

The Relationship Between Energy Commodity Prices, Exchange Rate, And Stock Price Volatility Of The Energy Sector During The 2021–2025 Period

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Abstract: This study examines the relationship between natural gas, coal, and crude oil prices, the USD/IDR exchange rate, and stock price volatility of the IDXENERGY Index on the Indonesia Stock Exchange during February 2021–December 2025. The study employs a quantitative associative approach using 59 monthly observations. Energy commodity data were obtained from Investing.com, while USD/IDR data were obtained from Bank Indonesia. Multiple linear regression based on Ordinary Least Squares (OLS) was conducted using EViews 12, preceded by classical assumption tests and followed by partial and simultaneous significance tests. The findings show that natural gas prices and the USD/IDR exchange rate are positively and significantly associated with energy-sector stock volatility, whereas coal and crude oil prices are not statistically significant individually. The four regressors are jointly significant in explaining variation in IDXENERGY volatility. The results indicate heterogeneous transmission of external-market information into Indonesian energy-sector equity risk and highlight natural gas and exchange-rate movements as relevant risk indicators. Methodological limitations include the static OLS framework, price-level volatility measure, absence of reported stationarity tests, and limited control variables.

Keywords: Energy Commodity Prices; Exchange Rate; Stock Price Volatility

JEL: G12; Q41; F31

1. INTRODUCTION

Energy commodity prices such as natural gas, coal, and crude oil are among the key indicators of global market dynamics and the world economy. Changes in energy commodity prices are influenced by various factors, ranging from global supply-demand conditions and world energy policies to geopolitical circumstances such as inter-state conflicts and energy transition policies (Zhao *et al.*, 2024). The movement of global energy commodity prices during 2020–2023 exhibited extremely sharp fluctuations: coal prices surged by up to 591% from the 2020 baseline, natural gas rose by 396%, and crude oil increased by up to 122%, a trend that was further accelerated by the Russia–Ukraine geopolitical conflict in 2022.

This massive commodity price turmoil created high uncertainty in global financial markets, including in Indonesia. The IDXENERGY Index on the Indonesia Stock Exchange showed a consistent upward trend, rising from around 800 in early 2021 to above 4,500 by the end of 2024; however, this trajectory was marked by significant volatility spikes, particularly during 2022–2023 and again in 2024–2025. This pressure was further exacerbated by the depreciation of the Rupiah against the US Dollar, which weakened by 22.8% from its lowest point (Rp13,662 per USD in mid-2020) to Rp16,782 per USD by the end of 2025. Because global energy commodity prices are quoted in US Dollars, the weakening Rupiah increased cost pressures for domestic energy issuers while heightening uncertainty for investors. Previous studies show mixed findings regarding the relationship between energy commodity prices, exchange rates, and the stock market. Sari & Nugroho (2024) found that world oil prices had a positive and significant effect on mining company stock prices, while Wahyudi & Rahmawati (2025) showed that world oil price volatility and exchange rate fluctuations affect sectoral stock indices in Indonesia. Ikhsani *et al.* (2023) found a relationship between macroeconomic factors and commodity prices with the stock performance of the oil and gas subsector during the pandemic, while Prasada &

Pangestuti (2022) demonstrated that crude oil, coal, and exchange rates play a role in explaining the movement of the Composite Stock Price Index (IHSG).

In the ASEAN context, Kumajas *et al.* (2024) found that energy commodity prices are related to sustainable stock index returns in emerging markets. Although previous studies have examined the relationship between energy commodities, exchange rates, and stock-market performance, an explicit research gap remains. First, much of the existing literature focuses on stock returns, stock-price levels, broad market indices, or individual oil and gas and mining companies rather than the volatility of an aggregate energy-sector index. Second, previous studies often examine only one or two commodity variables, particularly crude oil, while the combined role of natural gas, coal, crude oil, and the USD/IDR exchange rate in explaining energy-sector stock volatility remains less explored. Third, the empirical evidence is not fully consistent across periods and market settings: some studies identify significant effects of oil, coal, or exchange rates, whereas others report weaker or insignificant relationships. These inconsistencies suggest that the transmission of global energy shocks to Indonesian energy-sector stock volatility may depend on the commodity considered, the structure of the sector, and the prevailing macroeconomic environment.

