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The Relationship between Exchange Rate, Money Supply, and Inflation in Indonesia: An ARDL Approach

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Abstract: This study examines the short- and long-term relationships between inflation, exchange rate, and money supply (M2) in Indonesia using the Autoregressive Distributed Lag (ARDL) approach over the period 2013–2024. Monthly time-series data obtained from official sources are analyzed to capture the dynamic interactions among variables. The bounds testing procedure confirms the existence of a long-run cointegration relationship, with the ARDL(5,1,2) model identified as the optimal specification. Empirical results indicate that, in the short run, inflation is significantly influenced only by its own past values, while the exchange rate and money supply are statistically insignificant in both the short and long term. These findings suggest that inflation dynamics in Indonesia are primarily driven by internal adjustment mechanisms rather than direct monetary or exchange rate shocks. The study contributes to monetary policy analysis by highlighting the importance of inflation expectations and domestic stability.

Keywords: *Inflation, Exchange Rate, Money Supply, ARDL, Time Series, Indonesia.*

Introduction

Inflation is a key macroeconomic indicator that reflects a general and sustained increase in the prices of goods and services. Unstable inflation rates can reduce people's purchasing power, increase economic uncertainty, and disrupt overall macroeconomic stability. Therefore, controlling inflation is a major focus in the formulation of economic policy, especially in developing countries (Khalil, 2024).

In an open economy such as Indonesia, inflation dynamics are inseparable from exchange rate movements. Fluctuations in the rupiah against major world currencies are often influenced by global economic conditions, international capital flows, and financial market sentiment. These exchange rate changes can affect domestic prices through the exchange rate pass-through mechanism, whereby increases in the prices of imported goods and production input costs have the potential to increase domestic inflationary pressures (Taylor, 2000).

In addition to exchange rates, the money supply is a monetary variable that plays an important role in inflation dynamics. Liquidity growth that is not in line with real output growth can increase aggregate demand and drive up price levels. Empirical research using the Autoregressive Distributed Lag–Error Correction Model approach shows that changes in the money supply have a significant effect on inflation in both the short and long term (Mverecha, 2025).

In the Indonesian context, the relationship between monetary variables and inflation has proven to be dynamic and not always consistent between observation periods. Research by Kurniasih et al., (2024) shows a significant long-term relationship between monetary variables and inflation, while in the short term there is an adjustment process towards economic equilibrium. These findings indicate that the relationship between macroeconomic variables cannot be analyzed statically.

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Although a number of studies have examined the relationship between exchange rates, money supply, and inflation, previous research results still show diverse findings and do not fully explain the dynamics of short-term and long-term relationships simultaneously in a single analytical framework. Therefore, an econometric approach is needed that can comprehensively capture the complexity of these relationships. The Autoregressive Distributed Lag (ARDL) approach was chosen for its ability to analyze short-term and long-term relationships simultaneously and accommodate differences in the degree of integration between economic variables (Linawati et al., 2021)

Literature Review and Hypothesis

Inflation is a macroeconomic phenomenon that reflects a general and sustained increase in the prices of goods and services in an economy. From a macroeconomic theory perspective, inflation is understood as the result of an imbalance between aggregate demand and aggregate supply, as well as unstable monetary conditions. High and uncontrolled inflation can reduce people's purchasing power, increase economic uncertainty, and disrupt macroeconomic stability, making its control a primary objective of monetary policy, especially in developing countries (Khalil, 2024).

Within the framework of monetary policy, interest rates are often viewed as the primary instrument for controlling inflation through the mechanism of aggregate demand transmission. Theoretically, an increase in interest rates will increase borrowing costs, thereby suppressing consumption and investment, which in turn can reduce inflationary pressures. However, the effectiveness of interest rates as an instrument for controlling inflation is highly dependent on the structural conditions of the economy and the functioning of monetary transmission channels. Therefore, in addition to interest rates, other monetary variables such as the money supply and exchange rates continue to play an important role in influencing inflation dynamics.

