

ARDL Approach to Investigating Relationships Between Tribes Loan Interest, Money Supply, and Exchange Rates in Indonesia

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Abstract,

This study investigates the dynamic relationship between lending interest rate, money supply and the Exchange Rate in Indonesia using the Autoregressive Distributed Lag (ARDL) bounds testing approach over the period 1986-2023. The empirical findings reveal that lending rates and money supply have a short-run relationship to the exchange rate, although in the long run, none of them are associated with the exchange rate. These results underline that lending rates and money supply quickly affect the exchange rate. Finally, some lessons will be drawn for monetary policy in Indonesia, related to the impact of the role of money and lending rates and their expected implications in the future regarding the implementation of effective monetary policy.

Keywords: *Lending Interest Rate, Money Supply, Exchange Rate, Autoregressive distributed lag (ARDL)*

1. Introduction

Exchange rate fluctuations are an inevitable phenomenon in an open economy. Exchange rates reflect the relative strength of a currency against other currencies, and their fluctuations can impact trade competitiveness, capital flows, inflation, and economic growth. For developing countries like Indonesia, the rupiah exchange rate is often a key indicator of economic health and a key focus of monetary policy. Exchange rate fluctuations can be influenced by various factors, both internal and external.

Internal factors include inflation, interest rates, the money supply, political stability, and domestic economic performance. External factors include global economic conditions, commodity prices, and the monetary policies of trading partners. Among these factors, lending rates and the money supply are two monetary variables closely related to exchange rates.

In theory, an increase in domestic interest rates can attract capital inflows, increase demand for the local currency, and ultimately strengthen the exchange rate. Conversely, an increase in the money supply tends to drive inflation, which can weaken the purchasing power of the currency, leading to exchange rate depreciation. However, This relationship is not always linear or consistent, as it is influenced by structural factors and specific economic conditions. For example, during periods of financial crisis or global uncertainty, the effect of interest rate increases on exchange rates may diminish or even reverse.

Previous research has yielded varying results. Some studies found that the money supply has a significant influence on exchange rates, while interest rates are not always significant, especially in the short term. Conversely, other studies show that in the long run, both variables can significantly influence exchange rates. These differing findings highlight the need for analyses that clearly distinguish short-term and long-term effects.

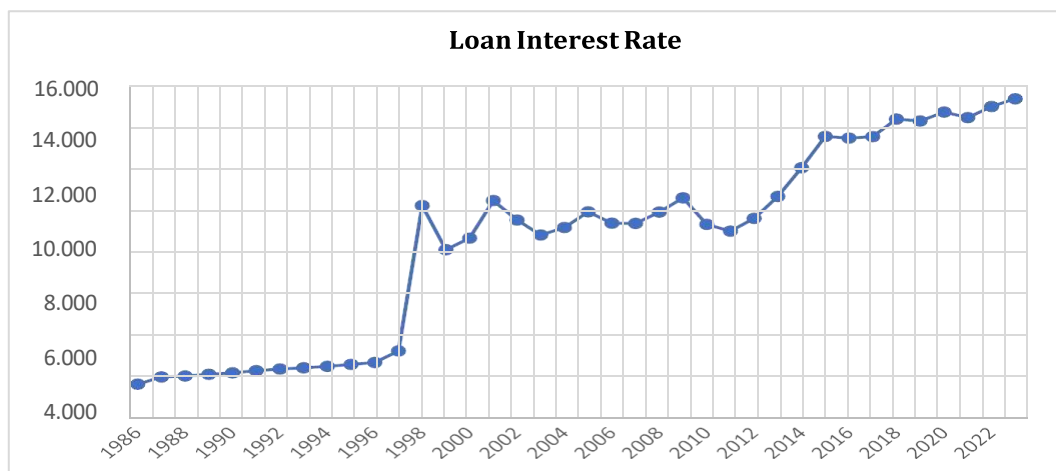
The Autoregressive Distributed Lag (ARDL) method is the right choice to test this relationship because it is able to handle variables with different levels of integration ($I(0)$ and $I(1)$) and estimate short-term and long-term coefficients simultaneously. Using annual data for the period 1986–2023 from the World Bank, this study aims to: (1) analyze the influence of loan interest rates and the amount of money in circulation on the rupiah exchange rate in the short term, (2) analyze the influence of these two variables in the long term, and (3) provide recommendations for appropriate monetary policies to maintain exchange rate stability.