The contribution of this study is not limited to combining three energy commodities and the USD/IDR exchange rate in one model. Conceptually, the study examines whether the information content of different external energy and currency markets is transmitted into aggregate energy-sector equity volatility with heterogeneous intensity. This distinction is important because a significant relationship with stock returns or price levels does not necessarily imply a significant relationship with volatility. Empirically, the study compares the marginal contribution of natural gas, coal, crude oil, and USD/IDR within the same specification and focuses on the post-pandemic and geopolitical-shock period of 2021–2025. The study therefore contributes evidence on which external indicators are more closely associated with energy-sector volatility in an emerging-market setting. The analysis is relational rather than causal because the research design does not employ an identification strategy for causal inference.

2. LITERATURE REVIEW

2.1. Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) asserts that security prices incorporate available information, including information originating from macroeconomic conditions and international commodity markets (Liu *et al.*, 2022). In the context of the energy sector, changes in natural gas, coal, and crude oil prices, as well as movements in the USD/IDR exchange rate, can become relevant information for investors because they affect expectations regarding corporate revenues, production costs, profitability, and future cash flows. Under an informationally efficient market, such information is rapidly incorporated into stock prices. Consequently, when new information is unexpected or materially changes investors' expectations, the adjustment process may be accompanied by greater price fluctuations and volatility. EMH therefore provides a theoretical basis for understanding why external shocks can be reflected in the risk characteristics of energy-sector stocks rather than only in their price levels.

2.2. External Shock Transmission and Market Connectedness

The external shock transmission perspective explains how information and uncertainty originating in one market can be reflected in another through economic linkages, investor expectations, portfolio rebalancing, and changes in risk premiums. Prior international research shows that commodity and equity markets can exhibit time-varying return and volatility connectedness, particularly during major market disruptions (Ghorbel & Jeribi, 2021; Lakshmanasamy, 2022; Mensi *et al.*, 2022). Studies using GARCH, connectedness, and related dynamic methods generally find that energy-market shocks can be transmitted to equity markets, although the intensity and direction of transmission vary across countries, assets, and crisis periods. For example, Mensi *et al.* (2022) document time-varying spillovers between strategic commodity futures and stock markets in developed and emerging economies, while Ghorbel & Jeribi (2021) identify volatility transmission between energy assets and financial assets during the COVID-19 crisis. More recent evidence also emphasizes dynamic and heterogeneous oil-to-

stock risk transmission (Tian *et al.*, 2022) and connectedness among energy firms in emerging markets (Chuliá *et al.*, 2024).

These studies provide a broader theoretical context for the present research, but the current model should not be interpreted as directly estimating volatility spillovers because the explanatory variables are commodity and exchange-rate price levels rather than their own conditional volatilities or returns. Accordingly, the present study uses the transmission/connectedness perspective to interpret the results, while recognizing that formal spillover measurement would require a dynamic volatility or connectedness model. spread across markets when investors rebalance portfolios in response to a common global shock. Wahyudi & Rahmawati (2025) provide evidence that fluctuations in world oil prices and exchange rates are associated with sectoral stock-market performance in Indonesia. From this perspective, a rise in energy commodity uncertainty can spill over into the volatility of the IDXENERGY Index, even when the underlying companies have different business models

2.3. Energy Commodity Prices, Exchange Rate, and Stock Volatility

Energy commodity prices are primarily formed through the interaction of global supply and demand, but the process is also shaped by inventories, production capacity, weather, transportation constraints, geopolitical events, energy policy, and expectations about future economic activity (Soumaré, 2022; Zhao *et al.*, 2024). Natural gas prices are particularly sensitive to seasonal demand, storage capacity, supply disruptions, and geopolitical developments because gas markets are relatively regional and infrastructure-dependent. Coal prices are influenced by electricity demand, industrial activity, export availability, freight costs, and the global energy transition. Crude oil prices are strongly affected by global demand, production decisions of major producers, inventories, and geopolitical risk. These different price-formation mechanisms imply that each commodity may transmit shocks to energy-sector equities with different intensity and timing (Riani & Iryani, 2023).

The exchange-rate channel provides an additional mechanism linking international commodity markets to domestic stock volatility. Because many energy commodities are traded internationally and denominated in US Dollars, depreciation of the Rupiah raises the domestic-currency cost of imported energy inputs and can alter the Rupiah value of foreign-currency revenues. The net effect depends on the firm's position as an exporter or importer, its cost structure, and its ability to pass costs through to customers. Exchange-rate changes also influence foreign investors' valuation of Indonesian assets and can alter capital flows and risk premiums. Thus, USD/IDR movements can affect stock volatility through both corporate fundamentals and financial-market channels (Bank Indonesia, 2024).