In addition to interest rates, the money supply is a monetary variable that is closely related to inflation. This relationship is explained in the Quantity Theory of Money proposed by Irving Fisher, which states that growth in the money supply that is not matched by growth in real output will drive up price levels. Excess liquidity in the economy increases aggregate demand, thereby potentially causing inflationary pressure. Empirical findings by Mverecha (2025)show that growth in the money supply is significantly related to inflation in both the short and long term.

The relationship between exchange rates and inflation is theoretically explained through the concept of exchange rate pass-through. Taylor (2000) states that changes in exchange rates will be passed on to domestic prices through the prices of imported goods and production costs. Exchange rate depreciation causes an increase in the prices of imported goods, which ultimately increases inflationary pressure, especially in open economies that are highly dependent on imports. However, the degree of exchange rate pass-through to inflation may differ between the short and long term, depending on market structure, the level of competition, and the response of monetary policy.

In the Indonesian context, the relationship between monetary variables and inflation is dynamic and not always consistent across observation periods. Kurniasih et al. (2024) found a long-term relationship between monetary variables and inflation, while in the short term there is an adjustment process towards economic equilibrium. The differences in results between studies show that the relationship between exchange rates, money supply, and inflation cannot be analyzed statically, but requires an approach that can comprehensively capture the dynamics of the relationship between variables. The Autoregressive Distributed Lag (ARDL) approach is considered relevant because it is capable of analyzing short-term and long-term relationships simultaneously and accommodating differences in the degree of integration between variables, as long as they are not integrated at second order (Linawati et al., 2021).

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Theoretical Framework

Referring to economic theory and previous research results, this research hypothesis was formulated to examine the effect of money supply and exchange rates on inflation.The hypotheses in this study are as follows:

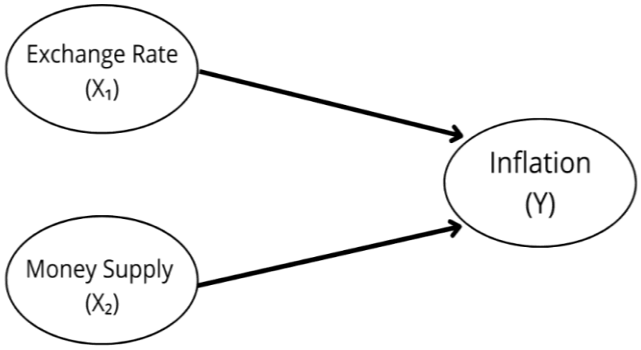

Figure 1 . Research Framework (compiled by researchers)

1. *Money Supply and Inflation*
   Based on the quantity theory of money, an increase in the money supply that is not matched by growth in output will drive up price levels. Increased liquidity increases aggregate demand, which ultimately leads to inflationary pressure.In monetary policy, the money supply is the main instrument for controlling inflation, so changes in it are expected to affect inflation in both the short and long term.
   H1: *The money supply has a positive and significant effect on inflation.*

2. *Exchange Rates and Inflation*
   Exchange rates affect inflation through the mechanism of imported inflation. Depreciation of the exchange rate increases the price of imported goods and production costs, which in turn drives up domestic prices.In addition, exchange rate fluctuations can affect inflation expectations, so changes in the exchange rate are expected to have a significant impact on inflationto crises.
   H2: Exchange rates have a positive and significant effect on inflation.

3. *The Dynamic Relationship between Money Supply and Exchange Rates on Inflation*
   The effect of money supply and exchange rates on inflation is dynamic. In the short term, inflation can fluctuate, while in the long term it will move toward equilibrium. The ARDL approach is used to capture these short-term and long-term relationships simultaneously.
   H3: Money supply and exchange rates have a long-term relationship with inflation.

