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Article

# Volatility Spillover Effect of Macroeconomic Indicators on Inflation: A BEKK-GARCH Approach

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*Abstract*

This study aims to examine the transmission of macroeconomic volatility—specifically, exchange rates and bond yield spreads—to inflation volatility, using monthly data from January 2012 to December 2024. The research begins with univariate modeling, employing GARCH and EGARCH to elucidate the volatility characteristics of each variable. The findings indicate that inflation and exchange rates exhibit asymmetric volatility, while the bond yield spread demonstrates a symmetric pattern. Furthermore, this study uses a multivariate BEKK-GARCH methodology to examine the influence of volatility from key macroeconomic indicators—specifically, the exchange rate and bond yield spread—on inflation in Indonesia. The results of the BEKK-AGARCH(1,1) model demonstrate significant volatility spillovers, notably a bidirectional link between inflation and the currency rate. Furthermore, this analysis confirms an asymmetric spillover effect from bond yield spreads to inflation, indicating that inflation volatility is more profoundly affected by negative shocks in the bond market than by positive shocks. The research highlights the necessity of monitoring macroeconomic volatility, as it profoundly affects the efficacy of monetary policy and inflation stability. This research offers policymakers crucial information to build more flexible methods for addressing inflation threats in an ever-evolving macroeconomic environment.

**Keywords:** volatility spillover; inflation; bond yield spread; exchange rate; BEKK-AGARCH; Indonesia.

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## 1. Introduction

Inflation is integral to a nation's economic equilibrium and is intricately associated with long-term growth and stability (Portes, 1979). As a prominent developing country in Southeast Asia, Indonesia faces considerable hurdles in managing inflation while aiming for consistent and sustainable economic growth. Fluctuations in inflation rates have a significant impact on various economic aspects, including price stability, people's living standards, and purchasing power.

Price stability, as reflected by low and stable inflation, is a key component of overall economic stability (Poole & Wheelock, 2008; Kiley, 2024). This economic stability is a primary goal for all countries in improving public welfare. Unstable and uncontrolled inflation can undermine people's ability to purchase goods and services, disrupt financial planning, and create severe economic pressures (Sekarsari *et al.*, 2024). Changes in purchasing power not only reflect the economic conditions of a country but also have broad implications for social welfare and stability.

Indonesia's inflation was highly uncontrolled following the 1998 Monetary Crisis. Nevertheless, starting from 2017 to 2023, Indonesia began to show improvements in managing annual inflation, as reflected in the declining and stabilizing inflation trends among the ASEAN-5 countries. In addition, Indonesia's annual inflation has started to align with the inflation targets set by Bank Indonesia and the Ministry of Finance, as stated in Minister of Finance Regulations (PMK) No. 124 of 2017 and No. 101 of 2021, which set the target range at 1.5% to 4% (Kementerian Keuangan RI, 2017, 2021). However, unstable inflation trends remain a challenge in maintaining price stability, resulting in uncertainty, investor hesitation, difficulties in directing monetary policy, and changing of people's purchasing power.

Changes in people's purchasing power not only reflect a country's economic condition but also have broad implications for social welfare and stability. Therefore, the movement of a country's inflation rate is an important aspect to monitor. The inflation trends of ASEAN-5 countries from 2000 to 2023 are visualized in Figure 1.

Figure 1 shows that in 2023, Indonesia ranked third among ASEAN-5 countries in terms of the lowest year-on-year (Y-on-Y) inflation rate, following Thailand and Malaysia. However, from 2000 to 2016, Indonesia had previously experienced the highest and most volatile inflation in the ASEAN-5 region. The high and extremely volatile inflation during this period was a prolonged consequence of various economic challenges in Indonesia, such as the global oil price surge, depreciation of the rupiah which triggered imported inflation, an increase in the money supply without a corresponding rise in real output, and structural weaknesses in the economy (Atmadja, 1999; Ginting, 2016; Yanti & Soebagiyo, 2022). In addition, Indonesia experienced deflation for five consecutive months from May to September 2024 (Month-to-Month) (BPS, 2024). This indicates that the control of monthly inflation in Indonesia is still not optimal.

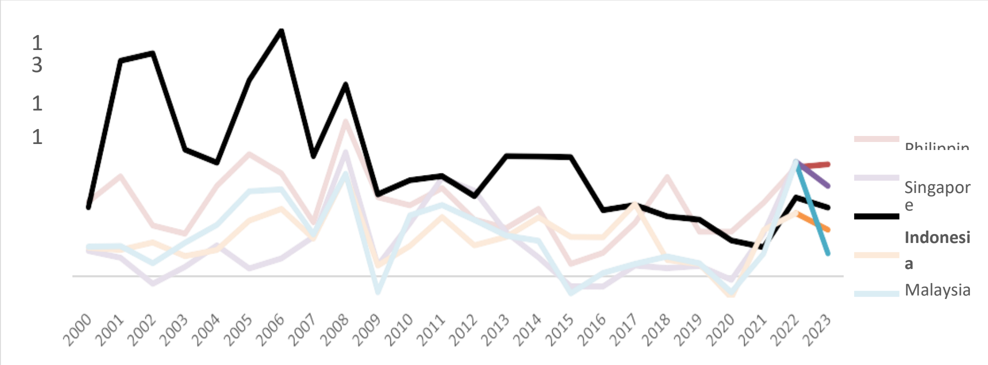



**Figure 1.** Inflation Trends of ASEAN-5 Countries from 2000 to 2023 (Year-on-Year, %)
**Source***:* World Bank (processed)

Inflation management in Indonesia is often influenced by various factors, such as exchange rate movements, as well as domestic political conditions and fiscal policies (Desfitra *et al.*, 2024). According to the inflation disaggregation defined by Statistics Indonesia (BPS), exchange rates are part of the core inflation component, which is affected by external conditions and fundamental factors (Bank Indonesia, 2025). Therefore, Indonesia's inflation management is highly dependent on the volatility of macroeconomic indicators.

The formulation of monetary policy has a significant impact on a country's inflation. One of the monetary policy tools that can be used to control inflation is maintaining exchange rate stability (Luwihadi & Arka, 2017). The exchange rate is one of the macroeconomic indicators used in stock market activities, financial markets, and international trade. Therefore, exchange rate instability will affect investment and trade flows, ultimately leading to more volatile domestic inflation (Perlambang, 2010; Setyawati *et al.*, 2024).

Interest rates indicate the trajectory of monetary policy, as evidenced by the disparity between long-term and short-term bond yields (Sun, 2020; Timmer, 2018). The bond yield spread, representing the difference between long-term and short-term bond yields, indicates the financial stress of the money market and may forecast future changes in economic activity (Ozcelebi *et al.*, 2024). A narrower bond yield differential may indicate increased confidence in the economy, as individuals perceive fewer significant dangers that could adversely affect it in the future. This elevated trust can attract additional investors, strengthen the domestic currency, enhance the economy, and ultimately mitigate inflation. Research in Indonesia has demonstrated that bond interest rates can influence inflation and vice versa (Astari & Badjra, 2018; Fauziyah, 2015; Janah & Pujiati, 2018; Listiawati & Paramita, 2018; Purwanti & Purwidianti, 2017; R *et al.*, 2000; N. W. L. N. Sari & Abundanti, 2015). The volatility of bond yield spreads complicates the maintenance of steady inflation in Indonesia.

An evolving economy is an excellent opportunity for analysis, as fluctuations in macroeconomic indicators influence individual variables and significantly impact inflation volatility in Indonesia. Understanding the fluctuations of inflation is crucial, since it can impede economic growth by rendering prices and inflation unpredictable (Judson & Orphanides, 1999; Rastogi & Kanoujiya, 2023, 2024). The spillover effects illustrate how alterations in macro-level variables can diminish consumer purchasing power and escalate production costs, hence exacerbating price volatility.