The transmission of commodity-price shocks to investment risk occurs through several stages. First, a commodity-price shock changes expected revenue or operating costs of energy-related firms. Second, investors revise expected cash flows, profitability, and required rates of return. Third, the revision in expectations changes stock valuation and trading behavior. When the shock is large or unexpected, disagreement among investors and rapid portfolio reallocation can increase trading intensity and price dispersion, producing higher volatility. This mechanism explains why a commodity can be important for volatility even when its effect on the average stock-price level is limited. The magnitude of transmission is also likely to differ across commodities because the IDXENERGY Index contains firms with diversified exposures to oil, gas, coal, and other energy activities (Ilori & Tanimowo, 2022; Indartini & Lakeisha, 2024).

2.4. Previous Studies and Hypothesis Development

International and Indonesian evidence indicates that the relationship between energy markets, exchange rates, and equities is heterogeneous and depends on the market, period, and methodological framework. Mensi *et al.* (2022) find time-varying volatility spillovers between strategic commodity futures and stock markets in both developed and emerging economies. Ghorbel & Jeribi (2021) document volatility transmission between energy assets and financial assets during the COVID-19 crisis, while Lakshmanasamy (2022) reports volatility spillover among crude oil prices, exchange rates, and stock prices using GARCH estimation. Zhang *et al.* (2022) further show that oil-to-stock risk spillovers vary across countries and over time. Evidence from emerging energy markets also indicates that energy-stock connectedness remains important after controlling for common global factors (2023). In Indonesia, Prasada & Pangestuti (2022) show that world oil prices, coal prices, inflation, and exchange rates are relevant to stock-index movements; Ikhsani *et al.* (2023) identify exchange-rate and

oil-price relationships with oil-and-gas stock performance; Kumajas *et al.* (2024) link energy commodity prices with ASEAN sustainable stock returns; Sari & Nugroho (2024) report a significant relationship between world oil prices and mining-stock performance; and Wahyudi & Rahmawati (2025) find that world oil-price volatility and exchange-rate fluctuations are associated with Indonesian sectoral stock performance. The literature therefore suggests that external energy and currency shocks can be relevant to equity risk, but their effects are not necessarily uniform across commodities, sectors, countries, or measures of market performance. This study tests that heterogeneity within the IDXENERGY Index during 2021–2025.

H1: Natural gas prices, coal prices, crude oil prices, and the USD/IDR exchange rate have a significant simultaneous effect on the stock price volatility of the IDXENERGY Index.

H2: Natural gas prices have a significant partial effect on the stock price volatility of the IDXENERGY Index.

H3: Coal prices have a significant partial effect on the stock price volatility of the IDXENERGY Index.

H4: Crude oil prices have a significant partial effect on the stock price volatility of the IDXENERGY Index.

H5: The USD/IDR exchange rate has a significant partial effect on the stock price volatility of the IDXENERGY Index.

3. METHOD

3.1. Research Type and Approach

This study employs an associative quantitative approach, i.e., an approach aimed at objectively testing the relationship between two or more variables using numerical data and statistical techniques (Creswell & Creswell, 2023).

3.2. Population, Sample, and Data Sources

The study population comprises the entire set of monthly data on global energy commodity prices (natural gas, coal, and crude oil), the USD/IDR exchange rate, and the IDXENERGY energy sector stock price index for the period from February 2021 to December 2025, totaling 59 monthly observations. The sampling technique used is saturated sampling, in which all members of the population are used as the sample. Natural gas futures, coal (Newcastle), and crude oil (WTI) price data are sourced from Investing.com in USD, while the USD/IDR middle exchange rate data is sourced from Bank Indonesia (www.bi.go.id).

3.3. Operational Definition of Variables

The independent variables consist of natural gas price (X1), coal price (X2), crude oil price (X3), and the USD/IDR exchange rate (X4), each measured using the monthly closing price. The dependent variable (Y) is the stock price volatility of the IDXENERGY Index, measured using the standard deviation method applied to daily closing prices within each month (Gupta & Mishra, 2024). This operationalization follows the dataset used in the original analysis. However, because volatility is more conventionally defined from returns, the use of price-level standard deviation should be interpreted as a proxy measure and constitutes a methodological limitation. Future replication should construct volatility from daily log returns before monthly aggregation.

