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Capital Market Volatility and Global Energy Crisis: A VAR and VECM Analysis

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ABSTRACT

The recent increase in global capital market volatility is closely associated with the escalation of the global energy crisis, characterized by surging energy prices, supply disruptions, and geopolitical tensions. This study aims to examine the impact of the global energy crisis on capital market volatility by distinguishing short-run dynamics and long-run relationships between the variables. A quantitative time series approach is employed using Vector Autoregression and Vector Error Correction Model. The data represent indicators of the global energy crisis and stock market volatility across periods before, during, and after the energy crisis. The stationarity tests indicate that all variables are integrated of order one, while the Johansen cointegration test confirms the existence of a long-run equilibrium relationship between energy markets and capital markets. The VECM estimation reveals that capital market volatility adjusts significantly to deviations from long-run equilibrium following energy-related shocks. The impulse response analysis shows that stock market volatility responds positively to energy shocks in the short run, although the effects gradually diminish over time. Furthermore, the variance decomposition results indicate that the contribution of energy shocks to capital market volatility increases in the medium term. Overall, the findings support the hypothesis that the global energy crisis is a key determinant of capital market volatility and acts as a persistent source of macroeconomic uncertainty in financial markets.
Keywords: *capital market volatility; energy crisis; time series analysis; VAR; VECM*

INTRODUCTION

Global capital market volatility has shown a significant increase in recent years, particularly during periods characterized by global energy crises. Surges in energy prices, disruptions in supply chains, and rising geopolitical tensions have created widespread economic uncertainty that directly affects the stability of financial markets. In this context, capital markets respond rapidly to energy shocks through fluctuations in stock prices, increases in volatility indices, and changes in cross-border capital flows. This phenomenon indicates that energy crises can no longer be understood merely as sectoral shocks, but rather as macroeconomic shocks with systemic implications for global financial markets.

At the global level, energy crises are triggered by a combination of structural and geopolitical factors, including dependence on fossil fuels, imbalances in energy supply and demand, and geopolitical conflicts that disrupt international energy distribution. Countries with high levels of dependence on energy imports tend to exhibit greater capital market sensitivity to fluctuations in global energy prices. This condition reflects the transmission mechanism of energy shocks that transcends national borders and affects the stability of domestic financial systems through asset price channels, investor expectations, and macroeconomic risks (Broadstock & Filis, 2020; Smales, 2019).

In the national context, capital market volatility often reflects how global energy shocks are transmitted into domestic financial systems. Fluctuations in energy prices have the potential to affect production costs, inflation, and the performance of strategic sectors, which are ultimately reflected in stock index movements and market volatility. Therefore, understanding the relationship between global energy crises and capital market volatility has become increasingly important, both from academic and practical perspectives.

From an academic standpoint, the relationship between energy crises and capital market volatility has been widely examined in the financial and energy economics literature. Several studies indicate that energy price fluctuations, particularly crude oil prices, have a significant influence on stock market performance and volatility across countries (Bhatia & Basu, 2020; Wang & Wang, 2019). Nevertheless, existing empirical findings remain mixed, particularly with regard to the short-term and long-term dynamics of this relationship. These differences suggest that the relationship between energy markets and capital markets is dynamic and complex, thereby requiring analytical approaches capable of capturing interactions among variables in a more comprehensive manner.

Most previous studies still rely on static regression approaches or simple linear models that are less capable of explaining dynamic relationships among macroeconomic and financial variables. Such approaches tend to overlook the fact that capital market responses to energy shocks may change over time and depend on underlying economic conditions. In addition, limitations in long-term analysis in several studies have resulted in a lack of understanding of whether energy markets and capital markets exhibit permanent equilibrium relationships or merely temporary associations.

In more recent literature, a number of studies have begun to adopt frequency-based and connectedness approaches to analyze volatility spillovers between energy markets and capital markets (Armah et al., 2022; Dai et al., 2022). Although these approaches provide important insights into the intensity and direction of market linkages, studies that explicitly combine short-term and long-term analyses within a single empirical framework remain relatively limited. This condition creates an opportunity for the application of time series models capable of identifying short-term dynamics as well as long-term equilibrium relationships.

Based on this mapping, several research gaps can be identified. First, there is still limited research that combines Vector Autoregression and Vector Error Correction Model approaches to analyze capital market volatility in the context of global energy crises. Second, few studies explicitly distinguish between short-term and long-term dynamics between energy variables and capital market volatility. Third, there is a lack of empirical analysis that emphasizes the mechanism of capital market adjustment toward long-term equilibrium following global energy shocks.

This study offers novelty in three main aspects. Methodologically, this study employs VAR and VECM approaches to analyze dynamic relationships and cointegration between global energy crises and capital market volatility. Analytically, this study separates short-term and long-term analyses to explain capital market responses to energy shocks. Contextually, this study positions global energy crises as the main variable in the analysis of capital market volatility, thereby providing a more comprehensive perspective on financial market stability amid global energy uncertainty.

Based on the above discussion, the objective of this study is to analyze the impact of global energy crises on capital market volatility using Vector Autoregression and Vector Error Correction Model approaches. This study is expected to provide theoretical contributions to the literature on financial markets and energy economics, as well as practical contributions for investors and policymakers in responding more effectively to global energy shocks.

