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RESEARCH ARTICLE

Interdependence of Gold Prices and Macroeconomic Variables Using A Vector Autoregression (VAR) Approach

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ABSTRACT
This study examines the dynamic interdependence between gold prices and selected macroeconomic variables in Indonesia, namely inflation, exchange rates, and interest rates, using a Vector Autoregression (VAR) approach. The study uses annual time-series data from 1990 to 2024. The empirical procedure includes the Augmented Dickey-Fuller unit root test, optimal lag length selection, VAR stability test, Granger causality test, Johansen cointegration test, Impulse Response Function, and Forecast Error Variance Decomposition. The VAR model is estimated using stationary first-differenced variables because no long-run cointegration relationship is detected among the variables. The results show that the relationships among gold prices, inflation, exchange rates, and interest rates are partial and mostly unidirectional. Exchange rates significantly influence inflation and interest rates, while inflation significantly influences interest rates. However, domestic macroeconomic variables have relatively weak direct effects on gold prices in the short run. Gold price fluctuations are primarily explained by their own innovations, although interest rate shocks generate a negative response in gold prices, supporting the opportunity cost channel. This study provides updated evidence on gold price dynamics in Indonesia and shows that gold prices are embedded in an asymmetric macroeconomic transmission system. The findings offer implications for investors, policymakers, and financial institutions in understanding gold as a partial hedging asset in an emerging market context.

1. INTRODUCTION

Gold has long been recognized as a strategic financial asset because of its ability to preserve value during periods of macroeconomic instability, inflationary pressure, and financial market uncertainty. Unlike interest-bearing assets, gold does not generate periodic returns, yet it remains attractive because of its liquidity, durability, and perceived role as a hedge and safe-haven asset. Previous studies show that gold may function as a hedge against inflation in the long run and as a safe haven during periods of extreme financial stress, although its effectiveness may vary across countries, market conditions, and crisis periods (Bampinas & Panagiotidis, 2015; Baur & McDermott, 2010; Bredin et

al., 2015; Shahzad et al., 2020). This suggests that gold price movements cannot be understood solely from commodity market dynamics, but must also be examined in relation to broader macroeconomic and monetary conditions.

In Indonesia, gold plays an important role not only as a traditional store of value but also as an increasingly accessible investment instrument. The expansion of digital financial services, gold savings products, and online investment platforms has widened public participation in gold investment, particularly among younger and retail investors. Recent evidence from Hasanuddin Economics and Business Review shows that gold prices can influence investment motivation among Generation Z in Indonesia, indicating that domestic investors increasingly treat gold as part of financial planning and portfolio management rather than merely as a consumption or cultural asset (Habbe et al., 2025). This is also consistent with studies emphasizing the importance of financial literacy and investor beliefs in shaping investment decision-making (Mediaty et al., 2025). Therefore, understanding the macroeconomic determinants of gold prices is increasingly important for investors, policymakers, and financial institutions in Indonesia.

Macroeconomic theory suggests that gold prices are closely linked to inflation, exchange rates, and interest rates through several transmission channels. Inflation may increase demand for gold because investors seek to protect the real value of their assets when purchasing power declines. Exchange rate depreciation may raise domestic gold prices because gold is internationally priced in U.S. dollars, making local gold prices sensitive to movements in the rupiah. Meanwhile, interest rates affect gold prices through the opportunity cost channel; when interest rates rise, interest-bearing assets become more attractive relative to gold, thereby potentially reducing gold demand (Beckmann et al., 2019; Reboredo, 2014; Tiwari et al., 2019). These relationships are particularly relevant for Indonesia as an open emerging economy, where exchange rate movements, inflation dynamics, and monetary policy adjustments interact with external shocks and domestic investment behavior.

Although the literature on gold prices and macroeconomic variables is extensive, several gaps remain. First, many studies focus on global markets, developed economies, or specific crisis periods, while empirical evidence from emerging economies such as Indonesia remains relatively limited. Second, previous studies often examine the relationship between gold prices and individual macroeconomic variables separately, whereas inflation, exchange rates, and interest rates may interact dynamically within a broader macroeconomic system. Third, limited attention has been given to how gold price dynamics are connected to domestic investment behavior in a period of growing financial digitalization and retail investment participation. Addressing these gaps is important because gold prices in Indonesia may be shaped not only by global market forces, but also by domestic macroeconomic transmission mechanisms and investor responses to uncertainty.

Therefore, this study aims to analyze the dynamic interdependence between gold prices and selected macroeconomic variables in Indonesia, namely inflation, exchange rates, and interest rates, using a Vector Autoregression (VAR) approach. The study uses

annual data from 1990 to 2024 and applies a sequence of time-series procedures, including stationarity testing, optimal lag selection, model stability testing, Granger causality, Johansen cointegration, Impulse Response Function, and Forecast Error Variance Decomposition. This study contributes to the literature by providing updated evidence on gold price dynamics in Indonesia, clarifying the transmission channels among macroeconomic variables, and offering implications for investment strategy and macroeconomic policy in an emerging market context. Practically, the findings are expected to help investors better understand the role of gold in portfolio allocation and assist policymakers in assessing how inflation, exchange rate movements, and interest rate changes interact with domestic gold price dynamics.