3.4. Data Analysis Technique

Data analysis employs multiple linear regression based on Ordinary Least Squares (OLS) with the aid of EViews 12 student version software, using the following model:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \epsilon$$

Description: Y = stock price volatility; α = constant; β_1 – β_4 = regression coefficients; X1 = natural gas price; X2 = coal price; X3 = crude oil price; X4 = USD/IDR exchange rate; ϵ = error term.

Prior to hypothesis testing, the model was tested using classical assumption tests, including

residual normality, multicollinearity, autocorrelation, and heteroscedasticity. The OLS specification is a static linear model and is used to estimate conditional associations rather than causal effects. The study does not estimate a dynamic conditional-volatility process and therefore does not directly identify volatility spillovers. In addition, the available analysis does not report Augmented Dickey-Fuller (ADF) or Phillips-Perron (PP) stationarity tests. Consequently, the results should be interpreted cautiously as evidence from the specified monthly regression rather than as a complete time-series volatility model. Future research should first test stationarity and, where appropriate, employ cointegration/ARDL or dynamic volatility models such as ARCH/GARCH, GARCH-X, EGARCH, or GJR-GARCH. Additional control variables should also be considered to reduce omitted-variable concerns.

4. RESULTS AND DISCUSSION

4.1. Classical Assumption Test

Prior to hypothesis testing, the regression model was tested with a series of classical assumption tests to satisfy the Best Linear Unbiased Estimator (BLUE) criteria. A summary of the test results is presented in Table 1.

Table 1. Classical Assumption Test Results

Test	Indicator	Result	Decision
Normality	Jarque–Bera probability	0.1173	Normal residuals
Multicollinearity	Highest Centered VIF (COAL)	2.5054	No multicollinearity
Autocorrelation	Durbin–Watson	1.8066	No autocorrelation
Heteroscedasticity	Breusch–Pagan–Godfrey Prob. F	0.2581	No heteroscedasticity

Source: Data processed by the researcher (EViews 12), 2026

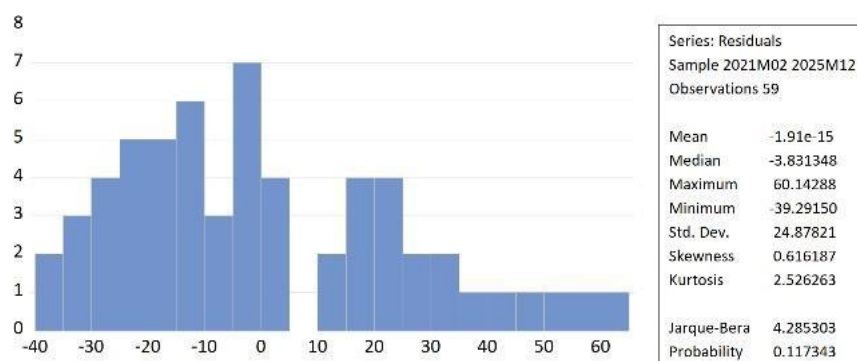


Figure 1. Normality Test Results (Residual Histogram and Jarque–Bera Statistic)

Source: Data processed by the researcher (EViews 12), 2026

The test results show that the Jarque-Bera probability value of 0.1173 is above 0.05, so the model's residuals are declared normally distributed. The Durbin-Watson value of 1.8066 lies between dU (1.7266) and 4-dU (2.2734), indicating that the model is free from autocorrelation. The highest Centered VIF value is found in the COAL variable at 2.5054, well below the threshold of 10, so the model is free from multicollinearity. The Breusch-Pagan-Godfrey test results show an F-statistic probability value of 0.2581 (> 0.05), meaning the model is homoscedastic. Thus, all classical assumptions have been satisfied and the regression model is appropriate for further hypothesis testing.

4.2. Multiple Linear Regression Analysis

Based on the OLS estimation results, the model estimates the conditional association between the four external variables and IDXENERGY stock-price volatility. Because the research design is

observational and static, the coefficients should not be interpreted as causal effects.

