rate response to inflation tends to fluctuate between 0.02 and 0.05 to 10. This stability indicates that macroeconomic efforts such as controlling inflation through price adjustments and subsidies are able to reduce the impact of inflation on the exchange rate. However, small fluctuations still occur due to external factors such as fluctuations in global commodity prices and uncertainty in international monetary policy. This situation is in line with the trend in Indonesia, where inflation is often influenced by food prices, oil, and fiscal policy, especially during the global crisis and the COVID-19 pandemic.

Then in Table 5. Is the result of the contribution of decomposition variants on the exchange rate. The purpose of the variable decomposition analysis is to understand the nature of each shock in order to explain each variable or its dynamics (Hartarto, 2014).

Table 5 Variance Decomposition

Variance Decomposition of LOG(Y):						
Period	S.E.	LOG(Y)	X1	X2	LOG(X3)	X4
1	0.322846	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.362232	79.47913	1.909704	5.897601	10.20482	2.508741
3	0.383666	71.03394	3.554249	8.924366	12.99182	3.495622
4	0.389850	68.85904	3.444018	11.53577	12.72181	3.439365
5	0.391588	68.24921	3.448365	11.98390	12.63348	3.685035
6	0.393932	67.78056	3.438319	12.37423	12.66713	3.739758
7	0.396026	67.09125	3.407237	13.09969	12.58419	3.817632
8	0.397590	66.57206	3.384613	13.65228	12.52007	3.870982
9	0.398971	66.14702	3.361396	14.11188	12.46073	3.918977
10	0.400295	65.73784	3.339236	14.54946	12.40686	3.966606

Source: Data Processed

The table above shows that the exchange rate variability (LOG(Y)) is fully explained by itself (100%). Over time, this contribution decreases to 65.73% in the 10th period, indicating that other variables begin to play a role in explaining exchange rate movements. Investment (LOG(X3)) is a factor that consistently contributes significantly to the exchange rate, increasing from 10.20% in period 2, in period 10 to 12.41%. This shows that foreign capital flows, especially investment, are the main drivers of exchange rate stability in Indonesia. Meanwhile, GDP (X1) and inflation (X4) provide relatively small contributions, around 3.55% and 3.96% respectively in the 10th period, because their influence tends to be more structural or controlled by monetary policy, while Remittances (X2), based on the results of this test, do not show a significant contribution to exchange rate variability. This can be explained by several factors, such as the relatively small volume of remittances compared to the overall Indonesian economy, so it is not enough to significantly affect the supply of foreign exchange.

CONCLUSION

The conclusion that can be drawn from this study using the Vector Error Correction Model (VECM) method to analyze the relationship between the exchange rate (Y) and GDP (X1), remittances (X2), investment (X3), and inflation (X4) in Indonesia during the period 2011-2023. The results show that in the long term, investment has a significant influence on the exchange rate. Increased investment, especially in the form of Foreign Direct Investment (FDI), is able to encourage exchange rate appreciation. Meanwhile, other variables such as GDP, remittances, and inflation do not have a significant effect on the exchange rate in the long term. In the short term, investment also shows a strong influence, although the impact tends to be negative, illustrating high sensitivity to market dynamics.

In addition, the results of the variance decomposition show that the movement of the exchange rate is dominated by the influence of its own internal factors, especially at the beginning of the analysis period. Over time, the contribution of investment becomes increasingly important in influencing the exchange rate, illustrating the significant role of foreign capital flows in supporting economic stability. On the other hand, GDP, remittances, and inflation have relatively small effects on exchange rate fluctuations, indicating that these factors are more stable or controlled by macroeconomic policies. This study supports the Purchasing Power Parity (PPP) theory, which explains how differences in inflation rates between countries can affect exchange rates. However, in

Indonesia, investment has proven to be a more dominant factor than inflation in determining exchange rate stability. This theory can also still be used more relevantly if used to observe exchange rate movements and fluctuations in the long term rather than the short term.

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