2. LITERATURE REVIEW

Gold has been widely examined in financial economics because of its distinctive role as a store of value, portfolio diversifier, inflation hedge, and safe-haven asset. Unlike financial assets that generate interest or dividend income, gold derives its investment value from scarcity, liquidity, durability, and investor perceptions of stability during periods of macroeconomic uncertainty. Baur and McDermott (2010) argue that gold may act as a safe haven during episodes of extreme financial market stress, although its effectiveness differs across countries and market conditions. Similarly, Bredin et al. (2015) show that gold can provide hedging and safe-haven benefits over specific investment horizons, while Shahzad et al. (2020) emphasize that the role of gold as a hedge or safe haven depends on market regimes and crisis intensity. Beckmann et al. (2019) further argue that uncertainty affects gold price dynamics differently across time frequencies and market conditions. These findings suggest that gold does not behave uniformly across all economic conditions, making country-specific empirical investigation necessary, particularly in emerging economies where macroeconomic volatility, exchange rate uncertainty, and financial market depth differ from those of developed economies.

Inflation is one of the most important macroeconomic variables associated with gold price movements. Theoretically, gold is expected to have a positive relationship with inflation because investors tend to shift toward real assets when purchasing power declines. Bampinas and Panagiotidis (2015) demonstrate that gold and silver can function as inflation hedges over the long run, while Tiwari et al. (2019) provide evidence that the inflation-hedging property of gold may vary across quantiles and market conditions. Earlier studies also suggest that gold may preserve purchasing power over longer horizons, although the short-run relationship between gold and inflation can be unstable due to monetary policy changes, market expectations, and financial volatility (Blose, 2010; Capie et al., 2005; Wang et al., 2011). During periods of heightened uncertainty, inflation may increase the demand for gold by strengthening the perception that gold preserves real wealth more effectively than financial assets whose real returns

are eroded by rising prices (Mensi et al., 2020; Salisu et al., 2020). However, the inflation-hedging role of gold is not always stable because gold may respond more strongly to inflation expectations, inflation uncertainty, or broader macroeconomic instability than to realized inflation alone.

Exchange rates represent another important channel through which macroeconomic conditions affect domestic gold prices. Since gold is internationally traded and priced in U.S. dollars, movements in the domestic currency directly influence the local currency value of gold. When the rupiah depreciates against the U.S. dollar, the domestic price of gold tends to increase because purchasing gold becomes more expensive in local currency terms. Conversely, rupiah appreciation may reduce domestic gold prices by lowering the local cost of internationally priced gold. Beyond this currency valuation mechanism, exchange rate movements may also influence gold prices through the financial risk channel. Currency depreciation often signals macroeconomic instability, external imbalance, or declining investor confidence, which may increase demand for safe-haven assets such as gold. Reboredo (2013) finds that gold may serve as a hedge or safe haven against U.S. dollar movements, while Reboredo (2014) shows that gold can provide hedging benefits against currency risk across different investment horizons. Beckmann et al. (2015) also demonstrate that the relationship between gold prices and exchange rates involves causality and volatility transmission, indicating that exchange rate effects operate not only through price conversion but also through uncertainty and market risk.

The exchange rate channel is particularly relevant for Indonesia as an open emerging economy. Rupiah movements are affected by global interest rate changes, commodity price cycles, foreign capital flows, and external uncertainty. Exchange rate depreciation may increase inflation through imported goods prices, influence monetary policy responses, and alter investor preferences toward assets perceived as more stable. Empirical studies in international markets show that the interaction between gold and currency markets may be nonlinear and time-varying, especially during periods of financial stress and global uncertainty (Balcilar et al., 2016; Beckmann et al., 2019; Bouri et al., 2020). These findings imply that gold price dynamics in Indonesia should not be examined only through a direct bilateral relationship with the exchange rate, but within a broader macroeconomic system involving inflation and interest rate adjustments.

Interest rates influence gold prices mainly through the opportunity cost channel. Because gold does not generate periodic income, higher interest rates increase the relative attractiveness of interest-bearing instruments such as deposits, bonds, and other fixed-income assets. When interest rates rise, investors may reduce their allocation to gold because the opportunity cost of holding a non-yielding asset becomes higher. Conversely, lower interest rates reduce the return advantage of financial assets and may increase demand for gold as an alternative store of value. This mechanism is consistent with studies showing that gold price dynamics are influenced by monetary policy conditions, bond market movements, and uncertainty in financial markets (Beckmann et al., 2019; Bredin et al., 2015; Blose, 2010). In a broader commodity pricing framework,

interest rate changes may affect commodity prices through storage costs, expectations, liquidity conditions, and portfolio allocation decisions (Frankel, 2008; Hamilton, 2009). Therefore, the interest rate–gold relationship should be interpreted not only as a direct asset-substitution effect, but also as part of monetary policy transmission and investor risk reallocation.

In Indonesia, the interest rate channel is closely linked to inflation management and exchange rate stabilization. Bank Indonesia may adjust policy rates in response to inflationary pressure or rupiah depreciation, meaning that interest rate movements are often part of a broader macroeconomic response system. When inflation rises, monetary authorities may increase interest rates to maintain price stability. When the rupiah depreciates sharply, interest rate adjustments may also be used to support currency stability and investor confidence. These interactions imply that inflation, exchange rates, and interest rates may influence gold prices both directly and indirectly. Therefore, a dynamic multivariate framework is required to capture the interaction among these variables and to identify whether gold prices are driven mainly by their own internal dynamics or by macroeconomic shocks.