When macroeconomic indicators exhibit significant volatility, they can exert both direct and indirect influences on inflation, frequently operating in unequal manners. When this occurs, price increases typically exert a greater impact than price decreases. Research by Mello & Moccero (2009) indicates that increased alterations in monetary policy may elevate inflation expectations, complicating inflation control. Inflation often responds more vigorously to upward shocks than to downward shocks. This indicates the presence of disparate volatility patterns. Consequently, it is essential to identify and analyze these spillover tendencies to formulate policies that can more effectively regulate inflation and mitigate its adverse impacts on the Indonesian economy.

Numerous studies examine the relationship between macroeconomic indicators and inflation; however, few investigate how fluctuations in these indicators influence inflation (Rastogi & Kanoujiya, 2024). Previous studies predominantly focused on establishing causal relationships or forecasting trends, frequently overlooking the importance of volatility. In Indonesia, the majority of research has concentrated on the impact of individual macroeconomic indicators on inflation, neglecting the influence of their collective volatility on inflation. This mismatch indicates that additional research is required to examine the impact of fluctuations in macroeconomic indices on inflation in Indonesia.

## 2. Methods

This study uses secondary data obtained from Statistics Indonesia (BPS), Bank Indonesia (BI), and the Investing.com website. The study period spans from January 2012 to December 2024, using monthly data comprising 156 series or observations. The selection of research variables is based on theory, data availability, and the significance of volatility to produce more robust and relevant results. The variables analyzed are inflation, exchange rate, and bond yield spread. The inflation variable used is the Consumer Price Index (CPI) inflation, while the exchange rate refers to the selling rate. The bond yield spread variable is calculated as the difference between the yields of 10-year and 5-year government bonds.

In this study, the author begins by examining whether inflation, bond yield spread, and exchange rate exhibit volatility through univariate volatility modeling using GARCH or EGARCH. If volatility is found, the analysis proceeds to multivariate modeling using either BEKK-GARCH or BEKK-AGARCH. EViews 12 is the software used for conducting the univariate volatility analysis. When the univariate results indicate asymmetric volatility (modeled using EGARCH), the corresponding multivariate model applied is BEKK-AGARCH. On the other hand, if the univariate volatility is symmetric, the multivariate approach used is BEKK-GARCH.

### 2.1. Symmetric Univariate Model

A univariate time series model involves modeling a variable using only the information contained in its own past values and possibly the past values of the residuals or error terms (Brooks, 2008). When both the past values of the variable and its residuals are used, the approach is referred to as modeling the *conditional mean* and is typically done using ARMA models. In addition to modeling the conditional mean, univariate models in finance often focus on volatility. Volatility, commonly measured by the standard deviation or the variance of returns, serves as a rough indicator of the total risk associated with a financial asset.

Volatility modeling aims to capture the conditional variance of residuals, which fluctuates over time according to preceding residuals and their historical variances. The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is a frequently utilized framework for this objective. Researchers commonly employ the Maximum Likelihood Estimation (MLE) method to estimate model parameters (Brooks, 2008). The full specification of the univariate time series model is as follows:

*Conditional Mean* $Y_t$ (ARMA)

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=1}^{q} \beta_j u_{t-j} + u_t \quad (1)$$

*Conditional Variance* $\sigma_t^2$ (GARCH)

$$\sigma_t^2 = \omega + \sum_{i=1}^{r} \gamma_i u_{t-i}^2 + \sum_{j=1}^{s} \theta_j \sigma_{t-j}^2 \quad (2)$$

Conditions:

$$\omega > 0$$
$$\gamma_i \geq 0$$
$$\theta_j \geq 0$$
$$0 \leq \sum_{i=1}^{s} \gamma_i + \sum_{j=1}^{r} \theta_j < 1$$

Explanation of terms:

$\alpha_0$ : Intercept coefficient in the ARMA model

$\alpha_i$ : *i-th* autoregressive (AR) coefficient, where $i = 1, 2, ..., p$

$\beta_j$ : *j-th* moving average (MA) coefficient, where $j = 1, 2, ..., q$

$u_t$ : White noise error term at time $t$

$u_{t-j}$ : *j-th* lag of the white noise error term, where $j = 1, ..., q$

$Y_t$ : Time series variable at time $t$

$Y_{t-i}$ : *i-th* lag of the time series variable, where $i = 1, ..., p$

${\sigma^2}_t$ : Conditional variance of the error term at time $t$ (from the variance equation)

$\omega$ : Intercept coefficient in the GARCH variance equation

$\gamma_i$ : *i-th* ARCH coefficient, where $i = 1, ..., r$

$u_{t-i}$ : *i-th* lag of the white noise error term from the ARMA model, where $i = 1, ..., r$

$\theta_j$ : *j-th* GARCH coefficient, where $j = 1, ..., s$

${\sigma^2}_{t-j}$ : *j-th* lag of the conditional variance, where $j = 1, ..., s$

The ARMA model is a stochastic framework that incorporates both the history values of a variable and its previous error terms or white noise components (Makridakis *et al.*, 1997).

Thus, Equation 1 delineates an autoregressive moving average model of order ARMA(p, q). The GARCH model enhances the ARCH methodology by integrating both historical error terms and previous conditional variances (Engle & Kroner, 1995). This improvement enables the model to maintain simplicity while retaining its explanatory power. Thus, Equation 2 can be expressed as a GARCH(s, r) model. The outcomes derived from both ARIMA and GARCH estimations are evaluated utilizing identical assessment methods, including joint (simultaneous) and partial significance testing. The symmetric univariate model is chosen according to consistent criteria: the maximum log-likelihood value and the minimum AIC and SBC values. The notion of parsimony is a fundamental criterion for identifying the optimal model.

## 2.2. Asymmetric Univariate Model

The standard GARCH model has a key limitation: it imposes a symmetric response to volatility resulting from both positive and negative shocks (Brooks, 2008). Equation (2) uses squared lagged residuals, which eliminates information about whether the shocks are positive or negative. In reality, economic and financial conditions often show that negative shocks tend to trigger a greater increase in volatility compared to positive shocks of the same magnitude. This phenomenon is known as the leverage effect.

According to Brooks (2008), one of the most widely used asymmetric univariate models is the Exponential GARCH (EGARCH) model. The Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model is an extension of the GARCH model that allows for the presence of asymmetry or leverage effects in volatility (Nelson, 1991). Below is the conditional variance equation for the EGARCH(1,1) model (Enders, 2014).

$$ln\, ln\, (\sigma_t^2) = \omega + \gamma \left|\frac{u_{t-1}}{\sigma_{t-1}}\right| + \theta ln(\sigma_{t-1}) + \varphi \left(\frac{u_{t-1}}{\sigma_{t-1}}\right) \quad (3)$$

Explanation of terms:

$\omega$ : Intercept coefficient

$\gamma$ : ARCH coefficient

$\left|\frac{u_{t-1}}{\sigma_{t-1}}\right|$ : Absolute value of the standardized residual from time *t-1*

$\theta$ : GARCH coefficient

$\sigma_{t-1}$ : Conditional variance of the error term at time *t-1*

$\varphi$ : EGARCH coefficient (captures the asymmetry or leverage effect)

$\left(\frac{u_{t-1}}{\sigma_{t-1}}\right)$ : Standardized residual at time *t-1*

## 2.3. Multivariate Model

The main limitation of univariate volatility models is that they estimate the conditional variance of each series independently from others (Brooks, 2008). However, many situations in economics and finance are better suited to multivariate modeling than univariate approaches. According to Brooks (2008), a key advantage of multivariate models is their ability to analyze volatility spillovers between markets or assets. Volatility spillover refers to the tendency of volatility in one market or asset to change in response to volatility shifts in another (Enders, 2014). Additionally, the covariance between time series data is also important to analyze, not just their individual variances. Multivariate GARCH models can accommodate this need, offering a significant advantage over univariate models.

