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Long-run dynamics and error correction mechanism of inflation in Indonesia: a vector error correction model approach

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Abstract

This study examines the impact of BI Rate fluctuations and exchange rate movements on inflation stability in Indonesia from August 2016 to August 2025. The Vector Error Correction Model (VECM) maps long-term, short-term, and dynamic responses among variables. VECM estimations reveal a significant long-term equilibrium with an Exchange Rate coefficient of 1.9314 and a BI Rate coefficient of -0.0917. These findings highlight a high exchange rate pass-through, in which price stability is more sensitive to currency fluctuations than to interest rate policy. Variance Decomposition analysis confirms substantial inflation inertia, dominated by a self-shock of 97.16%. Meanwhile, the insignificant Error Correction Term (ECT) of -0.0554 suggests a slow adjustment mechanism toward equilibrium. Consequently, monetary authorities are advised to prioritize exchange rate stability and public expectation management to mitigate structural price pressures.

Keywords: BI Rate; Exchange Rate; Inflation; VECM

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INTRODUCTION

Bank Indonesia (2024) defines inflation as the sustained and general tendency for prices of goods and services to rise over a given period. In recent years, inflation has emerged as a primary concern due to its significant impact on public welfare. Pangesti and Susanto (2018) assert that inflation is one of the key indicators affecting purchasing power and price stability. General price instability carries adverse implications for both global and domestic economic structures. According to Louis (2024), inflation-induced erosion of market absorption capacity leads to a decline in real household consumption. Meanwhile, high price volatility creates uncertainty for investors and increases production costs for firms, which, in turn, can decelerate economic growth. The causes of inflation are generally classified into two main categories: Demand-Pull Inflation, arising when demand for goods and services exceeds supply, and Cost-Push Inflation, driven by rising production costs (raw materials, wages, transportation), as well as other factors such as government policy, exchange rate movements, and external shocks.

Based on Indonesia's Economic Report (Laporan Perekonomian Indonesia/LPI), over the past decade, inflation dynamics in Indonesia have demonstrated remarkable resilience, transitioning from a period of low stability in 2016 (3.02%) through successive phases of recovery and policy consolidation. Despite experiencing deflationary pressures during the pandemic period (2020–2021), reaching a low of 1.68%, and a post-pandemic surge in 2022 reaching 5.51% due to global energy price adjustments, monetary policy successfully brought inflation back within target faster than projected through the implementation of a coordinated pro-stability policy mix. This was supported by the restructuring of the policy rate instrument (BI7DRR) introduced in 2016 (Bank Indonesia, 2017), as well as strengthened food inflation control synergies through the Central and Regional Inflation Control Teams (TPIP/TPID) and the National Food Inflation Control Movement (GNPIP), so that by 2024–2025, inflation was consistently maintained within the new, lower target range of 2.5% ± 1%.

The effectiveness of inflation control was further supported by Bank Indonesia's foundational step of strengthening the monetary framework through changes in the policy rate instrument. Effective August 19 2016, monetary policy officially restructured its benchmark instrument from the BI Rate to the BI 7-Day Reverse Repo Rate (BI7DRR). As explained in the Indonesian Economic Report (2017), this restructuring aimed to strengthen the monetary policy transmission mechanism. Ratri and Munawar (2022) emphasize that despite the change in tenor, this instrument remains crucial in the long run for anchoring inflation expectations amid global financial market dynamics.

Beyond internal factors such as interest rates, Indonesia's inflation stability is also significantly influenced by an external variable: the movement of the Rupiah exchange rate against the US Dollar (USD). The USD/IDR exchange rate was selected as an indicator due to its role as the primary currency in international transactions, which makes it both a barometer of domestic economic resilience against global shocks and a channel for transmitting foreign goods prices into the domestic market. Sari and Nurjannah (2023) confirm that the exchange rate exerts a significant influence on inflation, with Rupiah depreciation against the USD often triggering increases in the prices of imported goods (imported inflation), ultimately burdening household purchasing power. Consistent with this, Riwana et al. (2024) highlight that maintaining exchange rate stability against the dollar is the primary key to dampening economic turbulence, especially during periods of

uncertainty. External factors, including global monetary policy normalization and escalating geopolitical uncertainty, have further amplified depreciatory pressures on the Rupiah, in turn exacerbating import-side inflation risks (Maharani et al., 2025). This situation confirms that the interaction between the USD exchange rate and inflation is not merely a statistical issue but reflects a structural interdependency that directly influences the trajectory of national economic growth.