The Indonesian context provides an important setting for examining gold price dynamics because gold has both cultural and financial significance. Traditionally, gold has been used as a store of value and household wealth preservation instrument. More recently, the development of digital financial services, gold savings products, and online investment platforms has expanded access to gold investment, particularly among retail and younger investors. Evidence from Hasanuddin Economics and Business Review shows that gold price perceptions can influence investment motivation among Generation Z in Indonesia, indicating that gold price movements may shape investment intentions among young investors (Habbe et al., 2025). In a related context, Mediaty et al. (2025) show that financial literacy and beliefs influence investment decision-making, suggesting that investor knowledge affects how individuals respond to financial information and investment opportunities. These studies indicate that gold price movements should be understood not only through macroeconomic variables but also through changing investor behavior, financial literacy, and financial inclusion dynamics in Indonesia.

Although inflation, exchange rates, and interest rates are often examined as separate determinants of gold prices, these variables are theoretically interconnected. Inflation may influence monetary policy responses, exchange rate depreciation may increase imported inflation, and interest rate adjustments may affect both exchange rates and investor portfolio allocation. These interactions suggest that gold price dynamics are embedded in a broader macroeconomic system. A single-equation model may be insufficient to capture feedback mechanisms and dynamic responses among variables. A Vector Autoregression (VAR) approach is therefore appropriate because it treats all variables as endogenous and allows dynamic interactions among gold prices, inflation, exchange rates, and interest rates to be examined simultaneously (Hamilton, 1994; Lütkepohl, 2005; Sims, 1980). Through Granger causality, the direction of

predictive relationships among variables can be identified; through Impulse Response Function analysis, the response of each variable to shocks in other variables can be traced over time; and through Forecast Error Variance Decomposition, the relative contribution of each variable in explaining fluctuations within the system can be assessed (Enders, 2010; Granger, 1969; Johansen, 1988).

Based on the literature, this study argues that gold prices in Indonesia are shaped by three main macroeconomic transmission channels. First, inflation may affect gold prices through the purchasing power preservation channel. Second, exchange rates may affect gold prices through the currency valuation and financial risk channels. Third, interest rates may affect gold prices through the opportunity cost and monetary policy channels. However, the strength and direction of these relationships may vary across time and depend on the interaction among macroeconomic variables. Therefore, this study examines the dynamic interdependence between gold prices and macroeconomic variables in Indonesia using a VAR framework, with particular attention to how inflation, exchange rates, and interest rates interact with domestic gold price movements in an emerging market context.

3. METHODOLOGY

This study uses secondary annual time-series data covering the period from 1990 to 2024. The use of annual data is intended to capture the long-term macroeconomic dynamics between gold prices and selected macroeconomic variables in Indonesia. Based on the observation period, the study consists of 35 observations. The variables examined are gold prices, inflation, exchange rates, and interest rates. Gold prices are measured in Indonesian rupiah per gram, inflation and interest rates are measured in annual percentages, and exchange rates are measured as the Indonesian rupiah against the United States dollar. Gold price data were obtained from domestic gold price publications and related economic statistics, while inflation, exchange rate, and interest rate data were collected from official publications of Bank Indonesia and Badan Pusat Statistik.

The empirical analysis applies a Vector Autoregression (VAR) approach, originally introduced by Sims (1980), to examine the dynamic interdependence among gold prices and macroeconomic variables. The VAR framework is appropriate because it treats all variables in the system as endogenous and allows each variable to be explained by its own lagged values and the lagged values of other variables. This feature enables the model to capture feedback effects and short-run dynamic interactions among gold prices, inflation, exchange rates, and interest rates without imposing strong prior restrictions on causal ordering (Hamilton, 1994; Lütkepohl, 2005). In this study, the VAR framework is used to examine whether shocks to inflation, exchange rates, and interest rates affect gold prices and whether gold price movements also transmit information to domestic macroeconomic variables.

Before estimating the VAR model, the stationarity properties of the variables were examined using the Augmented Dickey-Fuller (ADF) unit root test. This step is important because the use of non-stationary time-series data may produce spurious regression results and misleading statistical inference (Enders, 2010). The model specification was determined based on the integration order of the variables and the Johansen cointegration test. If the variables are stationary at level, a VAR model in levels is appropriate. If the variables become stationary after differencing and no cointegration relationship is found, a VAR model in first differences is used. If the variables are non-stationary but cointegrated, a Vector Error Correction Model (VECM) is more appropriate because it captures both short-run dynamics and long-run equilibrium adjustment (Engle & Granger, 1987; Johansen, 1988). Based on the empirical testing procedure, most variables were stationary after first differencing and no cointegration relationship was detected. Therefore, this study estimates a VAR model using first-differenced variables. The use of first differences also helps ensure that the estimated model is based on stationary series and is appropriate for analyzing short-run dynamic interactions among the variables.