One such multivariate GARCH model is the Baba, Engle, Kraft, and Kroner GARCH (BEKK-GARCH) model. BEKK-GARCH addresses the limitations found in earlier multivariate models, such as the VECH model. It defines the covariance matrix in a more structured way and applies constraints that ensure the resulting covariance estimates remain positive definite (Kroner & Ng, 1998). The estimation method used for BEKK- GARCH is Maximum Likelihood Estimation (MLE). As with univariate models, the BEKK-GARCH model requires an iterative process to find the optimal coefficients, as there is no closed-form solution for maximizing the likelihood function. The asymmetric BEKK model (BEKK-AGARCH) is an extension of the standard BEKK model that incorporates a squared term based on the outer product of negative shocks to capture asymmetric effects (Kroner & Ng, 1998). The BEKK-AGARCH(p,q) model is specified as follows.

$$\sum_t = C'C + \sum_{i=1}^{p} A_i'(\varepsilon_{t-i}\varepsilon_{t-i}')A_i + \sum_{j=1}^{q} B_j'\sum_{t-j}B_j + \sum_{l=1}^{r} D'_l(\underline{\varepsilon}_{t-l}\underline{\varepsilon}_{t-l}')D_l \quad (4)$$

$$\sum_t = [\sigma_{11,t}\ \sigma_{12,t} \cdots \sigma_{1s,t} \cdots \sigma_{1k,t}\ \sigma_{21,t}\ \sigma_{22,t} \cdots \sigma_{2s,t} \cdots \vdots \vdots \ddots \cdots \cdots \vdots\ \sigma_{m1,t}\ \sigma_{m2,t} \cdots \sigma_{ms,t} \cdots \sigma_{mk,t} \vdots\ \vdots \cdots \cdots \ddots \vdots\ \sigma_{k1,t}\ \sigma_{k2,t} \cdots \sigma_{ks,t} \cdots \sigma_{kk,t}]$$

$$A_i = [\alpha_{11,t-i}\ \alpha_{12,t-i} \cdots \alpha_{1s,t-i} \cdots \alpha_{1k,t-i}\ \alpha_{21,t-i}\ \alpha_{22,t-i} \vdots \vdots \ddots \cdots \cdots \vdots\ \alpha_{m1,t-i}\ \alpha_{m2,t-i} \cdots \alpha_{ms,t-i} \cdots \alpha_{mk,t-i} \vdots\ \vdots \cdots \cdots \ddots\ \vdots\ \alpha_{k1,t-i}\ \alpha_{k2,t-i} \cdots \alpha_{ks,t-i} \cdots \alpha_{kk,t-i}]$$

$$B_j = [\beta_{11,t-j}\ \beta_{12,t-j} \cdots \beta_{1s,t-j} \cdots \beta_{1k,t-j}\ \beta_{21,t-j}\ \beta_{22,t-j} \vdots \vdots \ddots \cdots \cdots \vdots\ \beta_{m1,t-j}\ \beta_{m2,t-j} \cdots \beta_{ms,t-j} \cdots \beta_{mk,t-j} \vdots \vdots \cdots \cdots \ddots \vdots\ \beta_{k1,t-j}\ \beta_{k2,t-j} \cdots \beta_{ks,t-j} \cdots \beta_{kk,t-j}]$$

$$C = [c_{11}\ 0 \cdots 0 \cdots 0\ c_{21}\ c_{22} \cdots 0 \cdots 0 \vdots \vdots \ddots \cdots \cdots \vdots\ c_{m1}\ c_{m2} \cdots c_{ms} \cdots 0 \vdots\ \vdots \cdots \cdots \ddots\ \vdots\ c_{k1}\ c_{k2} \cdots c_{ks} \cdots c_{kk}]$$

$$D_l = [\gamma_{11,t-l}\ \gamma_{12,t-l} \cdots \gamma_{1s,t-l} \cdots \gamma_{1k,t-l}\ \gamma_{21,t-l}\ \gamma_{22,t-l} \cdots \vdots \vdots \ddots \cdots \cdots \vdots\ \gamma_{m1,t-l}\ \gamma_{m2,t-l} \cdots \gamma_{ms,t-l} \cdots \gamma_{mk,t-l} \vdots \vdots \cdots \cdots \ddots \vdots\ \gamma_{k1,t-l}\ \gamma_{k2,t-l} \cdots \gamma_{ks,t-l} \cdots \gamma_{kk,t-l}]$$

$$\varepsilon_{t-i} = [\varepsilon_{1,t-i}\ \varepsilon_{2,t-i} \vdots\ \varepsilon_{k,t-i}]$$

Condition:

$$\underline{\varepsilon}_t = \{1,\ if\ \varepsilon_t < 0\ 0, if\ \varepsilon_t \geq 0$$

Explanation of terms:

$\Sigma_t$ : conditional variance-covariance matrix at time $t$, with dimension $k \times k$, where $k$ is the number of assets/variables.

$\sigma_{ms,t}$ : conditional variance at time $t$, where $m$=1,2,…,$k$; $s$=1,2,…,$k$; $m = s$.

$\sigma_{ms,t}$ : conditional covariance between asset $m$ and $s$ at time $t$, where $m$ =1,2,…,$k$; $s$ =1,2,…,$k$; $m \neq s$.

$C$ : lower triangular matrix, where $C'C$ is a symmetric and positive definite matrix.

$A_i$ : ARCH coefficient matrix for the $i$-th equation with order $k \times k$, where $i=1,2,\dots,p$.

$\alpha_{ms,i}$ : ARCH effects of asset $m$ on the volatility of asset $m$ itself, where $m=1,2,\dots,k$; $s=1,2,\dots,k$; $m=s$.

$\alpha_{ms,i}$ : *cross*-ARCH *effects* from assay $m$ on the volatility of asset $s$, where $m=1,2,\dots,k$; $s=1,2,\dots,k$; $m \neq s$.

$\varepsilon_{t-i}$ : error vector at time $t-i$.

$\varepsilon_{t-i}\varepsilon'_{t-i}$ : error matrix at time $t-i$.

$B_j$ : GARCH coefficient matrix for the $j$-th equation with order $k \times k$, where $j=1,2,\dots,q$.

$\beta_{ms,j}$ : GARCH effects of asset $m$ on the volatility of asset $m$ itself, where $m=1,2,\dots,k$; $s=1,2,\dots,k$; $m=s$.

$\beta_{ms,j}$ : *cross*-GARCH *effects* from asset $m$ on the volatility of asset $s$, where $m=1,2,\dots,k$; $s=1,2,\dots,k$; $m \neq s$.

$D_l$ : asymmetric coefficient matrix for the $l$-th equation with order $k \times k$, where $l=1,2,\dots,r$.

$\gamma_{ms,l}$ : asymmetric effects, meaning the negative shock effects of asset $m$ on the volatility of asset $m$ itself, where $m=1,2,\dots,k$; $s=1,2,\dots,k$; $m=s$.

$\gamma_{ms,l}$ : cross-asymmetric effects, meaning the negative shock effects from asset $m$ on the volatility of asset $s$, where $m=1,2,\dots,k$; $s=1,2,\dots,k$; $m \neq s$.

$\underline{\varepsilon}_{t-l}$ : negative shock vector.