Methodology

Research Approach and Data Types

This study uses a quantitative approach with the aim of analyzing the causal relationship and short-term and long-term dynamics between macroeconomic variables empirically. The quantitative approach was chosen because it allows for objective testing of the relationship between variables through numerical data processing and the application of measurable statistical methods (Tamurang, 2024).

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The data used is monthly secondary data with an observation period from May 2013 to December 2024, resulting in 144 observations. The use of monthly data aims to capture economic dynamics and fluctuations in greater detail, both in the short and long term, compared to the use of annual data. All data was obtained from official publications of credible institutions, namely the Central Statistics Agency (BPS) and Bank Indonesia.

Definition and Operationalization of Variables

The variables used in this study consist of one dependent variable and two independent variables (Eka E. T. Laloan, 2023). The dependent variable is inflation (INF), which is defined as the percentage change in the Consumer Price Index (CPI) on a monthly basis, reflecting a general and sustained increase in the prices of goods and services.

The first independent variable is the money supply (M2), which includes currency, demand deposits, and quasi-money as a representation of the level of liquidity in the economy. This variable is transformed into a natural logarithm ($lnM2$) to reduce extreme fluctuations and improve the stability and efficiency of the estimation.

The second independent variable is the exchange rate (KURS), which indicates the price of the rupiah against the US dollar (USD). This variable is used to capture the effect of imported inflation on the Indonesian economy. Similar to M2, the exchange rate is also transformed into a natural logarithm ($lnKURS$) to meet requirements.

Analysis Method

The analysis method used in this study is Autoregressive Distributed Lag (ARDL). The ARDL model was chosen because it is capable of analyzing short-term and long-term relationships simultaneously and can be used on variables with different integration levels, namely $I(0)$ and $I(1)$, as long as there are no variables integrated at a relatively limited sample size order and is widely used in macroeconomic time series analysis in developing countries, including Indonesia (Linawati et al., 2021).

Conceptually, the ARDL model combines an autoregressive component that captures the influence of past values of the dependent variable on current values, and a distributed lag component that represents the influence of independent variables in both the current and previous periods (Nugroho, 2025).

ARDL Model Specification

Mathematically, the ARDL model used in this study can be formulated as follows:

$$INF_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i INF_{t-i} + \sum_{j=0}^{q} \beta_j \ln M2_{t-j} + \sum_{k=0}^{r} \gamma_k \ln KURS_{t-k} + \varepsilon\_t$$

Where (INF_t) is the inflation rate in period (t), ($ln\ M2\_t$) is the natural logarithm of the money supply, ($ln\ KURS\_t$) is the natural logarithm of the exchange rate, and (ε_t) is the error term. This model is used to test the effect of the money supply and exchange rate on inflation in both the short and long term.

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Model Estimation Stages

The analysis began with a stationarity test to avoid spurious regression. The Augmented Dickey–Fuller (ADF) test was employed to ensure that none of the variables were integrated at the second order, I(2), as required for the ARDL framework. A variable is considered stationary if its probability value is below the 5 percent significance level. After that, the optimum lag length is determined to accurately capture the dynamics of the relationship between variables. The selection of the optimal lag is based on several information criteria, namely the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC/BIC), Hannan–Quinn Criterion (HQ), Likelihood Ratio (LR), and Final Prediction Error (FPE). The best lag is selected based on the smallest criterion value or the highest number of stars.

The next step is to test for cointegration using the Bounds Testing Approach to determine the existence of long-term relationships between variables in the model. The testing decision is based on a comparison of the F-statistic value with the lower bound and upper bound values. If the F-statistic value is greater than the upper bound, it can be concluded that there is a cointegration relationship between the variables. If cointegration is proven, then the long-term and short-term relationships are estimated using the ARDL model. The short-term estimate is supplemented with an Error Correction Term (ECT) that represents the speed of adjustment towards long-term equilibrium. The ECT coefficient is expected to be negative and significant with a value between 0 and −1, which indicates the existence of an error correction mechanism and the validity of the long-term relationship in the model.