The first-difference VAR model consists of four endogenous variables: gold prices, inflation, exchange rates, and interest rates. The general specification of the model is expressed as follows:

$$\Delta GOLD_t = \alpha_1 + \sum_{j=1}^{p} \beta_{11,j}\,\Delta GOLD_{t-j} + \sum_{j=1}^{p} \beta_{12,j}\,\Delta INF_{t-j} + \sum_{j=1}^{p} \beta_{13,j}\,\Delta ER_{t-j} + \sum_{j=1}^{p} \beta_{14,j}\,\Delta i_{t-j} + \varepsilon_{1t} \quad (1)$$

$$\Delta INF_t = \alpha_2 + \sum_{j=1}^{p} \beta_{21,j}\,\Delta GOLD_{t-j} + \sum_{j=1}^{p} \beta_{22,j}\,\Delta INF_{t-j} + \sum_{j=1}^{p} \beta_{23,j}\,\Delta ER_{t-j} + \sum_{j=1}^{p} \beta_{24,j}\,\Delta i_{t-j} + \varepsilon_{2t} \quad (2)$$

$$\Delta ER_t = \alpha_3 + \sum_{j=1}^{p} \beta_{31,j}\,\Delta GOLD_{t-j} + \sum_{j=1}^{p} \beta_{32,j}\,\Delta INF_{t-j} + \sum_{j=1}^{p} \beta_{33,j}\,\Delta ER_{t-j} + \sum_{j=1}^{p} \beta_{34,j}\,\Delta i_{t-j} + \varepsilon_{3t} \quad (3)$$

$$y\Delta i_t = \alpha_4 + \sum_{j=1}^{p} \beta_{41,j}\,\Delta GOLD_{t-j} + \sum_{j=1}^{p} \beta_{42,j}\,\Delta INF_{t-j} + \sum_{j=1}^{p} \beta_{43,j}\,\Delta ER_{t-j} + \sum_{j=1}^{p} \beta_{44,j}\,\Delta i_{t-j} + \varepsilon_{4t} \quad (4)$$

where ΔGOLD represents the first difference of gold prices, ΔINF represents the first difference of inflation, ΔER represents the first difference of the exchange rate, and ΔINT represents the first difference of interest rates. The term α denotes the intercept, p represents the optimal lag length, β, γ, δ, and θ denote the estimated coefficients, and ε represents the error term.

After stationarity testing, the optimal lag length was determined using information criteria, including the Akaike Information Criterion, Schwarz Criterion, and Hannan-Quinn Criterion. Selecting the appropriate lag length is important because an insufficient lag may omit relevant dynamics, while an excessive lag may reduce the degrees of freedom, particularly in a model with a relatively limited number of annual observations. After the optimal lag was determined, the stability of the VAR model was tested using the inverse roots of the autoregressive characteristic polynomial. A VAR model is considered stable when all roots lie inside the unit circle, indicating that the system is non-explosive and suitable for further dynamic analysis (Lütkepohl, 2005).

The Granger causality test was then used to identify the direction of predictive relationships among the variables (Granger, 1969). This test examines whether past values of one variable contain useful information for predicting another variable within the VAR system. In this study, Granger causality is used to assess whether inflation, exchange rates, and interest rates help predict gold price movements and whether gold prices help predict domestic macroeconomic variables. The Johansen cointegration test was also conducted to determine whether a long-run equilibrium relationship exists among the variables. Since no cointegration relationship was found, the subsequent analysis was conducted using the VAR model in first differences rather than a VECM specification.

Finally, the study employed Impulse Response Function and Forecast Error Variance Decomposition to analyze the dynamic behavior of the variables. The Impulse Response Function traces the response of each variable to one-standard-deviation shocks in other variables within the VAR system, thereby showing the direction, magnitude, and duration of shock transmission over time. Forecast Error Variance Decomposition complements this analysis by identifying the proportion of forecast error variance in each variable that can be attributed to shocks from itself and from other variables (Enders, 2010; Lütkepohl, 2005). Together, Granger causality, IRF, and FEVD provide a comprehensive framework for examining the dynamic interdependence among gold prices, inflation, exchange rates, and interest rates in Indonesia.

4. RESULTS

Before estimating the Vector Autoregression (VAR) model, the stationarity properties of all variables were examined using the Augmented Dickey-Fuller (ADF) unit root test. The results show that inflation is stationary at level, while gold prices, exchange rates, and interest rates become stationary after first differencing. This indicates that the variables satisfy the stationarity requirement for VAR estimation after being transformed into stationary form.

Table 1. Results of the Augmented Dickey-Fuller (ADF) Unit Root Test

Equation	Order of Integration Test	Statistic (Prob)	Critical Value
GOLD	I(1)	-3,714810 (0,0084)	-2,954021
INF	I(0)	-4,256150 (0,0000)	-2,981038

ER	I(1)	-7,174123 (0,0000)	-2,954021
i	I(1)	-3,546057 (0,0140)	-2,971853

Source: Secondary data regression by authors (2026)

The next step was to determine the optimal lag length. The lag selection results indicate that lag 2 is the most appropriate specification because most information criteria, including LR, FPE, AIC, and HQ, select lag 2. Although the Schwarz Criterion indicates lag 1, the use of lag 2 is considered more appropriate because it captures more dynamic interactions among the variables while remaining feasible given the available annual observations.

Table 2. Results of the Optimal Lag Length Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-732,3462	NA	1.14e+15	46.02164	46.20486	46.08237
1	-615.6981	196.8437	2.14e+12	39.73113	40.64722*	40.03479
2	-592.9913	32.64108*	1.48e+12*	39.31196*	40.96091	39.85854*
3	-579.9845	15.44554	2.04e+12	39.49903	41.88085	40.28854

Source: Secondary data regression by authors (2026)

The VAR stability test was then conducted by examining the roots of the characteristic polynomial. The results show that all modulus values are below one, indicating that the VAR model satisfies the stability condition. This means that the model is non-explosive and suitable for subsequent dynamic analysis, including Granger causality, Impulse Response Function, and Forecast Error Variance Decomposition.