The parameters in matrices A, B, and D capture different types of volatility dynamics, both within individual markets and across markets. Specifically, the parameters $\alpha_{11}$, $\alpha_{22}$, $\alpha_{33}$, $\beta_{11}$, $\beta_{22}$, $\beta_{33}$, $\gamma_{11}$, $\gamma_{22}$, and $\gamma_{33}$ represent the volatility effects within their respective markets. In contrast, the other parameters capture volatility spillovers between markets. Using equation (4), we can derive the formulas for conditional variance and conditional covariance for BEKK-AGARCH(1,1), as shown below.

$$\sigma_{11,t} = c_{11}^2 + c_{21}^2 + c_{31}^2 + \alpha_{11}^2\varepsilon_{1,t-1}^2 + 2\alpha_{11}\alpha_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + 2\alpha_{11}\alpha_{31}\varepsilon_{1,t-1}\varepsilon_{3,t-1}$$
$$+\alpha_{21}^2\varepsilon_{2,t-1}^2 + 2\alpha_{21}\alpha_{31}\varepsilon_{2,t-1}\varepsilon_{3,t-1} + \alpha_{31}^2\varepsilon_{3,t-1}^2 + \beta_{11}^2\sigma_{11,t-1} + 2\beta_{11}\beta_{21}\sigma_{12,t-1}$$
$$+2\beta_{11}\beta_{31}\sigma_{13,t-1} + \beta_{21}^2\sigma_{22,t-1} + 2\beta_{21}\beta_{31}\sigma_{23,t-1} + \beta_{31}^2\sigma_{33,t-1}$$
$$+\gamma_{11}^2\underline{\varepsilon}_{1,t-1}^2 + 2\gamma_{11}d\gamma_{21}\underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{2,t-1} + 2\gamma_{11}\gamma_{31}\underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{3,t-1} + \gamma_{21}^2\underline{\varepsilon}_{2,t-1}^2$$

$$+2\gamma_{21}\gamma_{31}\underline{\varepsilon}_{2,t-1}\underline{\varepsilon}_{3,t-1} + \gamma_{31}^{2}\underline{\varepsilon}_{3,t-1}^{2}$$

$$\sigma_{22,t} = c_{22}^{2} + c_{32}^{2} + \alpha_{12}^{2}\varepsilon_{1,t-1}^{2} + 2\alpha_{12}\alpha_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + 2\alpha_{12}\alpha_{32}\varepsilon_{1,t-1}\varepsilon_{3,t-1} + \alpha_{22}^{2}\varepsilon_{2,t-1}^{2}$$

$$+2\alpha_{22}\alpha_{32}\varepsilon_{2,t-1}\varepsilon_{3,t-1} + \alpha_{32}^{2}\varepsilon_{3,t-1}^{2} + \beta_{12}^{2}\sigma_{11,t-1} + 2\beta_{12}\beta_{22}\sigma_{12,t-1}$$

$$+2\beta_{12}\beta_{32}\sigma_{13,t-1} + \beta_{22}^{2}\sigma_{22,t-1} + 2\beta_{22}\beta_{32}\sigma_{23,t-1} + \beta_{32}^{2}\sigma_{33,t-1}$$

$$+\gamma_{12}^{2}\underline{\varepsilon}_{1,t-1}^{2} + 2\gamma_{12}\gamma_{22}\underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{2,t-1} + 2\gamma_{12}d_{32}\underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{3,t-1} + \gamma_{22}^{2}\underline{\varepsilon}_{2,t-1}^{2}$$

$$+2\gamma_{22}\gamma_{32}\underline{\varepsilon}_{2,t-1}\underline{\varepsilon}_{3,t-1} + \gamma_{32}^{2}\underline{\varepsilon}_{3,t-1}^{2}$$

$$\sigma_{33,t} = c_{33}^{2} + \alpha_{13}^{2}\varepsilon_{1,t-1}^{2} + 2\alpha_{13}\alpha_{23}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + 2\alpha_{13}\alpha_{33}\varepsilon_{1,t-1}\varepsilon_{3,t-1}$$

$$+\alpha_{23}^{2}\varepsilon_{2,t-1}^{2} + 2\alpha_{23}\alpha_{33}\varepsilon_{2,t-1}\varepsilon_{3,t-1} + \alpha_{33}^{2}\varepsilon_{3,t-1}^{2} + \beta_{13}^{2}\sigma_{11,t-1} + 2\beta_{13}\beta_{23}\sigma_{12,t-1}$$

$$+2\beta_{13}\beta_{33}\sigma_{13,t-1} + \beta_{23}^{2}\sigma_{22,t-1} + 2\beta_{23}\beta_{33}\sigma_{23,t-1} + \beta_{33}^{2}\sigma_{33,t-1}$$

$$+\gamma_{13}^{2}\underline{\varepsilon}_{1,t-1}^{2} + 2\gamma_{13}\gamma_{23}\underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{2,t-1} + 2\gamma_{13}\gamma_{33}\underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{3,t-1}$$

$$+\gamma_{23}^{2}\underline{\varepsilon}_{2,t-1}^{2} + 2\gamma_{23}\gamma_{33}\underline{\varepsilon}_{2,t-1}\underline{\varepsilon}_{3,t-1} + \gamma_{33}^{2}\underline{\varepsilon}_{3,t-1}^{2}$$

The following outlines the research stages:

1. Descriptive Analysis: This initial phase aims to provide an overview of the development of strategic commodities, macroeconomic indicators, and inflation in Indonesia. This is achieved using line graphs and statistical measurements, primarily processed with Microsoft Excel[1].
2. Univariate Volatility Modeling: This comprehensive stage of inferential analysis focuses on modeling univariate volatility. It encompasses several sub-steps including stationarity testing of time series data; the formation, estimation, and testing of Autoregressive Moving Average (ARMA) models; diagnostic testing of ARMA models and ARCH-LM tests; the development and evaluation of Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models; and the construction and assessment of Asymmetric GARCH (EGARCH) models to capture asymmetric shock effects. Volatility calculations are derived from the best-fit asymmetric GARCH models for each variable
3. Multivariate Volatility Modeling: This final stage of inferential analysis specifically examines the volatility spillover effect from strategic commodities and macroeconomic indicators to inflation in Indonesia. This is accomplished using multivariate GARCH models, namely BEKK-GARCH and BEKK-AGARCH. The process involves estimating parameters using the Maximum Likelihood Estimation (MLE) method, conducting significance tests on BEKK-AGARCH model parameters, and performing diagnostic tests, including the portmanteau test for white noise residuals.

## 3. Results, Analysis, and Discussions

### 3.1. Descriptive Overview and Statistics

In this study, the researcher first conducts a descriptive analysis of inflation, bond yield spread, and exchange rate, as presented in Table 1. Table 1 and Figure 2 show that Indonesia's inflation was relatively volatile from 2012 to December 2024. Although the inflation rate remained generally low, its fluctuations were unstable, especially during 2013 and 2014. This instability was driven by high global crude oil prices, the Taper Tantrum, and the increase in subsidized fuel prices in 2012–2013.The inflation spike in 2022 was triggered by the Russia–Ukraine war, which disrupted global supply chains.

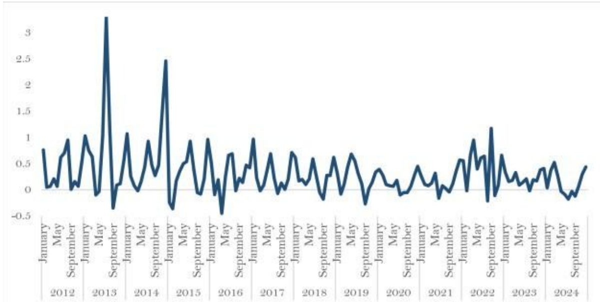
Indonesia also experienced five consecutive months of deflation from May to September 2024 (BPS, 2024). This deflation was attributed to falling food prices, weakened consumer purchasing power, and a potential decline in demand for goods and services. The persistent volatility in Indonesia’s inflation calls for special attention to ensure price stability.

Based on Table 1 and Figure 2, the bond yield spread experienced highly volatile movements, with an upward trend on a monthly basis. The development of the bond yield spread reflects movements in financial stress indicators within the money market, which signal potential future changes in actual economic activity (Ozcelebi *et al.*, 2024). Indonesia’s bond yield spread remains relatively narrow, ranging from 0 to 1 percent, with a maximum value of 1.26 percent and a minimum of -0.07 percent. A narrow spread reflects greater confidence in the economy, suggesting that there are no significant perceived risks affecting future economic performance. This growing confidence can lead to increased investor inflows, a strengthening of the domestic currency, economic growth, and ultimately more controlled inflation. The COVID-19 pandemic also had an impact on the research variables, including the bond yield spread, which saw a decline following the recovery in 2022.