2. Literature Review

2.1 Loan Interest Rates

The interest rate on a loan is the cost of using borrowed funds over a specific period. Its changes are influenced by monetary policy, inflation, credit demand, and banking risk (Mishkin & Eakins, 2021). High interest rates typically attract capital inflows, strengthening the exchange rate, although under certain conditions the effect can be reversed (Ibhagui & Olokoyo, 2023).

Chart
Development of Loan Interest Rate Data in Indonesia, 1986-2023



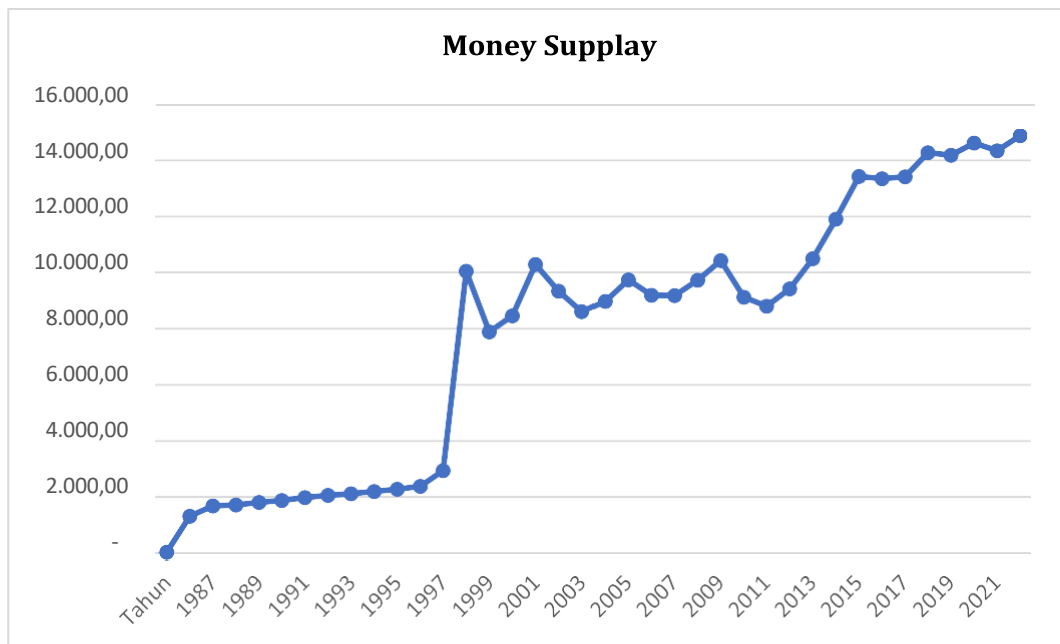
The graph shows the trend in loan interest rates in Indonesia from 1986 to 2023. At the beginning of the period, in 1986, interest rates were still relatively low, below 2%. This trend remained stable until the early 1990s. However, a significant spike occurred around 1998, coinciding with the Asian monetary crisis, when interest rates rose sharply, reaching around 10% in 1999.

Following the crisis, interest rates exhibited relatively stable movement, with a slight decline in the early 2000s, then gradually increasing again from 2010 onward. The increase continued until 2023, when interest rates reached a peak of around 15%. Overall, this graph reflects the monetary policy response to changing economic conditions, including the financial crisis, economic stabilization, and long-term inflation and exchange rate dynamics.

2.2 Money Supply

The money supply consists of currency, demand deposits, and deposits available for transactions. An increase in the money supply tends to drive inflation, which in turn weakens the exchange rate (Presetyo & Mulyadi, 2023).