The regression coefficients should be interpreted primarily in economic rather than purely statistical terms. The positive coefficient of GAS indicates that increases in natural gas prices are associated with higher volatility in the IDXENERGY Index, holding the other variables constant. Economically, this relationship is plausible because natural gas markets are highly sensitive to supply disruptions, seasonal demand, storage constraints, and geopolitical developments. Unexpected movements in gas prices can therefore change investors' expectations about the earnings and risk exposure of energy-sector firms, increasing uncertainty in stock valuation. The positive USD/IDR coefficient indicates that Rupiah depreciation is associated with greater energy-sector stock volatility. This can occur because energy commodities are internationally priced in US Dollars, so exchange-rate depreciation changes domestic cost structures, affects the Rupiah value of foreign-currency cash flows, and can influence foreign investor risk perceptions. In contrast, the negative coefficients for COAL and OIL indicate an inverse direction in the estimated relationship, but the absence of a significant individual effect means that their price movements did not provide sufficiently consistent information to explain changes in IDXENERGY volatility after controlling for natural gas prices and the exchange rate. The different responses across commodities suggest that the energy sector is heterogeneous and that the transmission of external shocks depends on firms' commodity exposure, operating structure, hedging practices, and the broader macroeconomic environment.

Table 2. Multiple Linear Regression Estimation Results

Variable	Coefficient	t-statistic	Prob.
Constant	-317.2059	–	–
COAL (Coal)	-0.0453	-0.5873	0.5596
GAS (Natural Gas)	8.6897	2.9999	0.0041
OIL (Crude Oil)	-0.6104	-1.6040	0.1146
USD/IDR (Exchange Rate)	0.0252	5.4138	0.0000
Observations (n)	59		
R-squared	0.4569		
Adjusted R-squared	0.4168		
F-statistic (Prob.)	11.3564 (0.000001)		

Source: Data processed by the researcher (EViews 12), 2026

The GAS coefficient of 8.6897 indicates a positive association between natural gas prices and energy-sector stock-price volatility, while the USD/IDR coefficient of 0.0252 indicates a positive association between the exchange rate and volatility. COAL (-0.0453) and OIL (-0.6104) have negative estimated coefficients, but neither is statistically significant. The coefficient magnitudes should not be interpreted as directly comparable economic importance across variables because the variables are measured in different units. The results therefore support statistical significance for GAS and USD/IDR, but not for COAL and OIL.

The simultaneous test indicates that the four regressors are jointly significant in explaining variation in IDXENERGY stock-price volatility. This does not mean that each commodity individually has a significant effect, because the partial tests show that coal and crude oil are statistically insignificant. Rather, the F-test indicates that the set of regressors, considered together, provides statistically significant explanatory information relative to a model containing only the intercept. The Adjusted R-squared value of 0.4168 also indicates that 41.68% of the variation in the dependent variable is accounted for by the current model specification, while 58.32% remains unexplained by that specification. The latter should not be interpreted as being entirely explained by omitted variables because it also contains random disturbance, measurement error, and possible model misspecification.

4.3. Hypothesis Testing

Table 3. Hypothesis Test Results (F-test and t-test)

Hypothesis	Test	Result	Decision
H1 (Simultaneous)	F-test	F = 11.3564; Sig. = 0.000001 (< 0.05); F-table = 2.5395	Accepted
H2 (GAS)	t-test	t = 2.9999; Sig. = 0.0041 (< 0.05)	Accepted
H3 (COAL)	t-test	t = -0.5873; Sig. = 0.5596 (> 0.05)	Rejected
H4 (OIL)	t-test	t = -1.6040; Sig. = 0.1146 (> 0.05)	Rejected
H5 (USD/IDR)	t-test	t = 5.4138; Sig. = 0.0000 (< 0.05)	Accepted

Source: Data processed by the researcher (EViews 12), 2026

The F-test produces an F-statistic of 11.3564 with a probability of 0.000001, below 0.05 and above the F-table value of 2.5395. Therefore, H1 is supported in the sense that the four regressors are jointly significant in explaining IDXENERGY stock-price volatility. This joint significance should be distinguished from the partial results: GAS and USD/IDR are individually significant, whereas COAL and OIL are not. The Adjusted R-squared value of 0.4168 indicates that 41.68% of the variation in energy-sector stock-price volatility is accounted for by the variables included in the current specification. The remaining 58.32% is unexplained by the model specification and may reflect other omitted determinants, random disturbance, measurement error, or misspecification. Accordingly, the statistic should be viewed as an indication of the model's explanatory capacity rather than as a decomposition of the dependent variable into named external factors.