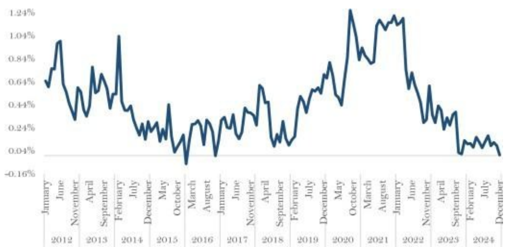
**Table 1.** Descriptive Summary of Research Variables

| Statistical Measure | Inflation | Bond Yield Spread | Exchange Rate |
|---|---|---|---|
| Mean | 0.32 | 0.45 | 13698.60 |
| Median | 0.21 | 0.39 | 14215.83 |
| Maximum | 3.29 | 1.26 | 16824.71 |
| Minimum | -0.45 | -0.07 | 9204.00 |
| Standard error | 0.45 | 0.32 | 1903.95 |

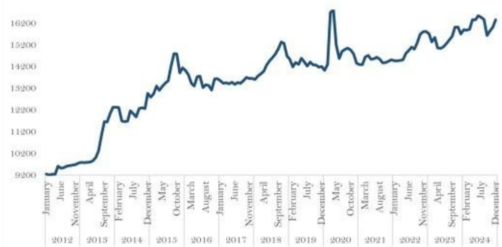
**Source***:* Author's data processing results, 2025



(a) Inflation



(b) Bond Yield Spread



(c) Exchange Rate

**Figure 2.** (a) Monthly Inflation, (b) Bond Yield Spread, and (c) Exchange Rate Fluctuations in Indonesia from January 2012 to December 2024 (M-to-M, %)

**Source***:* Author's data processing results, 2025

The IDR/USD exchange rate showed relatively volatile movements with an upward trend on a monthly basis. The upward trend in the IDR/USD rate indicates a depreciation of the Indonesian rupiah against the US dollar, which serves as the primary currency for international transactions (Mirović & Petrović, 2023). As a result, the weakening of the rupiah against the dollar leads to more expensive imported goods, driving up domestic prices in Indonesia and potentially prompting foreign investors to withdraw from the country. The IDR/USD exchange rate experienced its most significant shock in 2020, during the onset of the COVID- 19 pandemic.

### 3.2. GARCH/EGARCH Modelling

One of the most important assumptions in time series analysis is stationarity. Stationarity indicates that the mean, variance, and autocovariance (at various lags) remain constant over time. Data that meet the stationarity assumption can be generalized across different time periods and help avoid the issue of spurious regression (Gujarati & Porter, 2008). The stationarity test was conducted using the Augmented Dickey-Fuller (ADF) test, as presented in Table 2.

Table 2 presents the three variables that have met the stationarity assumption, as indicated by p-values below the significance level and non-significant trend components. The research variables have undergone the same transformation process, namely first-order differencing, applied to the exchange rate (IDR/USD), bond yield spread, and inflation. Following the stationarity test, the ARMA model was developed using the Box- Jenkins (BJ) approach as outlined by Gujarati & Porter (2008). This method consists of three main stages: identifying a preliminary model, estimating the parameters of the ARMA model, and performing diagnostic checks. The next section outlines the diagnostic evaluation carried out on the ARMA model.

**Table 2.** ADF Test Results of the Three Research Variables After Transformation

| Research Variables | Transformation | Test Statistic | ADF p-value | Trend p-value | Remark |
|---|---|---|---|---|---|
| Inflation | d(Inflation) | -11.69488 | <0.0001 | 0.8152 | Stationary |
| Bond Yield Spread | d(Bond Yield Spread) | -14.27247 | <0.0001 | 0.7665 | Stationary |
| Exchange Rate | d(Exchange Rate) | -10.98251 | <0.0001 | 0.3436 | Stationary |

**Source***:* Author's data processing results, 2025

Based on the model identification results using the order of *p* and *q* from the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF), and by testing various ARMA(p,q) orders, the best ARMA model was selected based on the highest log-likelihood value and the lowest values of the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC). The results of the best ARMA model are presented in Table 3.

**Table 3.** Results of the Best ARMA Model

| Research Variables | Model | ARCH-LM | ADF *p-value* | Conclusion |
|---|---|---|---|---|
| Inflation | AR(3) | 0.0003*** | <0.0001*** | There is an ARCH Effect |
| Bond Yield Spread | ARMA(3,3) | 0.0771* | <0.0001*** | There is an ARCH Effect |
| Exchange Rate | MA(2) | 0.0787* (*lag* 2) | <0.0001*** | There is an ARCH Effect |

**Note:** The ***, **, and * implies statistical significance at 1%, 5%, and 10% levels

**Source***:* Author's data processing results, 2025

Table 3 presents the best ARMA models for each of the three research variables. The best mean equation model for the exchange rate is MA(2), indicating that the IDR/USD exchange rate is influenced by other information or residuals from the past two periods. Additionally, the best mean equation model for the bond yield spread is ARMA(3,3), suggesting that the bond yield spread is affected by its own values from the previous three periods as well as residuals from the same time span. Finally, the optimal mean equation model for inflation is AR(3), indicating that current inflation is influenced by inflation from the preceding three periods.

Table 3 also shows that the bond yield spread, exchange rate (IDR/USD), and inflation variables have ADF residual *p*-values below the 0.05 significance level. This indicates that, at the 5% significance level, the residuals of all three variables have a constant mean of zero, thus meeting the white noise assumption. The ARCH-LM test results in Table 3 display varying levels of significance. The inflation variable shows a *p*-value below the 0.05 threshold, meaning that at the 5% significance level, the inflation residuals exhibit heteroskedasticity. Meanwhile, the bond yield spread and exchange rate variables have *p*-values below the 0.10 level, indicating that at the 10% significance level, both variables also show signs of heteroskedasticity in their residuals. Given that residuals from these three variables exhibit ARCH effects or heteroskedasticity, it is necessary to proceed with volatility modeling using ARCH or GARCH approaches.

As with ARMA modeling, the selection of the GARCH or EGARCH model begins with identifying the appropriate order of *p* and *q* using the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF), followed by testing various ARMA(p,q) specifications. The most suitable GARCH/EGARCH model was selected based on the highest log-likelihood value and the lowest values of the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC). The final selected models are summarized in Table 4.

Table 4 displays the optimal variance equation models for each of the three macroeconomic variables analyzed. For the exchange rate, the EGARCH(1,1) model was identified as the best fit, indicating that the volatility of the IDR/USD exchange rate is influenced by both past volatility and past residuals. Additionally, the variance equation reveals the existence of an asymmetric effect, as shown by a positive and statistically significant asymmetry coefficient at the 1% level. This result aligns with the findings of Wulansari *et al.* (2021).

In the case of the bond yield spread, the most appropriate model is ARCH(1), suggesting that its volatility is primarily driven by shocks from the previous period's residuals. However, this finding contrasts with the study by Lithin *et al.* (2023), which identified asymmetric effects in the volatility of India's bond yield spread.

Lastly, the best variance equation model for inflation is also EGARCH(1,1), indicating that inflation volatility is affected by residual shocks from the previous period. The inflation variance equation also displays an asymmetric effect, with a positive coefficient statistically significant at the 1% level. This finding contrasts with the study by Salsabila *et al.* (2022), which found no evidence of asymmetry in Indonesian inflation from January 1979 to April 2021. This condition occurred because the research period includes the COVID-19 pandemic and subsequent geopolitical turmoil, which made Indonesia's inflation significantly more sensitive to negative news.