Model Specification and Diagnostic Testing

To ensure that the estimated ARDL model is valid and reliable in econometric terms, a series of specification and diagnostic tests were conducted. The heteroscedasticity test was performed using the Breusch–Pagan Test, while the autocorrelation test was performed using the Breusch–Godfrey LM Test. Multicollinearity tests were performed by looking at the Variance Inflation Factor (VIF) value, while residual normality tests were performed using the Jarque–Bera Test. In addition, parameter stability tests were performed using CUSUM and CUSUM of Squares. The model was declared feasible if it did not violate classical assumptions and showed parameter stability throughout the observation period.

Discussion

Stationarity Test (Unit-Root Test)

Variable	ADF t-Stat	Prob.	ADF t-Stat	Prob.
	Level		1st Difference	
Inflation	-8.584	0.0000	-	-
Exchange_Rate	-1.387	0.5885	-10.396	0.0000
Money_Supply	0.527	0.9850	-16.810	0.0000
Test critical values MacKinnon:				
1% level		-3.496		
5% level		-2.887		
10% level		-2.577		

Table 1 Stationarity Test Results with Augmented Dickey-Fuller (ADF) Using Stata 17 Application

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Based on the results of the stationarity test in Table 1, it was found that the inflation variable was stationary at the level with a p-value of 0.000, which was lower than alpha 0.058. However, there are two variables that are not stationary at the level, namely the exchange rate with a p-value of 0.58 and the money supply with a p-value of 0.985, which are higher than alpha 0.05. Therefore, further stationarity testing at the first difference level is required. If these two variables are stationary at the first difference level, then the selection of the ARDL model for this study is very appropriate.

These results indicate that both variables are stationary at the first difference level because the p-values for both variables are lower than alpha 0.05. and this result is also reinforced by the statistical test value for the exchange rate variable of -10.396, which is lower than the critical values of 1%, 5%, and 10%, and also the statistical test value for the money supply variable of -16.810, which is lower than the critical value at any level. Thus, the selection of the ARDL model for this study is very appropriate because there is stationary diversity in each data set studied.

Cointegration Test (Bounds Testing)

F-Bounds Test		**Null Hypotesis: No levels relationship**		
Test Stat.	**Value**	**Signif.**	**I(0)**	**I(1)**
			Asymptotic: n=144	
F-Statistics	8.02	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

Table 2 Cointegration Test Results with Bounds Testing Using Stata 17 Application

Based on the results of the bounds test according to Table 2, an f-statistic value of 8.024 was obtained, which is greater than the upper bounds of 4.85 at a significance level of 5%. This means that H0, which states that there is no long-term relationship, is rejected, and H1 is accepted. Thus, there is a cointegration relationship or long-term relationship between inflation and exchange rates and money supply. This means that changes in these independent variables will form a long-term equilibrium with inflation in Indonesia. Although these three variables may change in the short term, they move together towards the same equilibrium in the long term.

ARDL Estimation (Optimal Lag Selection)

	Dependent Variable: Inflation		
	Method: ARDL		
	Selected Model: ARDL(5, 1, 2)		
Variable	**Std. Error**	**t-Stat.**	**Prob.**
Inflation(-1)	0.125	0.59	0.559
Inflation(-2)	0.107	-1.35	0.181
Inflation(-3)	0.086	-1.28	0.203
Inflation(-4)	0.076	-2.73	0.007
Exchange_Rate(-1)	0.000	-1.97	0.051
Money_Supply(-1)	6.410	0.20	0.842
Money_Supply(-2)	3.740	1.53	0.129
C	0.064	2.81	0.006

Table 3 Results of ARDL Estimation Using Stata 17 Application

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Based on Table 3, the optimal lag selection indicates that the ARDL(5,1,2) model is the most appropriate specification for explaining inflation dynamics in Indonesia. This result suggests that current inflation is strongly influenced by its own past values over several periods, indicating a high degree of inflation persistence. Among the lagged inflation terms, only inflation at the fourth lag is statistically significant, reflecting a delayed adjustment process in price dynamics.