Table 3. Results of the Stability Model Test

Root	Modulus
0.992267	0.992267
0.627711 - 0.384929i	0.736337
0.627711 + 0.384929i	0.736337
0.722716	0.722716
-0.245993 - 0.535266i	0.589086
-0.245993 + 0.535266i	0.589086
-0.395072	0.395072
0.143739	0.143739

Source: Secondary data regression by authors (2026)

Table 3 indicates that there are no characteristic roots or modulus values exceeding one. This implies that the VAR model fulfills the condition of stability, as all roots lie within the unit circle. This condition is crucial because it confirms that the VAR model is stable and does not exhibit explosive behavior, thereby ensuring that the estimated results are valid and reliable. The stability condition is further illustrated by the reciprocal roots of the AR polynomial as presented below.

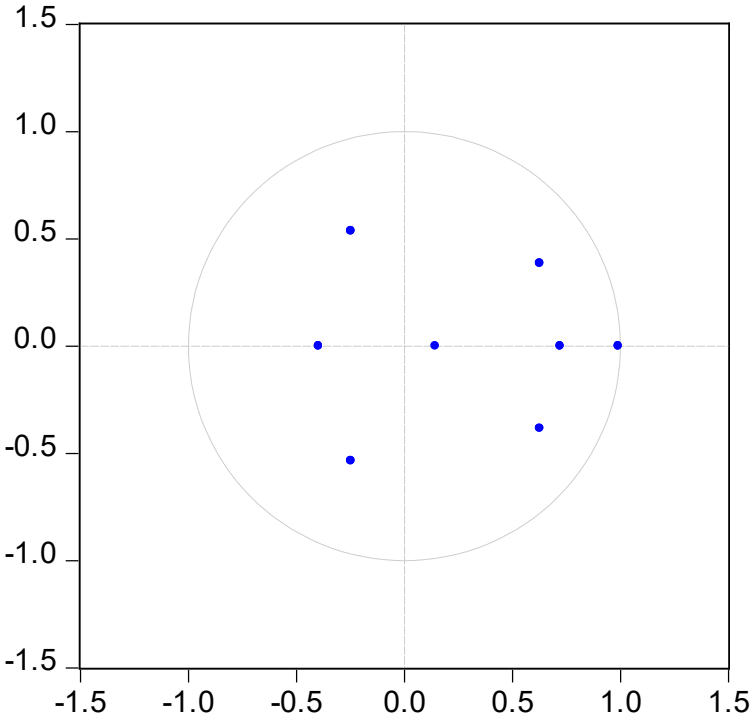

Figure 1. Result of Stability Model Test
Source: Secondary data regression by authors (2026)

The Granger causality results indicate that the dynamic relationships among gold prices, inflation, exchange rates, and interest rates are mostly unidirectional rather than fully reciprocal. At the 5 percent significance level, exchange rates are found to Granger-cause inflation, inflation is found to Granger-cause interest rates, and exchange rates are found to Granger-cause interest rates. In addition, several relationships are weakly significant at the 10 percent level, including gold prices to inflation, exchange rates to gold prices, and interest rates to exchange rates.

Table 4. Results of the Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
INF does not Granger Cause GOLD	33	0.24004	0.7882
GOLD does not Granger Cause INF		3.29451	0.0519
ER does not Granger Cause GOLD	33	2.70115	0.0846
GOLD does not Granger Cause ER		1.99212	0.1553
i does not Granger Cause GOLD	33	1.12916	0.3376
GOLD does not Granger Cause i		2.48387	0.1016
ER does not Granger Cause INF	33	4.44231	0.0211
INF does not Granger Cause ER		1.92108	0.1653
i does not Granger Cause INF	33	2.12077	0.1388
INF does not Granger Cause i		4.66424	0.0179
i does not Granger Cause ER	33	2.72397	0.0830
ER does not Granger Cause i		10.6266	0.0004

Source: Secondary data regression by authors (2026)

These results show that exchange rates play an important role in the macroeconomic system. Exchange rates significantly influence inflation and interest rates, suggesting that currency movements may transmit external shocks into domestic

price dynamics and monetary policy conditions. Inflation also significantly influences interest rates, indicating that interest rate movements respond to inflationary dynamics. However, the direct causal relationship between macroeconomic variables and gold prices is relatively weak. Inflation does not significantly cause gold prices, while exchange rates only weakly predict gold prices at the 10 percent level. Gold prices also weakly predict inflation at the 10 percent level, suggesting that the link between gold prices and inflation is present but not strong at the conventional 5 percent significance level.

The Johansen cointegration test was conducted to determine whether the variables share a long-run equilibrium relationship. The results show that the trace statistics are lower than the 5 percent critical values across all hypothesized cointegrating equations. Therefore, the null hypothesis of no cointegration cannot be rejected. This indicates that gold prices, inflation, exchange rates, and interest rates do not exhibit a stable long-run cointegrating relationship during the period of analysis. Accordingly, the VAR model in first differences is used for the subsequent dynamic analysis.