Graph
Development of the Amount of Money in Circulation in Indonesia, 1986-2023



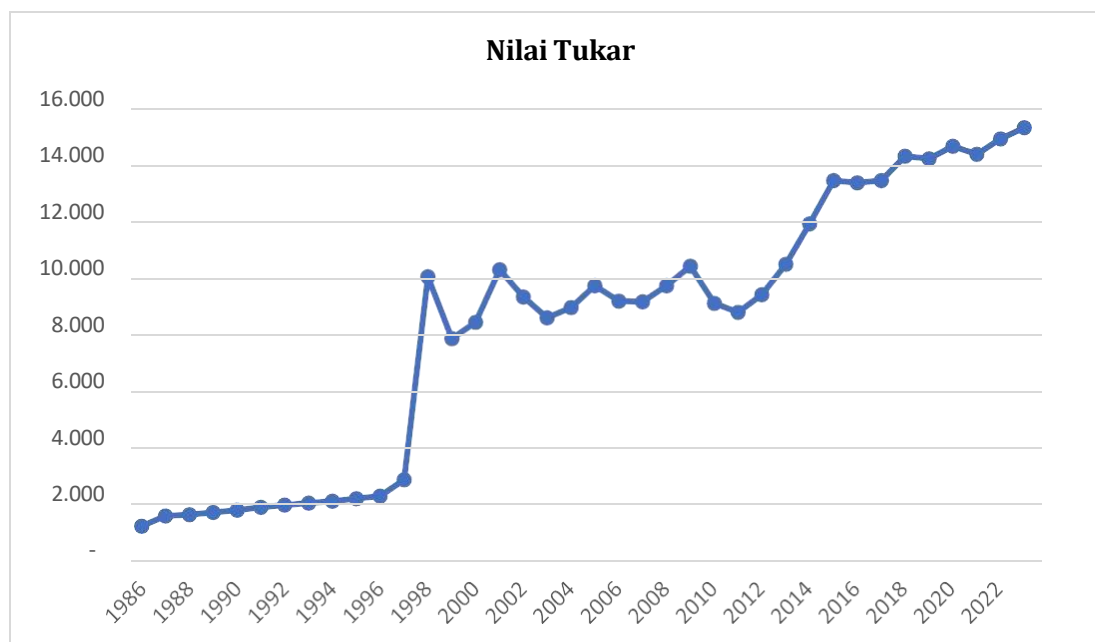
The graph shows the trend in the money supply in Indonesia from 1986 to 2023. In 1986, the money supply was recorded at around 28 trillion, then experienced a significant surge, peaking at 60 trillion around 1997, just before the Asian monetary crisis. This increase was likely influenced by expansionary monetary policy and increased economic activity prior to the crisis.

After reaching a peak, the graph shows a gradual decline, from around 55 trillion in 1999 to a low of around 39 trillion in 2015–2018. However, starting in 2020, the money supply has shown an upward trend again, which can be attributed to monetary stimulus policies during the COVID-19 pandemic. This increase appears to continue until 2023, when The money supply reached approximately 45 trillion. Overall, the graph shows that the money supply is influenced by a combination of factors such as monetary policy, crisis conditions, and national economic recovery efforts.

2.3 Exchange Rate

The exchange rate is the price of one currency relative to another. Its fluctuations are influenced by monetary conditions, the trade balance, and global external factors (Hakim & Aji, 2025).

Graph
Exchange Rate Development in Indonesia, 1986-2023



The graph shows the development of the rupiah exchange rate against the US dollar from 1986 to 2020. In 1986, the exchange rate was still below Rp2,000 per USD. However, this trend changed drastically in the late 1990s, particularly during the 1997–1998 monetary crisis, when the exchange rate soared to around Rp10,000. This sharp increase reflected significant pressure on economic stability and weak foreign exchange reserves at the time.

After briefly strengthening near Rp8,000 in 1999, the exchange rate weakened again to around Rp10,000 and remained relatively stable until the early 2000s. Over time, particularly after 2008 and leading up to 2020, the exchange rate continued to gradually depreciate, reaching around Rp14,000. This trend reflects the rupiah's sensitivity to global dynamics, such as the international financial crisis, monetary policies of developed countries, and domestic economic fundamentals.