4.4. Discussion

The study found that natural gas prices and the USD/IDR exchange rate are positively and significantly associated with IDXENERGY stock-price volatility, whereas coal and crude oil prices are not statistically significant over 2021–2025. The results indicate heterogeneous relationships between external-market variables and Indonesian energy-sector equity risk. The interpretation below distinguishes the empirical associations from stronger causal or formal spillover claims because the model is a static OLS specification and does not estimate dynamic volatility transmission.

The positive and significant effect of natural gas prices on IDXENERGY stock price volatility indicates that fluctuations in the natural gas market represent an important source of uncertainty for Indonesian energy-sector investors. Natural gas prices are highly sensitive to supply disruptions, weather conditions, storage levels, transportation infrastructure, geopolitical tensions, and changes in global energy demand. Unlike a relatively predictable price movement, sudden changes in natural gas prices may generate uncertainty regarding future production costs, corporate profitability, and expected cash flows. When investors receive new information indicating a potential disruption in natural gas supply or a sharp change in global demand, they may revise their valuation of energy-related companies rapidly. This adjustment can increase trading activity and create greater dispersion in investor expectations, ultimately increasing stock-price volatility. The finding is consistent with evidence that energy commodity prices are relevant to stock-market performance in emerging markets (Kumajas *et al.*, 2024) and with Wahyudi & Rahmawati (2025), who demonstrate that global energy-market fluctuations can be transmitted into Indonesian sectoral stock performance.

From the perspective of the Efficient Market Hypothesis (EMH), the significant relationship between natural gas prices and stock volatility suggests that information originating from international energy markets is incorporated into domestic stock prices. However, the result also provides a more nuanced interpretation of EMH. Market efficiency does not imply that stock prices remain stable after new information arrives; rather, efficient markets adjust prices in response to information. When information is unexpected and materially changes investors' expectations, the adjustment process itself

can produce substantial short-term price fluctuations. Thus, the significant effect of natural gas prices can be interpreted as evidence that investors actively process information from global energy markets and incorporate it into the valuation of energy-sector stocks. Liu *et al.* (2022) argues that market prices respond to available information, while the present findings extend this argument by showing that the information process is also reflected in the volatility dimension of stock prices.

The finding can also be explained through Volatility Spillover Theory. According to this perspective, volatility generated in one market can be transmitted to another interconnected market through economic linkages, investor sentiment, and portfolio reallocation. A shock in the natural gas market may initially affect energy-sector expectations at the global level and subsequently influence domestic equity investors who reassess the risk and future profitability of energy-related firms. Investors may respond by reallocating their portfolios, increasing or reducing exposure to energy-sector stocks, which can amplify price fluctuations. Therefore, the significant effect of natural gas prices provides empirical support for the existence of a volatility transmission mechanism from the global energy commodity market to the Indonesian energy-sector stock market. The theoretical contribution of this finding is that the spillover mechanism appears to be stronger for natural gas than for other commodities included in the model, suggesting that commodity-market interconnectedness is not homogeneous.

In contrast, coal prices do not have a statistically significant individual relationship with IDXENERGY stock-price volatility. One possible explanation is that established production capacity, long-term sales contracts, export arrangements, hedging, or diversification may reduce the immediate sensitivity of some firms' expected cash flows to monthly international coal-price movements. Another possible explanation is the heterogeneous composition of the IDXENERGY Index, in which different firms have different commodity exposures and therefore firm-level responses may offset one another at the aggregate-index level. These mechanisms were not directly tested in the present study and should therefore be regarded as plausible explanations rather than established causal mechanisms. The finding should not be interpreted as evidence that coal prices are economically irrelevant; rather, their marginal statistical contribution is weak after the other variables are controlled for.

This finding also provides an important theoretical implication for Volatility Spillover Theory. Although the theory predicts that shocks can be transmitted across interconnected markets, the transmission process depends on the strength of the economic and financial linkages between the source and recipient markets. In other words, spillover is not necessarily automatic or identical across commodities. Coal-price shocks may have a weaker transmission mechanism when firms are able to manage price risk through contracts, operational strategies, or diversification. The result therefore suggests that the existence of a global commodity market does not necessarily imply an equally strong volatility spillover into every domestic stock-market segment. This interpretation helps explain why the finding differs from Prasada & Pangestuti (2022), who identified a relationship between coal prices and broader stock-index movements. Differences in the dependent variable, market aggregation, observation period, and sector composition may alter the strength of the transmission mechanism.