In addition, Table 4 shows that the residuals of all three research variables have a constant mean of zero, indicating that they satisfy the white noise assumption. The results of the ARCH-LM test also show varying levels of significance. For the inflation variable, the *p*-value is above the 0.05 significance level, meaning that at the 5% level, the residuals are homoskedastic. Meanwhile, the crude oil price, exchange rate (IDR/USD), and bond yield spread variables show *p*-values above the 0.10 significance level, indicating that at the 10% level, the residuals of these variables are also homoskedastic. Therefore, the univariate models for all three research variables have met the required assumptions and passed the diagnostic tests.

**Table 4.** Results of the Best GARCH/EGARCH Model

| Research Variables | Model | ARCH-LM | ADF *p-value* | Conclusion |
|---|---|---|---|---|
| Inflation | EGARCH(1,1) | 0.0521 | <0.0001*** | Assumptions fulfilled |
| Bond Yield Spread | ARCH(1) | 0.8866 | <0.0001*** | Assumptions fulfilled |
| Exchange Rate | EGARCH(1,1) | 0.8955 | <0.0001*** | Assumptions fulfilled |

**Note:** The ***, **, and * implies statistical significance at 1%, 5%, and 10% levels

**Source***:* Author's data processing results, 2025

### 3.3. Volatility Spillover Effect

Enders (2014) states that volatility shocks in one variable can influence the volatility of other related variables, as captured by the multivariate GARCH model. The number of lags or the GARCH order also affects the model parameters; therefore, this study adopts a simplified version of the BEKK-GARCH model. The log- likelihood, Akaike Information Criterion (AIC), and Schwarz Criterion (SBC) are still employed to guide the selection of the best model (Tagliafichi, 2003). Based on the optimal model selection, the BEKK-AGARCH(1,1) model is used to explain the volatility spillover effect among the bond yield spread, exchange rate, and inflation. The general equation for the BEKK-AGARCH(1,1) model for (1) inflation, (2) bond yield spread, and (3) the IDR/USD exchange rate, estimated at the 5% significance level, is presented below.

$$\sum_t = C'C + A'(\varepsilon_{t-1}\varepsilon'_{t-1})A + B'\sum_{t-1}B + D'(\underline{\varepsilon}_{t-1}\underline{\varepsilon}'_{t-1})D \qquad (5)$$

$$[\hat{\sigma}_{11,t}\ \hat{\sigma}_{12,t}\ \hat{\sigma}_{13,t}\ \ \hat{\sigma}_{21,t}\ \hat{\sigma}_{31,t}\ \ \hat{\sigma}_{22,t}\ \hat{\sigma}_{23,t}\ \hat{\sigma}_{32,t}\ \hat{\sigma}_{33,t}\ ]$$
$$= [0.090\ \ -0.001\ -13.963\ 0.000\ 0.000\ \ 202.238^{*}\ 0.000\ 0.000\ \ -0.003\ ][0.090\ \ 0.000\ 0.000$$
$$-0.001\ 0.000\ \ 0.000\ \ -13.963\ 202.238^{*}\ \ -0.003\ ]$$
$$+ [0.721^{***}\ 26.857\ 0.000\ \ -0.000\ \ -0.113\ 1\times10^{-6**}\ \ -26.620$$
$$-18774.626\ 0.266^{***}\ ][\varepsilon^2_{1,t-1}\ \varepsilon_{1,t-1}\varepsilon_{2,t-1}\ \varepsilon_{1,t-1}\varepsilon_{3,t-1}\ \varepsilon_{2,t-1}\varepsilon_{1,t-1}\ \varepsilon^2_{2,t-1}\ \varepsilon_{2,t-1}\varepsilon_{3,t-1}\ \varepsilon_{3,t-1}\varepsilon_{1,t-1}\ \varepsilon_{3,t-1}\varepsilon_{2,t-1}\ \varepsilon^2_{3,t-1}\ ]$$
$$[0.721^{***}\ \ -0.000\ \ -26.620\ 26.857\ \ -0.113\ \ -18774.626\ 0.000\ 1\times10^{-6**}\ 0.266^{***}\ ]$$
$$+ [0.705^{***}$$
$$-15.603\ 1.320\times10^{-4***}\ 0.000\ 0.868^{***}\ -2$$
$$\times10^{-6***}\ -67.564^{**}\ 47782.468^{***}\ 0.695^{***}\ ][\sigma_{11,t-1}\ \sigma_{12,t-1}\ \sigma_{13,t-1}\ \sigma_{21,t-1}\ \sigma_{22,t-1}\ \sigma_{23,t-1}\ \sigma_{31,t-1}\ \sigma_{32,t-1}\ \sigma_{33,t-1}\ ]$$
$$[0.705^{***}\ 0.000\ -67.564^{**}\ \ -15.603\ 0.868^{***}\ 47782.468^{***}\ 1.320\times10^{-4***}\ -2\times10^{-6***}\ 0.695^{***}\ ]$$
$$+ [0.051\ -100.930^{**}\ 0.000\ 0.000\ \ -0.109\ 0.000\ 15.138$$
$$-15351.215\ 0.016\ ]\left[\underline{\varepsilon}^2_{1,t-1}\ \underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{2,t-1}\ \underline{\varepsilon}_{1,t-1}\underline{\varepsilon}_{3,t-1}\ \underline{\varepsilon}_{2,t-1}\underline{\varepsilon}_{1,t-1}\ \underline{\varepsilon}^2_{2,t-1}\ \underline{\varepsilon}_{2,t-1}\underline{\varepsilon}_{3,t-1}\ \underline{\varepsilon}_{3,t-1}\underline{\varepsilon}_{1,t-1}\ \underline{\varepsilon}_{3,t-1}\underline{\varepsilon}_{2,t-1}\ \underline{\varepsilon}^2_{3,t-1}\right]$$
$$[0.051\ 0.000\ 15.138\ -100.930^{**}\ \ -0.109\ \ -15351.215\ 0.000\ 0.000\ 0.016\ ]$$

**Note:** The ***, **, and * implies statistical significance at 1%, 5%, and 10% levels

Based on the model and the significance of the BEKK-AGARCH(1,1) estimation results for (1) inflation, (2) bond yield spread, and (3) the IDR/USD exchange rate, several types of analysis can be conducted: auto effect, news spillover effect, volatility spillover effect, and asymmetric spillover effect. Moreover, the interpretation of spillover coefficients cannot be directly compared because each variable has a different range. This is because the spillover from the source variable adopts the characteristics (numerical values) from the range of the initial variable relative to the resulting variable

### 3.4. Auto Effect

The auto effect can be observed through the main diagonal of matrices A, B, and D. At a one percent level of significance, matrix A indicates that only the inflation and exchange rate variables are significant in the news auto effect. These variables are influenced by their own past news shocks. This finding is consistent with the results of univariate volatility modeling for both variables, where past residuals have a significant impact on current volatility. However, in the univariate modeling, past residuals of the bond yield spread variable are also found to significantly affect its current volatility, which is not aligned with the findings from the auto effect in matrix A.

The volatility auto effect in matrix B shows that inflation, bond yield spread, and exchange rate variables are significant at the one percent level. In other words, the volatility of inflation, bond yield spread, and exchange rate is influenced by their own past volatility. These results are consistent with the univariate volatility models for the inflation and exchange rate variables, where current volatility is affected by past volatility. However, the auto effect of the bond yield spread variable in matrix B presents different findings compared to its univariate model.

Matrix D represents the asymmetric matrix in the BEKK-AGARCH modeling, where its main diagonal reflects the asymmetric auto effect. Based on the main diagonal of matrix D, none of the studied variables are statistically significant. This result is in line with the univariate findings for the bond yield spread, which shows no asymmetric effect. However, the absence of asymmetry contradicts the univariate modeling results for the inflation and exchange rate variables. The discrepancy in findings between the EGARCH and BEKK-AGARCH models is due to differences in model structures and the influence of other research variables, which lead to different levels of statistical significance.