3. Previous Research Results

Previous research serves as supporting research to support the findings of the research conducted by the researcher. Abimanyu & Mandai's (2022) study found that the money supply had a significant positive effect on the exchange rate, while interest rates had no significant effect. Conversely, Gusmianto (2021) found that both variables had a significant long-term effect.

4. Method

This study uses annual secondary data for the period 1986–2023 obtained from the World Bank. The dependent variable is the rupiah exchange rate against the US dollar, while the independent variables are loan interest rates and the money supply (M2). The analysis method used is the Autoregressive Distributed Lag (ARDL), which is suitable for time series data with mixed integration of $I(0)$ and $I(1)$. The analysis stages include: 1) Stationarity test (ADF & PP) to ensure there are no $I(2)$ variables; 2) Cointegration test (Bounds Test) to examine long-term relationships; 3) Determination of the optimum lag based on AIC criteria; 4) ARDL model estimation to obtain short-term and long-term coefficients; 5) Classical assumption tests include normality, autocorrelation, heteroscedasticity, and model stability (CUSUM & CUSUMQ).

5. Results of Analysis and Discussion

1. Stationary Test

Before applying the ARDL model, a stationarity test must first be performed to determine the degree of integration of each variable. The goal is to ensure that no variables are stationary at two or more degrees of integration ($I(2)$), as the presence of $I(2)$ variables would invalidate the ARDL approach. The stationarity test is performed to determine whether the data has a unit root trend (root of one) that causes the data to be unstable over time. If the data contains units, a transformation such as differencing is necessary.

Table
Stationarity Test

Variabel	Level		First Difference	
	ADF	PP	ADF	PP
Suku Bunga Pinjaman	0.7900	0.8343	0.0000	0.0000
Jumlah Uang Beredar	0.0641	0.1847	0.0155	0.0177
Nilai Tukar	0.8105	0.7376	0.0000	0.0000

Based on the results of the stationarity test using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods, it can be concluded that all variables in this study are not stationary at the level (level level), but become stationary after the first differentiation (first difference). This can be seen from the probability value (p-value) at the level for each variable: loan interest rate (ADF = 0.7900; PP = 0.8343), money supply (ADF = 0.0641; PP = 0.1847), and exchange rate (ADF = 0.8105; PP = 0.7376), all of which are greater than the 0.05 significance level. Subryanto's (2025) research shows that the M2, interest rate, and inflation variables are not stationary at the level, but become stationary after the first difference. These results indicate that all variables are included in category $I(1)$, and support the findings of this study which show similar characteristics in the economic variables analyzed.

However, after the first difference was performed, all variables showed ADF and PP probability values that were far below 0.05, namely 0.0000 for loan interest rates and exchange rates, and 0.0155 (ADF) and 0.0177 (PP) for the amount of money. circulating. Thus, it can be concluded that all variables are stationary in the first difference or are included in the first order integrated data series, I(1).

2. ARDLBound Test Cointegration

This test is particularly relevant when the variables in the study are integrated at levels I(0) and I(1), but not at I(2). In the bound testing procedure, the obtained F-statistic value is compared with the lower and upper bound values at a certain significance level. If the F-statistic value is greater than the upper bound value, it can be concluded that there is cointegration or a long-term relationship between the variables. Conversely, if the F-statistic value is smaller than the lower bound, there is no cointegration. However, if the F-statistic value is between the lower and upper bounds, the results are inconclusive.