Within the VECM methodological framework, the core problem concerns uncertainty about the speed of the error correction mechanism in returning inflation to its target path following economic shocks (Amalia et al., 2025). Therefore, identifying the most dominant variable influencing inflation volatility becomes critically important to ensure that policy remains on a stable trajectory (Dewi et al., 2025). To address this uncertainty, the present study employs the VECM (Engle & Granger, 1987; Johansen, 1988). This method is deemed the most appropriate for accommodating volatile economic data, as it can capture the long-run equilibrium relationships among the BI Rate, the USD Exchange Rate, and Inflation. Its primary advantage lies in the Error Correction Term (ECT) (Engle & Granger, 1987), which measures how quickly the economic system returns to its stable position following a shock. Furthermore, the use of IRF and FEVD simulations will clearly identify which variable is most dominant in triggering price volatility, enabling a more accurate evaluation of policy effectiveness.

Several prior studies using the VECM approach offer empirical insights into the complexity of Indonesia's inflation dynamics. Sriyana (2022) demonstrates that, in the long run, monetary policy through the money supply (M1) significantly influences the level of domestic prices. This finding is reinforced by Dewi et al. (2025), who confirm that during the 2020–2024 period, money supply and the exchange rate were the primary drivers of inflation in the long run, although in the short run, only the exchange rate exhibited a significant effect. Consistent with these findings, Amalia et al. (2025) conclude, based on an Impulse Response Function (IRF) analysis, that the exchange rate is the most effective variable in explaining inflation variability, compared to the policy interest rate. Maharani et al. (2025), using monthly data from January 2010 to March 2025, find that although a long-run cointegration relationship exists among inflation, BI Rate, and the USD/IDR exchange rate, changes in the benchmark interest rate are not directly effective in controlling inflation in the short run. Their FEVD analysis further

reveals that inflation is the most dominant variable in explaining BI Rate variability, with a contribution reaching 63.65% in period 24, indicating that price stability is the primary consideration in monetary policy formulation. Collectively, these three studies confirm the existence of a long-run cointegration relationship between monetary indicators and inflation, wherein exchange rate stability remains a crucial factor in dampening price pressures in Indonesia.

The novelty of this study lies in its use of a comprehensive data range spanning August 2016 to August 2025. This time span is strategically significant because it captures three crucial phases of Indonesia's economic history: the early phase of BI7DRR implementation, the COVID-19 pandemic shock, and the post-pandemic recovery. Accordingly, this study not only fills gaps in the existing literature but also provides a genuine robustness test of monetary policy transmission under varying economic conditions. Based on this framework, the study aims to analyze the dynamics of long-run relationships and to measure the speed of adjustment among the BI Rate, the USD Exchange Rate, and Inflation. The empirical results of this study are expected to provide policy implications for monetary authorities in formulating more precise strategies to maintain price stability and household purchasing power amid global uncertainty.

METHODS

This study employs a quantitative approach using the VECM to analyze the dynamic relationships among the BI Rate, the USD/IDR exchange rate, and inflation. The data used consist of monthly secondary time series data covering the period from August 2016 to August 2025, sourced from Bank Indonesia and the Central Statistics Agency (Badan Pusat Statistik/BPS). The exchange rate and inflation variables were transformed to natural logarithms to mitigate heteroscedasticity.