Table 5. Results of the Johansen Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.391782	36.21767	47.85613	0.1005
At most 1	0.355770	23.38014	28.68707	0.1748
At most 2	0.275364	8.909122	17.48371	0.1267
At most 3	0.111507	2.573609	6.841445	0.4110

Source: Secondary data regression by authors (2026)

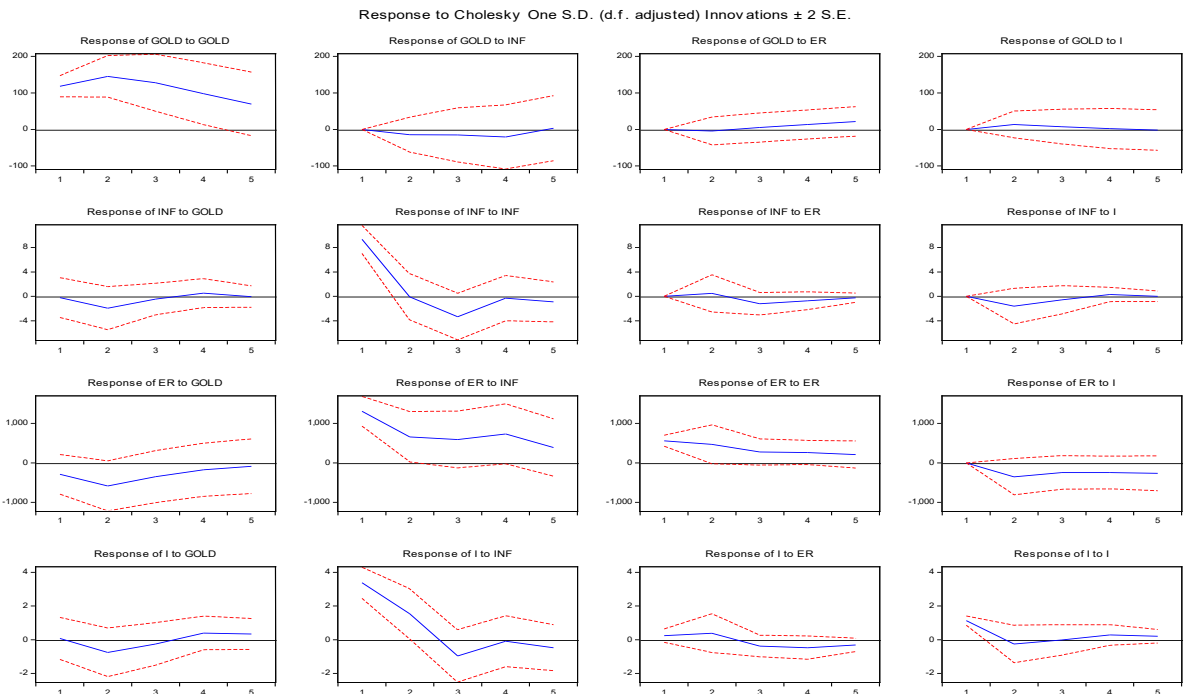

Figure 2. Result the Impulse Respond Test of Gold Prices, Inflation, Exchange Rates, and Interest Rates
Source: Secondary data regression by authors (2026)

The Impulse Response Function results indicate that the effects of shocks are generally temporary. The variables respond more strongly in the early periods and gradually move toward equilibrium over the forecast horizon. Gold prices respond positively to exchange rate shocks but show relatively weak responses to inflation shocks. Meanwhile, gold prices respond negatively to interest rate shocks, suggesting that an increase in interest rates tends to reduce the attractiveness of gold as a non-yielding asset. Overall, the IRF results indicate that gold prices are relatively stable in the short run and do not show strong sensitivity to macroeconomic shocks.

The Forecast Error Variance Decomposition results provide further evidence regarding the relative contribution of each variable to fluctuations in the system. The FEVD of gold prices shows that gold price variations are primarily explained by their own shocks. In period 1, gold price variation is fully explained by its own innovation. By period 5, gold prices still explain 97.30 percent of their own forecast error variance, while inflation contributes 1.30 percent, exchange rates contribute 1.04 percent, and interest rates contribute 0.37 percent. This indicates that short-run gold price movements are largely driven by internal dynamics, while the contribution of macroeconomic variables remains limited over the five-period horizon.

Table 6. Results the Variance Decomposition of Gold Prices

Period	S.E.	GOLD	INF	ER	i
1	118.0416	100.0000	0.000000	0.000000	0.000000
2	188.1481	98.84137	0.591713	0.055202	0.511710
3	228.1155	98.60643	0.847758	0.088387	0.457425
4	249.3789	97.85251	1.394816	0.359999	0.392676
5	259.8526	97.29632	1.300938	1.036743	0.366002

Source: Secondary data regression by authors (2026)

For inflation, the FEVD results show that inflation is also mainly explained by its own shocks. In period 1, inflation explains 99.95 percent of its own forecast error variance. By period 5, this contribution declines to 91.11 percent, while gold prices contribute 3.98 percent, interest rates contribute 2.77 percent, and exchange rates contribute 2.14 percent. These results indicate that inflation dynamics are largely internal in the short run, although the role of other variables gradually increases over time.