Table
Uji Bound Test Cointegration

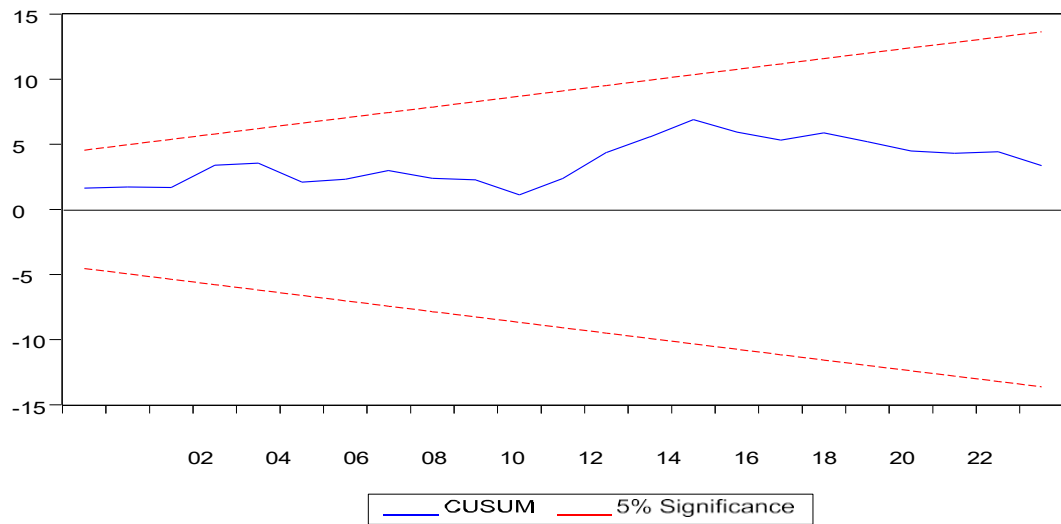
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic k	3.805099 2	Asymptotic: n=1000		
		10%	2.63	3.35
		5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5

Based on the results of the Cointegration Bound Test with a significance level of 5% and the null hypothesis (H_0) stating that there is no long-term relationship (no levels relationship), the F-statistic value is 3.805099. This value is between the lower limit ($I(0) = 3.10$) and the upper limit ($I(1) = 3.87$) at a significance level of 5%. Because the F-statistic value is between these two limits, the results of this test are included in the *inconclusive* or inconclusive category. This means that based on this bound test, a definite conclusion cannot be drawn whether or not there is a long-term relationship between the variables in the ARDL model, so additional analysis or consideration of other tests such as the Johansen cointegration test is needed to strengthen the results.

3. Cusum Test

Parameter stability is crucial to ensure that the relationship between variables does not change significantly over time. This test is performed by comparing the test result line with the critical limits at the 5% significance level. If the CUSUM line is within the critical limits, it can be concluded that the model is stable and there are no structural changes in the data during the study period. Conversely, if the line deviates from the critical limits, it indicates parameter instability, which could be caused by economic shocks, policy changes, or other external factors.

Tabel
Uji Cusum Test



Based on the CUSUM test results displayed in the graph, it can be seen that the CUSUM line (blue line) is within the 5% significance limit (dotted red line) throughout the observation period. This indicates that there are no significant structural changes in the ARDL model used. In other words, the model parameters remain stable throughout the analysis period, so the model can be considered valid and reliable for identifying short-term and long-term relationships between variables. This stability is an important indicator that the model is not affected by major disturbances or undetected changes during the study period.

4. Short Term Test Results

Lending interest rates have no significant effect on the exchange rate in the short term, indicating that the exchange rate's response to interest rate changes requires time to adjust. The money supply has a significant effect, indicating that excess liquidity quickly depreciates the rupiah.

Short-Term Equation Table

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1823.867	1664.473	-1.095763	0.2845
LN_Y(-1)*	0.003139	0.088806	0.035343	0.9721
LN_X1(-1)	72.93409	39.65176	1.839366	0.0788
LN_X2(-1)	-35.88394	88.66761	-0.404702	0.6894
D(LN_Y(-1))	-0.234088	0.195677	-1.196299	0.2438
D(LN_X1)	108.1147	71.78496	1.506091	0.1457
D(LN_X1(-1))	-159.7037	71.13847	-2.244969	0.0347
D(LN_X2)	414.0742	78.90662	5.247649	0.0000
D(LN_X2(-1))	52.84704	103.1358	0.512403	0.6133
D(LN_X2(-2))	216.0058	75.96516	2.843486	0.0092
D(LN_X2(-3))	163.1800	69.21868	2.357457	0.0273
* p-value incompatible with t-Bounds distribution.				