The insignificant relationship between crude oil prices and IDXENERGY stock-price volatility similarly indicates that monthly oil-price movements did not provide sufficiently consistent additional explanatory information after controlling for natural gas, coal, and USD/IDR. One possible explanation is that oil prices incorporate information about global demand, inflation expectations, geopolitical risk, and macroeconomic conditions that may overlap with other variables in the model. Another possibility is that firms in the IDXENERGY Index have heterogeneous exposure to oil-related activities, so aggregate responses may offset one another. These mechanisms were not directly tested in the present study and should therefore be treated as possible explanations. The result also reinforces the distinction between effects on stock returns or price levels and effects on stock-price volatility.

The finding also demonstrates the importance of distinguishing between the effect of a

commodity price on stock returns or price levels and its effect on stock-price volatility. Previous studies, including Sari & Nugroho (2024), have identified relationships between world oil prices and the performance of mining or energy-related stocks. However, a significant relationship with stock returns does not necessarily mean that the same variable will significantly determine stock-price volatility. The current finding therefore contributes to the literature by demonstrating that the transmission of oil-price information may be more relevant for expected returns or valuation than for aggregate volatility during the study period. From the EMH perspective, investors may have already incorporated information about crude oil prices into stock valuations, reducing the additional uncertainty generated by routine oil-price movements. Only unexpected or extreme oil-market shocks may be capable of producing substantial volatility, and such effects may not be captured by the average monthly price measure used in this study.

The USD/IDR exchange rate has a positive and significant effect on IDXENERGY stock price volatility, indicating that currency-market dynamics represent a particularly important source of uncertainty for Indonesian energy-sector stocks. This relationship can be explained through several economic channels. First, international energy commodities are generally denominated in US Dollars, meaning that Rupiah depreciation can alter the domestic-currency value of energy-related costs and revenues. Second, exchange-rate movements influence the financial position of firms with foreign-currency liabilities or transactions. Third, changes in the exchange rate affect foreign investors' returns when their investments are converted back into their home currencies, potentially influencing capital flows and portfolio decisions. These mechanisms can increase uncertainty regarding future corporate earnings and the required rate of return, resulting in greater stock-price volatility.

The significant exchange-rate effect is consistent with the findings of Turk & Akbulut (2025), who highlight the relationship between exchange-rate conditions and stock-market volatility, and with evidence that exchange-rate movements are relevant to the performance of Indonesian energy and mining-related stocks (Ikhsani *et al.*, 2023). However, the theoretical importance of the present finding extends beyond simple consistency with previous research. The result indicates that the exchange rate acts as a bridge connecting global commodity markets with domestic financial markets. When the Rupiah depreciates during periods of global uncertainty, the impact on energy-sector stocks may be amplified because investors simultaneously face commodity-price uncertainty and currency risk. Consequently, exchange-rate movements may function as a transmission mechanism through which global financial and commodity shocks are transformed into domestic stock-market volatility.

The result also strengthens the application of Volatility Spillover Theory to the Indonesian energy-sector market. Exchange-rate volatility can spill over into the equity market through foreign-investment flows, corporate financial exposure, and changes in investor risk perception. When currency uncertainty increases, investors may demand a higher risk premium or reduce exposure to domestic assets, thereby increasing stock-price fluctuations. This mechanism suggests that volatility spillover in the energy sector does not occur only through commodity prices but also through financial-market channels. The significant effect of USD/IDR therefore expands the theoretical interpretation of energy-sector volatility by demonstrating that commodity-market risk and currency-market risk can operate simultaneously and interactively.

The joint significance of natural gas prices, coal prices, crude oil prices, and the USD/IDR exchange rate indicates that the four regressors collectively provide statistically significant explanatory information about energy-sector stock volatility. This finding should not be interpreted as evidence that all four variables individually affect volatility. The partial tests show heterogeneous results, with significant associations for natural gas and USD/IDR but not for coal and crude oil. Thus, the evidence supports a multidimensional specification in which external commodity and currency variables jointly matter, while their individual contributions differ.