The FEVD of exchange rates shows that exchange rate movements are initially explained mainly by inflation and their own shocks. In period 1, inflation accounts for 81.18 percent of the forecast error variance of exchange rates, while exchange rates account for 14.86 percent and gold prices account for 3.96 percent. By period 5, inflation remains the dominant contributor at 66.30 percent, followed by exchange rates at 15.00 percent, gold prices at 12.13 percent, and interest rates at 6.58 percent. These results suggest that inflation plays a central role in explaining exchange rate variability during the forecast horizon.

For interest rates, the FEVD results show that inflation is the dominant source of variation. In period 1, inflation explains 89.51 percent of the forecast error variance of interest rates, while the interest rate's own shocks explain only 10.01 percent. By period 5, inflation continues to explain the largest share at 83.10 percent, followed by the

interest rate's own shocks at 8.13 percent, gold prices at 5.04 percent, and exchange rates at 3.73 percent. This indicates that interest rate dynamics are strongly associated with inflationary shocks.

Table 7. Summary of Forecast Error Variance Decomposition in Period 5

Dependent Variable	GOLD	INF	ER	INT	Main Contributor
GOLD	97.30	1.30	1.04	0.37	GOLD
INF	3.98	91.11	2.14	2.77	INF
ER	12.13	66.30	15.00	6.58	INF
INT	5.04	83.10	3.73	8.13	INF

Source: Secondary data regression by authors (2026)

Overall, the empirical results show that the dynamic interdependence among gold prices and macroeconomic variables in Indonesia is partial rather than fully reciprocal. Gold prices are mainly driven by their own innovations in the short run, while the contribution of inflation, exchange rates, and interest rates remains relatively limited. However, inflation emerges as a key macroeconomic variable in the broader system because it contributes substantially to variations in exchange rates and interest rates. The results also indicate that exchange rates significantly influence inflation and interest rates, reinforcing the role of exchange rate movements in transmitting external shocks into domestic macroeconomic conditions. These findings provide a basis for further discussion on gold's role as a hedge, the opportunity cost channel, and the implications of macroeconomic stability for domestic investment decisions.

5. CONCLUSION

The findings of this study show that the dynamic relationship between gold prices and macroeconomic variables in Indonesia is partial rather than fully reciprocal. The Granger causality results indicate that most statistically significant relationships occur among macroeconomic variables, particularly from exchange rates to inflation, from inflation to interest rates, and from exchange rates to interest rates. In contrast, the direct causal relationship between inflation, exchange rates, interest rates, and gold prices is relatively weak. This suggests that gold price movements in Indonesia are not fully determined by domestic macroeconomic variables in the short run. Instead, gold prices appear to be strongly influenced by their own internal dynamics, market expectations, and possibly external factors not directly captured in the model. This finding is consistent with previous studies showing that the role of gold as a hedge or safe haven may vary across countries, market conditions, time horizons, and macroeconomic regimes (Baur & McDermott, 2010; Bredin et al., 2015; Shahzad et al., 2020).

The weak short-run causal relationship between inflation and gold prices provides important insight into the inflation-hedging role of gold in Indonesia. Although gold is commonly viewed as an asset that protects purchasing power, the empirical results suggest that domestic inflation does not strongly predict gold price movements at the conventional significance level. This may indicate that Indonesian gold prices respond

not only to realized inflation but also to broader factors such as global gold prices, exchange rate expectations, international uncertainty, investor sentiment, and monetary policy credibility. The FEVD results further show that gold price variations are dominated by their own shocks, while inflation contributes only a limited share within the five-period horizon. Therefore, gold may function as a partial inflation hedge in Indonesia, but its hedging role is not immediate or mechanically driven by domestic inflation alone. This supports the argument that the inflation-hedging property of gold is time-varying and may depend on the investment horizon, inflation expectations, and macroeconomic uncertainty (Bampinas & Panagiotidis, 2015; Tiwari et al., 2019; Wang et al., 2011).

The exchange rate results highlight the importance of currency movements in Indonesia's macroeconomic transmission mechanism. Exchange rates significantly influence inflation and interest rates, indicating that rupiah movements may transmit external shocks into domestic prices and monetary policy responses. This finding is highly relevant for Indonesia as an open emerging economy, where exchange rate depreciation can raise import costs, increase inflationary pressure, and encourage monetary authorities to adjust interest rates to maintain macroeconomic stability. Although the exchange rate only weakly predicts gold prices, its indirect role remains important because exchange rate movements affect both inflation and interest rate dynamics. This finding is consistent with the currency valuation and financial risk channels, where domestic gold prices are influenced by the rupiah value of internationally priced gold and by investor responses to currency uncertainty (Beckmann et al., 2015; Reboredo, 2013, 2014).

The IRF results provide further support for the opportunity cost channel. Gold prices respond negatively to interest rate shocks, indicating that higher interest rates may reduce the attractiveness of gold as a non-yielding asset. When interest rates increase, investors may prefer deposits, bonds, or other interest-bearing instruments because these assets provide periodic returns. This reduces the relative appeal of gold, particularly for investors who compare gold with financial assets in portfolio allocation decisions. This finding is consistent with the theoretical view that interest rates affect gold demand through the opportunity cost of holding a non-yielding asset (Beckmann et al., 2019; Blose, 2010; Frankel, 2008). However, the relatively weak contribution of interest rates to gold price variance suggests that the opportunity cost channel exists but is not the dominant driver of gold price movements in the Indonesian context.