The exchange rate variable exhibits a marginal effect at the first lag, with a probability value slightly above the conventional 5 percent significance level, indicating a weak short-term influence. Meanwhile, the money supply variable remains statistically insignificant across all lags. Overall, these findings suggest that inflation dynamics in Indonesia are predominantly driven by internal adjustment mechanisms rather than direct responses to monetary expansion or exchange rate fluctuations.

Breusch–Godfrey Serial Correlation LM test:			
Chi2	0.022	Prob. Chi2	0.8817

Table 4 Autocorrelation Test Results with Breusch-Godfrey Using Stata 17 Application

The autocorrelation test results based on Table 4 show a Prob. Chi2 value of 0,8817, which is much greater than alpha 0.05. Because this probability value is high, H0 is not rejected and H1 is accepted, meaning that there is no autocorrelation in the model. In other words, the residuals from the ARDL model are random and do not correlate with each other between periods, so the estimated model is sufficient in capturing the dynamics of the data without any systematic patterns remaining.

Estimation of Long and Short Term Test

		Long Term	
Variable	**Coeff.**	**t-Stat.**	**Prob.**
Exchange_Rate	-0.000	-0.45	0.655
Money_Supply	5.260	0.32	0.748
		Short Term	
		ECM Regression	
Variable	**Coeff.**	**t-Stat.**	**Prob.**
D(Inflation(-1))	0.037	0.25	0.803
D(Inflation(-2))	-0.225	-1.76	0.080
D(Inflation(-3))	-0.195	-1.89	0.061
D(Inflation(-4))	-0.257	2.85	0.005
D(Exchange_Rate(-1))	-0.000	-1.15	0.254
D(Money_Supply(-1))	1.520	0.19	0.846
D(Money_Supply(-2))	5.360	1.18	0.239
CointEq(-1)	-0.615	-3.65	0.000
Adjusted R^2		0.418	

Table 5 Estimation Results of Long and Short Term Test Using Stata 17 Application

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Based on the results in Table 5, from the ARDL 5,1,2 model estimation table, the long-run or LR section shows that the exchange rate coefficient of -0.000 and the money supply of 5.260 are both statistically insignificant because their p-values are greater than alpha 0.05. This means that in the long run, changes in the exchange rate and money supply do not have a significant effect on inflation. In other words, inflation is determined more by factors other than these two variables, such as price expectations, fiscal policy, or domestic demand dynamics.

Meanwhile, in the short term or SR, the results show that the inflation variable in the 4th lag has a negative and significant effect on current inflation with a coefficient value of -0.257 and a p-value smaller than alpha 0.05. This means that there is an adjustment effect, where when inflation rises several months earlier, it tends to be followed by a decline in inflation in the current period. This effect illustrates the existence of a natural correction or stabilization process in the price system. Other variables such as exchange rate changes and money supply in the short term are also insignificant, indicating that their effects are not directly felt in monthly inflation fluctuations.

The long-term inflation lag coefficient of -0.615, which is significant at the 1% level, indicates that there is an adjustment mechanism towards long-term equilibrium. This negative and significant value indicates that the model has a strong cointegration relationship, where inflation will adjust to imbalances from the previous period by around 61.5% each month.

Hypothesis Evaluation and Economic Interpretation

The empirical results indicate that H1 and H2 are rejected, as neither the money supply nor the exchange rate has a statistically significant effect on inflation in both the short run and the long run. This finding contrasts with classical monetary theory and the exchange rate pass-through framework, which posit a direct relationship between monetary variables and inflation.The rejection of these hypotheses can be explained by Indonesia's monetary policy framework.