All estimation procedures were carried out in Python on the Google Colaboratory platform. The analytical stages include the Augmented Dickey-Fuller (ADF) stationarity test, determination of optimal lag length, and the Johansen cointegration test (Johansen, 1988). The analysis continues with VECM estimation, Impulse Response Function (IRF), and Variance Decomposition to evaluate the system and the inter-variable contributions in both the long and short runs.

RESULTS AND DISCUSSION

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Table 1. Results of the Augmented Dickey Fuller (ADF) Stationarity Test

Variable	*P-Value* (Level)	*P-Value (First Diff)*	Description
Inflasi	0.5408	0.0000	Stasioner pada $I(1)$.
BI Rate	0.2033	0.0000	Stasioner pada $I(1)$.
Nilai Tukar Kurs	0.3538	0.0000	Stasioner pada $I(1)$.

The ADF test results in Table 1 indicate that all variables became stationary at the same order of integration, namely I(1) (MacKinnon, 1996). Achieving data stability at this level (Dickey & Fuller, 1979; MacKinnon, 1996) allows the analysis to proceed to the determination of the optimal lag length and to cointegration testing, examining both long- and short-run relationships among variables.

Optimal Lag Length Determination

Table 2. Results of Optimal Lag Length Determination

Lag	AIC	BIC	EPE	HQIC
0	-18.06	-17.66*	1.438e-08	-17.90
1	-18.23	-17.60	1.211e-08	-17.97
2	-18.42	-17.55	1.007e-08*	-18.06*

Lag length determination was performed to capture the interaction dynamics among variables accurately. Based on the test results in Table 2, the majority of criteria (AIC, EPE, and HQIC) consistently recommend Lag 2 as the optimal point, yielding the minimum information criterion values. The selection of Lag 2 provides a robust statistical foundation for proceeding to the cointegration testing stage.

Johansen Cointegration Sensitivity Test

Table 3. Results of the Johansen Cointegration Sensitivity Test

Lag	*Trace Statistic*	*Critical Value* (5%)	Description
1	40.9465	29.7961	Cointegrated
2	26.4882	29.7961	Not Cointegrated
3	14.0142	29.7961	Not Cointegrated

Based on the AIC, EPE, and HQIC criteria in Table 2, the recommended optimal lag length is Lag 2. However, the Johansen cointegration test results at that lag indicate an absence of a long-run relationship, as the Trace Statistic value (26.4882) is smaller than the Critical Value (29.7961).

In response to this, a sensitivity test was conducted across various lag structures. The results reveal cointegration at Lag 1, with a Trace Statistic of 40.9465 exceeding the critical value. Therefore, Lag 1 was established as the basis for VECM model estimation to ensure the stability of the long-run relationship among variables (Johansen, 1988; MacKinnon et al., 1999).

Vector Error Correction Model (VECM) Estimation

Table 4. Results of the Vector Error Correction Model (VECM) Estimation

Component	**Coeffcient**	**Std. *Error***	***Z-Statistic***	***P-Value***
Long-Run Relationship				
Exchange Rate (USD/IDR)	1.9314	0.216	8.928	0.000*
BI Rate	-0.0917	0.014	-6.464	0.000*
Constant	-22.8453	2.042	-11.186	0.000*
Error Correction Mechanism				
ECT	-0.0554	0.049	-1.119	0.263
Short-Run Dynamics				
Δ Inflation $(t-1)$	0.0244	0.105	0.234	0.815
Δ BI Rate $(t-1)$	0.0099	0.018	0.541	0.588
Δ Exchange Rate $(t-1)$	0.1188	0.128	0.928	0.353

The VECM estimation results in Table 4 indicate the presence of a strong long-run equilibrium relationship among the study variables, with all long-run coefficients statistically significant at the 1% level. The exchange rate exerts a positive effect of 1.9314 (Z = 8.928), indicating a very high exchange rate pass-through whereby Rupiah depreciation significantly increases inflation in the long run. Conversely, the BI Rate has a significant negative effect of −0.0917 (Z = −6.464). Although consistent with monetary transmission theory, the small magnitude of the coefficient reflects the still-limited effectiveness of the interest rate instrument compared to the exchange rate's influence.