The FEVD results also show that inflation plays a central role in the broader macroeconomic system, particularly in explaining variations in exchange rates and interest rates. This finding indicates that inflationary dynamics remain highly relevant for monetary policy and macroeconomic stability in Indonesia. The dominance of inflation in explaining interest rate movements is consistent with the policy response mechanism, where monetary authorities adjust interest rates to manage inflationary pressure. At the same time, the relationship between exchange rates and inflation reflects the imported inflation channel, where currency depreciation may increase the domestic price of imported goods and production inputs. These results suggest that gold price dynamics

should not be interpreted in isolation, but within a broader macroeconomic environment shaped by inflation, exchange rate movements, and monetary policy responses.

From an investment perspective, the findings imply that Indonesian investors should treat gold as a useful but not risk-free or fully predictable hedging instrument. Since short-run gold price movements are primarily driven by their own innovations, investors should not rely solely on domestic inflation, exchange rates, or interest rates to predict gold price changes. Instead, gold investment decisions should consider both domestic macroeconomic fundamentals and external factors such as global gold prices, international interest rates, geopolitical risk, and U.S. dollar movements. This is particularly important as digital investment platforms and gold savings products expand access to gold investment among retail and younger investors in Indonesia. Evidence from Hasanuddin Economics and Business Review suggests that gold price perceptions influence investment motivation among Generation Z, while financial literacy shapes investment decision-making more broadly (Habbe et al., 2025; Mediaty et al., 2025). Therefore, strengthening financial literacy is essential so that investors understand both the benefits and limitations of gold as a portfolio asset.

From a policy perspective, the results suggest that exchange rate stability and inflation management remain important for maintaining broader financial and investment stability. Although domestic macroeconomic variables do not strongly determine gold prices in the short run, exchange rate movements and inflation dynamics influence the macroeconomic environment in which investment decisions are made. Policymakers should therefore continue to monitor the interaction between currency depreciation, inflationary pressure, and interest rate responses, particularly during periods of global uncertainty. For financial institutions and investment platforms, the findings highlight the need to provide transparent information regarding the risks and determinants of gold price movements. Gold should be communicated not only as a safe-haven asset but also as an asset whose price may be affected by global markets, exchange rate movements, monetary conditions, and investor sentiment.

Overall, this study contributes to the literature by showing that gold price dynamics in Indonesia are embedded in a broader but asymmetric macroeconomic system. The results support the relevance of the inflation-hedging, exchange-rate, and opportunity-cost channels, but also demonstrate that these channels operate with different strengths. Gold prices are relatively stable and mainly driven by their own shocks in the short run, while inflation and exchange rates play a more central role in the broader macroeconomic transmission process. These findings reinforce the importance of using a dynamic multivariate framework, such as VAR, to examine the interaction among gold prices and macroeconomic variables in emerging market contexts.

6. CONCLUSION

This study examines the dynamic interdependence between gold prices and macroeconomic variables in Indonesia using a Vector Autoregression (VAR) approach with annual data from 1990 to 2024. The findings indicate that the relationships among gold prices, inflation, exchange rates, and interest rates are partial and mostly unidirectional rather than fully reciprocal. The Granger causality results show that exchange rates significantly influence inflation and interest rates, while inflation significantly influences interest rates. However, the direct causal relationships between domestic macroeconomic variables and gold prices are relatively weak, suggesting that short-run gold price movements in Indonesia are not fully explained by inflation, exchange rate, or interest rate changes alone.

The Impulse Response Function results show that gold prices respond weakly to inflation and exchange rate shocks but respond negatively to interest rate shocks, supporting the opportunity cost channel in which higher interest rates reduce the attractiveness of gold as a non-yielding asset. The Forecast Error Variance Decomposition results further indicate that gold price fluctuations are primarily explained by their own innovations, while the contributions of inflation, exchange rates, and interest rates remain relatively limited over the forecast horizon. Nevertheless, inflation emerges as an important variable in the broader macroeconomic system because it contributes substantially to variations in exchange rates and interest rates. These findings suggest that gold may serve as a partial hedging asset in Indonesia, but its role is not immediate, uniform, or fully driven by domestic macroeconomic fundamentals.

This study contributes to the literature by providing updated empirical evidence on gold price dynamics in Indonesia and by showing that gold prices are embedded in an asymmetric macroeconomic transmission system. Practically, the findings suggest that investors should consider gold as part of a diversified portfolio while also recognizing that domestic macroeconomic variables alone may not be sufficient to predict gold price movements. Policymakers should continue to maintain inflation and exchange rate stability, as these variables influence the broader financial environment in which investment decisions are made. This study is limited by the use of annual data and a relatively small number of observations, which may restrict the ability to capture higher-frequency market responses. Future research may use monthly or quarterly data, incorporate global variables such as world gold prices, U.S. interest rates, oil prices, geopolitical risk, and financial uncertainty indices, and compare alternative models such as VECM, ARDL, SVAR, or time-varying parameter models to obtain deeper insights into gold price dynamics in emerging markets.

Author Contributions

S.S.W: Conceptualization, Methodology, Formal Analysis, Writing (Original Draft Preparation).

N.Z: Supervision, Writing (Review & Editing).
F: Data Curation, Investigation.
C.Z.R: Literature Review, Data Collection.
N.A: Visualization, Data Interpretation.
T.B: Review, Validation.

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