Based on the results of the Conditional Error Correction Regression (CECR) estimation, the short-term relationship between variables shows that D(LN_X2) and its lag have a significant influence on the dependent variable. The coefficient of D(LN_X2) is 414.0742 with a p-value of 0.0000 indicating a positive and strong influence. In addition, the 2nd and 3rd lags of D(LN_X2) are also significant, while D(LN_X1(-1)) has a significant negative influence. In contrast, other variables such as D(LN_Y(-1)), D(LN_X1), and the first lag of D(LN_X2(-1)) are not significant.

The error correction term (LN_Y(-1)*) component is insignificant (p-value = 0.9721), indicating the absence of an adjustment process towards long-term equilibrium in this model. Thus, the estimation results indicate that the influence of short-term variables is more dominant, and there is no strong evidence of a long-term relationship between the variables.

Overall, this CECR model shows that most of the significant short-term relationship comes from the variable LN_X2 and its lag, while there is no convincing evidence for a long-term relationship (as seen from the insignificant ECT). This indicates that short-term dynamics are more dominant in explaining the variation of LN_Y than the long-term relationship. These results are consistent with research in a study by Pachiyappan et al. (2021) who analyzed the relationship between financial innovation and economic growth in Ghana using the ARDL and NARDL models.

They found that most variables have a significant effect in the short run, while their contribution in the long run tends to be weak. Although the error correction term (ECT) component in that study was statistically significant, the coefficients of other variables in the long run did not show sufficient power to explain the dynamics of the relationship between the variables.

5. Long-Term Test Results

Both variables significantly influence the exchange rate. Higher interest rates tend to strengthen the rupiah by increasing the attractiveness of domestic assets, while growth in the money supply leads to rupiah depreciation.

Long-Run Equation Table

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_X1	-23237.10	663747.0	-0.035009	0.9724
LN_X2	11432.77	348813.8	0.032776	0.9741
C	581091.5	16068995	0.036162	0.9715
EC = LN_Y - (-23237.0976*LN_X1 + 11432.7684*LN_X2 + 581091.5378)				

Based on the results of the long-term equation estimation using the Levels Equation approach (Case 2: Restricted Constant and No Trend), the long-term equation section shows that there is no significant long-term relationship between the variables LN_X1 and LN_X2 to LN_Y, which is reflected in the very high p-value (above 0.97) for each variable. This is also reinforced by the note "*p-value incompatible with t-Bounds distribution*" which indicates that the estimation results for the variable LN_Y(-1)* in the CECR equation cannot be directly interpreted based on the usual t-Statistic distribution, because the bounds testing model does not support individual interpretation of the p-value on that component

The findings of this study align with those of Bhattacharjee et al. (2023), who used the ARDL panel approach to analyze the influence of monetary factors on economic variables. They found that although the bound test indicated a long-term relationship, most variables only showed significance in the short run. The long-run coefficients for several variables remained insignificant or inconsistent. This supports the findings of this study, which found a predominance of short-run relationships, while no strong evidence of long-run relationships between variables was found.

6. Conclusions and Recommendations

Conclusion :

1. Loan interest rates have a significant negative effect on the rupiah exchange rate in short term, but not significant in the long term.
2. The amount of money in circulation significantly influences the depreciation of the rupiah in the short term, but is not significant in the long term.
3. Simultaneously, both variables affect the exchange rate in the short run, but no evidence of a strong long-run relationship is found
4. Monetary policy has more impact in the short term, while the long term is influenced by non- monetary factors such as politics, trade, and global conditions.

Recommendation:

1. Bank Indonesia needs to optimize its policy of controlling the amount of money in circulation to anticipate exchange rate fluctuations.
2. Interest rate setting should take into account the long-term impact on exchange rate stability
3. Further research could include external variables such as commodity prices and foreign capital flows.

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