Since the adoption of the inflation targeting regime, Bank Indonesia has relied more on interest rate policy, macroprudential instruments, and inflation expectation management rather than monetary aggregates. In addition, the presence of administered prices and government interventions in key commodities, such as fuel and food, weakens the direct transmission of money supply and exchange rate changes to inflation. These results suggest that inflation in Indonesia during the 2013–2024 period is increasingly policy-anchored and driven by domestic price dynamics, rather than by monetary expansion or exchange rate movements alone.

Model Stability Test

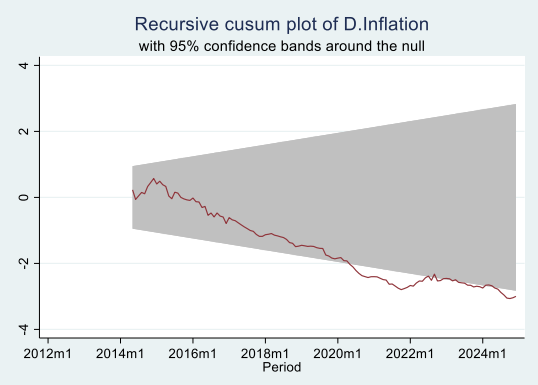

Figure 2 CUSUM Stability Test Graph Using Stata 17 Application

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Based on Figure 4, the Recursive CUSUM plot graph above, the CUSUM line that describes the stability of the model parameters appears to be within the 95% confidence limit throughout the observation period. This means that there is no violation of parameter stability, so that the ARDL model used is structurally stable during the 2013–2024 period. In other words, the relationship between inflation, exchange rates, and money supply in the model did not experience significant changes or structural breaks during the study period. This condition indicates that the estimated regression model is reliable for explaining Indonesia's inflation dynamics during that time period.

Conclusion, Limitations, and Suggestions

Conclusion

This study investigates the dynamic relationship between inflation, exchange rates, and money supply in Indonesia using the ARDL approach with monthly data from 2013 to 2024. The results confirm the existence of a long-run cointegration relationship among the variables, indicating that they move together toward a long-term equilibrium.

However, empirical evidence reveals that neither the exchange rate nor the money supply has a statistically significant impact on inflation in both the short and long run. Instead, inflation is predominantly influenced by its own past values, reflecting strong persistence and internal adjustment dynamics. The significant and negative error correction term indicates a relatively rapid adjustment toward long-term equilibrium, reinforcing the robustness of the cointegration relationship.

These findings contribute to the literature by providing evidence that inflation dynamics in Indonesia are less responsive to monetary aggregates and exchange rate fluctuations and more dependent on domestic stabilization mechanisms and inflation expectations. This underscores the importance of policy credibility and expectation management in maintaining price stability within an inflation-targeting framework.

Limitations

Despite providing meaningful insights, this study has several limitations. First, the analysis focuses only on two explanatory variables—money supply and exchange rate—while other important determinants of inflation, such as interest rates, fiscal policy, energy prices, and inflation expectations, are not included in the model. Second, the study relies on aggregate monthly data, which may not fully capture sectoral price variations or structural changes in the economy. Third, potential structural breaks caused by major economic shocks, such as the COVID-19 pandemic or global financial disturbances, are not explicitly modeled, which may affect the stability of the estimated relationships.

Suggestions

Future research is recommended to incorporate additional macroeconomic variables, including interest rates, output gaps, fiscal indicators, and inflation expectations, to obtain a more comprehensive understanding of inflation dynamics in Indonesia. Further studies may also apply alternative econometric techniques, such as Structural VAR or nonlinear ARDL models, to capture asymmetries and regime shifts in inflation behavior. From a policy perspective, the findings suggest that monetary authorities should place greater emphasis on managing inflation expectations and maintaining domestic economic stability, rather than relying solely on monetary expansion or exchange rate interventions, to achieve sustainable price stability.

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