### 3.5. News Spillover Effect

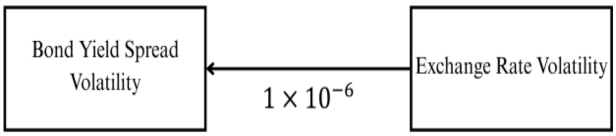



**Figure 3.** News Spillover Effect Diagram

**Source**: Author's data processing results, 2025

The elements of matrix A outside the main diagonal represent shocks or news effects caused by other variables. The news spillover effect is shown in Figure 3. Based on matrix A, no two-way spillover effect occurs. At the five percent significance level, there is a news spillover effect from the Rp/USD exchange rate on the bond yield spread ($\hat{\alpha}_{32}$=$1 \times 10^{-6}$) as shown in Figure 3. This indicates that $1 \times 10^{-10}$ percent ($\hat{\alpha}_{32}^2$=$1 \times 10^{-12}$) of the shock or fluctuation in the Rp/USD exchange rate from the previous month will be transmitted to the volatility of the bond yield spread in the current period. In other words, the news impact of the Rp/USD exchange rate has a very small, almost negligible (close to zero) effect on volatility.

The results of the news spillover effect analysis using the BEKK-AGARCH model show that although there is a statistically significant relationship between the shock of the Rp/USD exchange rate and the volatility of the Indonesian bond yield spread, its economic impact (macro-economically) can be considered insignificant. This is because the Indonesian bond market is more dominantly influenced by domestic fundamental factors, such as the monetary policy of Bank Indonesia (BI), especially the benchmark interest rate (Astuti & Hastuti, 2020), government fiscal conditions like budget deficits and new bond issuances (Muktiyanto & Aulia, 2019), and domestic investor sentiment, which is not highly reactive to daily exchange rate fluctuations.

This sentiment arises because the shock in the previous month's Rp/USD exchange rate is not considered a significant risk and is not viewed as economic uncertainty. Furthermore, bonds are considered long-term instruments that focus more on macroeconomic prospects and policy stability rather than short-term exchange rate movements, except in extreme cases (such as in 2008). Therefore, shocks/news from the Rp/USD exchange rate do not have a substantial impact on the volatility of the bond yield spread.

This finding aligns with the research by Maulidya *et al.* (2024) and Lestari (2020), who found that the Rp/USD exchange rate significantly affects bond yields with very small impacts (0.0001 and 0.004) using panel data regression and time series regression methods. Additionally, exchange rate depreciation is not always followed by an increase in bond yields. This is due to the high influx of foreign capital into portfolio investments in Indonesia, occurring simultaneously with the widening current account deficit (including the trade balance deficit) (Muktiyanto & Aulia, 2019). This study contrasts with the volatility spillover effect study by Rastogi *et al.* (2024), which did not show any significance between the exchange rate and the bond yield spread in India.

### 3.6. Volatility Spillover Effect

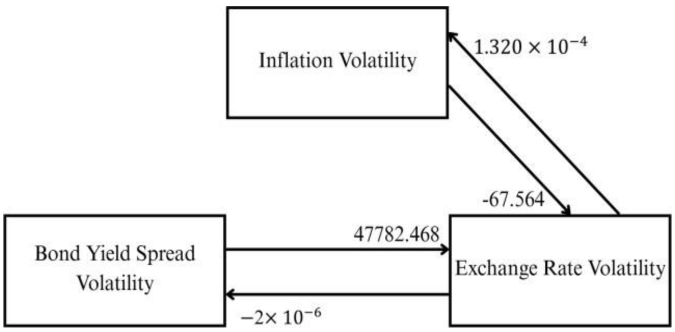



**Figure 4.** Volatility Spillover Effect Diagram

Source*:* Author's data processing results, 2025

The off-diagonal elements of matrix B represent the volatility effects transmitted by other variables. Figure 4 presents the volatility spillover diagram among the three variables. A bidirectional volatility spillover effect is observed between inflation and the exchange rate, as well as between the exchange rate and the bond yield spread. The analysis of the volatility spillover effects is as follows.

### 3.6.1 Volatility Spillover Effect Between Inflation and Exchange Rate

At a 5% significance level, a bidirectional volatility spillover effect is observed, indicating volatility transmission from the IDR/USD exchange rate to Indonesian inflation ($\hat{\beta}_{31}$=$1.320 \times 10^{-4}$) and vice versa, from Indonesian inflation to the IDR/USD exchange rate ($\hat{\beta}_{13}$ = -67.564), as shown in Figure 4. However, the large decimal values are still a result of the different ranges from exchange rate volatility to the inflation volatility. This bidirectional volatility spillover between inflation and the exchange rate suggests that volatility in one variable rapidly propagates to the other, particularly within Indonesia's macroeconomic context. However, this bidirectional relationship also presents complex challenges for Bank Indonesia in managing monetary policy. Any measure taken to control inflation may have direct implications for exchange rate stability, and vice versa. Consequently, this situation calls for a coordinated and holistic policy approach. The presence of this bidirectional volatility spillover effect supports the findings of Faizin (2020), who identified a long-term causal relationship between exchange rate and inflation using the Granger causality test. Furthermore, it is consistent with the study by Rastogi & Kanoujiya (2024), which found a bidirectional volatility spillover between inflation and exchange rate in India using the BEKK-GARCH model.

Figure 4 demonstrates that roughly $1.742 \times 10^{-6}$ percent of the prior month's exchange rate volatility ($\hat{\beta}_{31}^{2}$=$1.742 \times 10^{-8}$) is conveyed to the current period's inflation volatility in Indonesia. This outcome corroborates the Purchasing Power Parity (PPP) theory and the Exchange Rate Pass-Through (ERPT) notion, both of which emphasize the significant connection between exchange rates and inflation via the mechanism of imported commodities. A fall of the IDR/USD exchange rate elevates import costs, as foreign goods become pricier in-home currency, thus leading to increased domestic prices—an occurrence referred to as imported inflation. This discovery highlights how fluctuations in exchange rates might lead to increased inflation volatility. Although the transferred proportion seems negligible ($1.742 \times 10^{-6}$ percent), it indicates a genuine and statistically significant spillover impact.

The cumulative effect of ongoing exchange rate shocks can significantly influence price stability in Indonesia. Inadequate control of exchange rate volatility can instigate inflationary disturbances by transferring volatility into liquidity, highlighting the essential role of exchange rate stability in regulating both liquidity and inflation (Rudari *et al.* 2024). The volatility spillover effect of the exchange rate is corroborated by the research of Sari & Nurjannah (2023), which revealed that the IDR/USD exchange rate strongly impacts Indonesian inflation as an indicator of consumer purchasing power. Rudari *et al.* (2024) also discovered a prolonged spillover impact from currency rates to inflation in Iran.

Conversely, a significant portion—amounting to 456,489.410 percent ($\hat{\beta}^2$ = 4564.894)—of the volatility in Indonesian inflation from the previous month is transmitted to the current volatility in the IDR/USD exchange rate. Inflation volatility that causes spillover effects on the exchange rate indicates a market sentiment mechanism related to financial behavior and psychological factors as external factors in price volatility (Parulian, 2024). This finding is supported by Behavioural Finance Theory, which states that exchange rate stability—as a trading instrument in IDR-based investments—is strongly influenced by price stability, which is projected through inflation. When inflation rates are volatile or tend to rise, both domestic and foreign investors may become concerned that the purchasing power of the Rupiah will deteriorate. This concern can trigger a sell-off of Rupiah-denominated assets in favor of more stable foreign currencies, such as the US Dollar. Consequently, demand for the US Dollar surges while demand for the Rupiah declines, directly exerting downward pressure on the Rupiah's exchange rate and increasing its volatility.