The insignificance of the ECT coefficient (−0.0554, p = 0.263) indicates a substantive empirical finding rather than model misspecification; the VECM remains valid given the confirmed cointegration relationship (trace statistic = 40.9465 > the

critical value of 29.7961). The result indicates that only 5.54% of disequilibrium is corrected monthly (18-month full adjustment horizon) and, together with the insignificance of all short-run lag 1 dynamics, confirms the presence of pronounced inflation inertia driven by structural rigidities and adaptive expectations (Engle & Granger, 1987; Johansen, 1988).

Impulse Response Function (IRF)

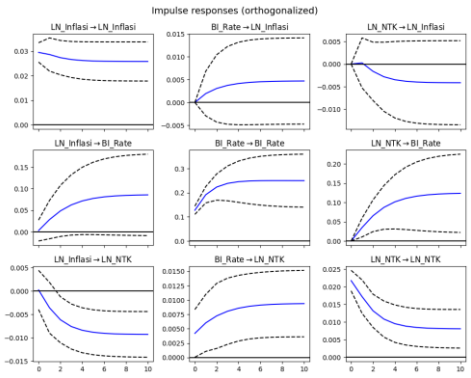

Figure 1. Impulse Response Function Results

Impulse Response Function (IRF) analysis reveals that inflation responds positively to a BI Rate shock, with a peak at period 3 (the price puzzle), and negatively to an exchange rate shock up to period 4, consistent with pass-through theory. Conversely, the BI Rate responds positively to both inflation and exchange rate shocks, reflecting Bank Indonesia's anticipatory policy stance in line with the Taylor Rule (Taylor, 1993). The persistence of responses through period 10 confirms slow monetary policy transmission, requiring 8–10 months to fully take effect.

Variance Decomposition (VD)

Table 5. Results of Variance Decomposition Analysis (Period 10)

Response of	**Inflation**	**BI Rate**	**Exchange Rate**
Inflation	97.16%	1.09%	1.75%
BI Rate	7.97%	79.33%	12.70%
Exchange Rate	18.66%	19.64%	61.70%

The Variance Decomposition results in Table 5 reinforce the IRF findings by showing that inflation's self-shock accounts for 97.16%. This confirms the presence of very strong inflation inertia in Indonesia, where adaptive expectations are more dominant than the influence of policy instruments in the short run.

The three-variable specification reflects a parsimonious approach to isolating the monetary transmission channel; the sample size of T = 109 observations constrains model dimensionality to avoid over-parameterization (Lütkepohl, 2005). Nevertheless, the dominant inflation self-shock (97.16%) indicates that nonmonetary structural factors, such as commodity price movements and fiscal impulses, remain outside the model's scope, constituting an acknowledged limitation. Future research is encouraged to extend the framework by incorporating exogenous indicators, such as global commodity price indices or proxies for financial market uncertainty.

CONCLUSION

This study establishes a significant long-run equilibrium relationship among the BI rate, the exchange rate, and inflation in Indonesia (trace statistic = 40.9465 > the critical value = 29.7961). The estimated cointegrating equation, $\ln(Inflation) = 1.9314 \ln(exchange\ Rate) - 0.0917 BI\ Rate - 22.8453$ confirms a strong exchange rate pass-through effect, with the exchange rate elasticity (1.9314) approximately 21 times greater than the interest rate coefficient (0.0917), both significant at α = 1% ($Z - 8.928$ and $Z = -6.464$). The ECT of −0.0554 implies a slow adjustment speed of 5.54% per month (18-month convergence horizon), while variance decomposition confirms dominant inflation inertia (self-shock: 97.16%). These findings indicate that monetary policy transmission operates primarily through the exchange rate channel, warranting prioritization of Rupiah stability and forward-looking communication strategies to anchor inflation expectations. Future studies may improve explanatory power by extending the model with global commodity price indices or financial market uncertainty indicators.

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