From the external shock transmission perspective, the joint significance suggests that the IDXENERGY Index is exposed to information from both commodity and foreign-exchange markets. However, formal volatility spillover cannot be established from this OLS model alone because the explanatory variables are price levels and the model does not estimate their conditional volatilities, directional spillover indices, or dynamic cross-market dependence. Studies using GARCH and connectedness methods provide stronger tools for identifying such transmission mechanisms (Ghorbel & Jeribi, 2021; Lakshmanasamy, 2022; Mensi *et al.*, 2022). the different individual effects provide evidence that spillover transmission is selective rather than uniform. The strength of transmission depends on the degree of economic exposure, the structure of commodity markets, corporate hedging practices, investor expectations, and the composition of the sectoral index. This finding contributes to the theoretical literature by suggesting that volatility spillover should not be understood merely as the existence of transmission between markets, but also as a process in which the intensity of transmission varies across different sources of shocks. The Indonesian energy-sector market therefore acts as a recipient of multiple external shocks, but the market response depends on the economic relevance and information content of each shock.

The theoretical contribution of this study is therefore more appropriately framed as evidence of heterogeneous information transmission into energy-sector equity volatility. EMH provides a rationale for why changes in internationally observed commodity and currency information can be incorporated into domestic stock prices. The empirical results add that the volatility response is not uniform: natural gas and USD/IDR show significant associations, while coal and crude oil do not. The external shock transmission perspective complements EMH by describing the economic channels through which information can be reflected in domestic equity risk, while avoiding the stronger claim that this study directly estimates volatility spillover.

Practically, investors can monitor natural gas prices and USD/IDR movements as indicators associated with energy-sector volatility, while energy-sector companies may consider commodity-price and foreign-exchange risk management. These implications should be interpreted as risk-monitoring guidance rather than causal prescriptions. The study has several limitations. First, volatility is measured from daily price levels rather than daily returns. Second, the static OLS framework does not capture volatility clustering, asymmetry, or time-varying spillovers. Third, stationarity tests such as ADF or PP are not reported in the current analysis, so possible non-stationarity is not fully addressed. Fourth, the specification contains only four external variables and may omit relevant controls such as interest rates, global market conditions, inflation, geopolitical risk, and investor sentiment. Fifth, the observational design does not identify causal effects or resolve possible endogeneity. Future research should address these limitations using return-based volatility measures, stationarity and cointegration testing where appropriate, and dynamic models such as ARCH/GARCH, GARCH-X, EGARCH, GJR-GARCH, VAR, or connectedness indices.

5. CONCLUSION

The study found that natural gas prices and the USD/IDR exchange rate are positively and significantly associated with IDXENERGY stock-price volatility during February 2021–December 2025, while coal and crude oil prices are not statistically significant individually. The four regressors are jointly significant in explaining variation in IDXENERGY volatility. These findings indicate that the relationship between external energy/currency markets and Indonesian energy-sector equity risk is heterogeneous rather than uniform across commodities. Theoretical implications are that EMH helps explain the incorporation of external market information into stock prices, while an external shock transmission perspective helps interpret the economic channels through which such information may be reflected in equity volatility. The study does not, however, establish formal volatility spillovers or causal effects because it uses static OLS and price-level explanatory variables. For practice, investors and energy-sector firms may use natural gas and USD/IDR movements as risk-monitoring indicators. Key

limitations include the price-level volatility proxy, the absence of reported ADF/PP tests, the static specification, possible omitted variables, and the lack of causal identification. Future research should use return-based volatility measures and dynamic models such as ARCH/GARCH, GARCH-X, EGARCH, GJR-GARCH, VAR, or connectedness approaches, together with additional macroeconomic and geopolitical controls.

FUTURE RESEARCH

Future research should first construct stock and commodity returns and derive volatility measures from returns rather than price levels. ADF or PP tests should be conducted before model estimation, with cointegration/ARDL considered when the variables exhibit appropriate integration properties. Because financial volatility commonly displays clustering and asymmetry, ARCH/GARCH-family models, GARCH-X, EGARCH, or GJR-GARCH can provide a more suitable dynamic framework. VAR, Diebold–Yilmaz connectedness, or Baruník–Křehlík frequency-domain methods can also be used when the objective is to measure the direction and intensity of volatility spillovers. Additional controls such as interest rates, inflation, global equity-market conditions, geopolitical risk, and investor sentiment may reduce omitted-variable concerns and improve the interpretation of energy-sector volatility.

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