The extent of the transmission (456,489.410 percent) underscores that inflation stability is a crucial foundation of currency rate stability. A minor fluctuation in inflation might induce a disproportionately significant impact on the exchange rate. This highlights the significance of sustaining low and stable inflation as a crucial strategy for safeguarding the stability of the Rupiah. The findings align with the research conducted by Sunday & Yuliarmi (2024) and Qarina (2019), both of which demonstrated that Indonesian inflation partially affects the IDR/USD exchange rate, utilizing panel data regression and multiple linear regression techniques, respectively.

### 3.6.2 Volatility Spillover Effect Between Exchange Rate and Bond Yield Spread

The research indicates a bidirectional volatility spillover between Indonesia's inflation and the IDR/USD exchange rate, as well as a reciprocal volatility transmission between the IDR/USD exchange rate and the bond yield spread. At the 5% significance level, a spillover effect from the exchange rate to the bond yield spread is detected ($\hat{\beta}_{32}$ = -2 × $10^{-6}$), along with a reciprocal effect from the bond yield spread to the exchange rate ($\hat{\beta}_{23}$ = 47,782.468), as illustrated in Figure 25. These results demonstrate a dynamic dependency between the two macroeconomic factors. This finding contrasts with the study of Rastogi *et al.* (2024), which reported no substantial volatility transmission between the exchange rate and bond yields in India. Additionally, the scale of the variables, which are normalized to a range of 0 to 1 (bond yield spread) percent, also affects the magnitude of this overflow.

A volatility spillover effect of 4 × $10^{-10}$ percent ($\hat{\beta}^2$ =4 × $10^{-12}$) from the prior month's exchange rate volatility is conveyed to the current period's bond yield spread volatility. The volatility effect from the IDR/USD exchange rate is minimal, nearly nearing zero. This minimal volatility effect aligns with the examination of the IDR/USD exchange rate's spillover impact on the bond yield spread within the framework of news spillover effects. The findings from the news and volatility spillover analysis indicate that the Indonesian bond market has considerable resilience to exchange rate swings. This signifies a level of structural robustness and underscores the ongoing necessity of integrating such resilience into macroeconomic policy development.

The spillover effect from the bond yield spread to the IDR/USD exchange rate is notably significant, with a transmission magnitude of 2,283 × $10^{11}$percent ($\hat{\beta}^2$ = 2,283 × $10^{9}$). This suggests that fluctuations in the bond yield spread from the previous month substantially affect the present exchange rate volatility. This outcome corresponds with Behavioural Finance Theory, which highlights how investor perceptions and responses to changes in the bond yield spread can influence market dynamics. An expansion in the yield spread—indicating a broader disparity between long-term (10-year) and short-term (5-year) interest rates—is generally perceived as an indication of escalating uncertainty concerning future economic circumstances. This uncertainty can exacerbate volatility, prompting investors to shift capital from Rupiah- denominated assets to more secure foreign currencies such as the US Dollar. This alteration in asset preference amplifies demand for the US Dollar while diminishing demand for the Rupiah, applying downward pressure on the exchange rate and heightening its volatility. The results align with those of Prananta & Alexiou (2024), who also identified a long-term association between bond yields and the IDR/USD exchange rate in Indonesia utilizing a Non-Linear Autoregressive Distributed Lag (NARDL) model.

### 3.7. Asymmetric Spillover Effect

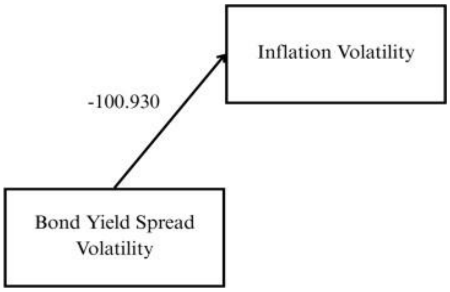



**Figure 5.** Asymmetric Spillover Effect Diagram

**Source***:* Author's data processing results, 2025

The asymmetric spillover effect is illustrated in Figure 5. At a 5% significance level, there is an asymmetric volatility spillover effect from the bond yield spread to inflation ($\hat{\gamma}_{21}$ = -100,930). This indicates that approximately 1,019 × $10^6$ percent ($\hat{\gamma}^2$ = 10186,865) of the negative news related to the bond yield spread from the previous month is transmitted to the current volatility of inflation in Indonesia. Apart from that, the magnitude of this overflow figure is also influenced by the variable scale which ranges from 0 to 1 percent.

In other words, negative news regarding the bond yield spread has a greater impact on current inflation volatility compared to positive news of the same magnitude. Specifically, if a negative shock (bad news) to the bond yield spread occurs in the previous month, the resulting increase in Indonesia's inflation volatility is 10908,163 ( $\hat{\alpha}_{21}^2$ + $\hat{\gamma}_{21}^2$=721,298+10186,865), whereas a positive shock (good news) leads to a volatility increase of only 721,298 ($\hat{\alpha}_{21}^2$).

Market sentiment can be broken down into positive and negative sentiment (Parulian *et al.*, 2024). However, investors in financial markets tend to be more sensitive to negative news. Adverse news concerning the bond yield spread can trigger panic, asset sell-offs, and a flight to safer assets. Indirectly, this behavior can influence inflation expectations as well as other macroeconomic indicators, such as exchange rates, ultimately contributing to increased inflation volatility. Furthermore, negative news undermines investor and market participants' confidence in the stability of the economy. This dynamic is consistent with the principles of Behavioural Finance Theory, which emphasizes the tendency of investors to reduce exposure to perceived investment risks in response to unfavorable information.

Findings from the BEKK-AGARCH(1,1) model show that macroeconomic indicators, representing monetary policy, have a volatility spillover effect on inflation in Indonesia. The finding that monetary policy affects market volatility up to inflation is also supported by research from Zuo (2025) in emerging countries. This study found a significant impact of monetary policy shocks in Malaysia.

### 3.8. Assumption Check

We also pursue diagnostics tests on residuals of the model. The results given at Table 5 confirms white noise and homoscedasticity (ARCH effect) characteristics of our models. Moreover, the model converged at the 137th iteration with the BFGS algorithm. Therefore, the BEKK-AGARCH(1,1) model is the best-fitting model, as it exhibits white noise residuals and successfully addresses the heteroskedasticity issues in all three research variables

**Table 5.** Diagnostic Test Results of the BEKK-AGARCH Volatility Model

| Assumption Test | Statistic | Prob. | Conclusion |
|---|---|---|---|
| Multivariate Q Test | 38,716 | 0,734 | White Noise |
| Muttivariate ARCH-LM | 159,60 | 0,861 | There is no longer any ARCH effect present |

**Source***:* Author's data processing results, 2025

## 4. Conclusion and Recommendation

This research used a BEKK-AGARCH model to analyze the volatility spillover effects of the exchange rate and bond yield spread on inflation in Indonesia, using monthly data from January 2012 to December 2024. Univariate modeling showed that inflation and the currency exchange rate exhibited asymmetric volatility, but the bond yield spread followed a symmetric pattern. Modeling using BEKK-AGARCH(1,1) showed the existence of substantial bidirectional volatility spillovers between inflation and the exchange rate, highlighting a strong volatility dependence between them. In addition, this analysis revealed asymmetric volatility spillovers from the bond yield spread to inflation, indicating that negative shocks in the bond market affect inflation volatility compared to positive shocks.

Based on these findings, several policy recommendations can be made. First, since inflation and the exchange rate are highly interconnected, the Ministry of Finance and Bank Indonesia need to manage them in a coordinated manner through strengthened macroprudential policies—for instance, limiting banks' exposure to exchange rate risk and improving monetary policy communication to better anchor market expectations. Second, as negative bond market shocks significantly increase inflation volatility, Bank Indonesia, the Ministry of Finance, the Financial Services Authority, and the Deposit Insurance Corporation should enhance coordination to safeguard financial stability. This can be achieved by improving bond market liquidity to withstand sudden shocks, maintaining a sustainable government debt ratio to prevent investor concerns, and ensuring strict supervision of the bond market to minimize speculative behavior that could trigger volatility.

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