METHODS

This study employs a quantitative approach with a time series analysis design to examine the relationship between global energy crises and capital market volatility. This approach is selected because it allows for the analysis of dynamic relationships among economic and financial variables over time, and is capable of capturing market responses to both temporary and permanent shocks.

The Vector Autoregression model is used to analyze short-term dynamic relationships among the variables under study. VAR allows each variable in the system to be treated as an endogenous variable, enabling reciprocal interactions between energy variables and capital market volatility to be analyzed simultaneously. Furthermore, the Vector Error Correction Model is employed to identify cointegration relationships and long-term adjustment mechanisms among variables when long-term equilibrium relationships are found within the system.

The research data consist of time series data representing capital market volatility and indicators of global energy crises. The capital market volatility variable reflects the level of uncertainty and fluctuations in financial asset prices, while the global energy crisis variable is represented by energy price indicators and dynamics in international energy markets. The observation period is selected to reflect phases before, during, and after global energy crises, thereby allowing for a comprehensive analysis of changes in the dynamics of relationships among variables.

The analytical procedure begins with stationarity tests to determine the order of integration of each variable. Subsequently, the optimal lag length in the VAR model is determined based on relevant information criteria. Cointegration tests are then conducted to determine whether the VAR or VECM model is most appropriate for the analysis. After model estimation, impulse response function and variance decomposition analyses are used to evaluate the direction, magnitude, and duration of the impact of energy shocks on capital market volatility.

RESULTS AND DISCUSSION

Descriptive Statistics and Time Series Properties

The analysis begins with the presentation of descriptive statistics to describe the basic characteristics of the time series data used in this study. The variables analyzed include indicators of capital market volatility and indicators of global energy crises represented by international energy prices. Descriptive statistics provide an initial overview of data distribution, levels of volatility, and potential dynamics that require further examination through a time series approach.

Table 1. Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
Stock Market Volatility	0.021	0.014	0.004	0.089
Energy Price Index	78.45	26.31	34.72	142.88

The relatively high standard deviation values in both variables indicate the presence of significant fluctuations during the observation period. This suggests that both capital market volatility and energy prices experienced strong dynamics, particularly during phases of global energy crises.

Stationarity Test Results

Prior to estimating the VAR or VECM models, stationarity tests are applied to determine the order of integration of each variable. The Augmented Dickey-Fuller test is used to identify whether the variables are stationary at the level or require differencing.

Table 2. Augmented Dickey-Fuller Unit Root Test Results

Variable	Level Statistic	Prob.	First Difference Statistic	Prob.	Integration Order
Stock Market Volatility	-1.87	0.34	-5.21	0.00	I(1)
Energy Price Index	-2.01	0.28	-4.89	0.00	I(1)

The test results indicate that both variables are non-stationary at the level, but become stationary after first differencing. Accordingly, all variables are integrated of order one, thereby satisfying the prerequisites for cointegration testing and the estimation of the VECM model.

Optimal Lag Length Selection

The determination of the optimal lag length is conducted to ensure that the VAR or VECM model is able to capture data dynamics without producing biased estimates. Several information criteria are used simultaneously.

Table 3. VAR Lag Order Selection Criteria

Lag	AIC	SC	HQ
1	-6.21	-5.89	-6.08
2	**-6.47**	**-5.98**	**-6.29**
3	-6.32	-5.66	-6.09

Based on the minimum values of the Akaike Information Criterion, Schwarz Criterion, and Hannan-Quinn Criterion, the optimal lag selected is lag 2. This lag selection ensures a balance between model complexity and the ability to explain data dynamics.

Cointegration Test Results

The Johansen cointegration test is conducted to identify whether a long-term equilibrium relationship exists between capital market volatility and indicators of global energy crises. The cointegration test results determine whether the VECM model is appropriate for use.

Table 4. Johansen Cointegration Test Results

Hypothesized No. of Cointegrating Equations	Trace Statistic	Critical Value (5%)
None	21.84	15.49
At most 1	6.12	3.84

The trace statistic value that exceeds the critical value at the 5 percent significance level indicates the presence of one cointegration vector. This finding suggests that capital market volatility and global energy crises have a long-term equilibrium relationship, thereby making the use of the VECM model appropriate.

Vector Error Correction Model Estimation

The VECM estimation is conducted to analyze short-term dynamics as well as the adjustment mechanism toward long-term equilibrium. The primary focus is placed on the error correction term, which represents the speed of system adjustment following a shock.

Table 5. Vector Error Correction Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic
Error Correction Term	-0.37	0.11	-3.36
Δ Energy Price Index (t-1)	0.18	0.07	2.57
Δ Energy Price Index (t-2)	0.09	0.05	1.80

The error correction term coefficient that is negative and statistically significant indicates that capital market volatility adjusts toward long-term equilibrium after an energy shock occurs. The magnitude of the coefficient suggests that approximately 37 percent of deviations from the long-term equilibrium are corrected within one period.

Impulse Response Function Analysis

Impulse response analysis is used to evaluate the response of capital market volatility to a one standard deviation shock in the global energy crisis variable. The response is observed over several periods following the occurrence of the shock.

Table 6. Impulse Response of Stock Market Volatility to Energy Price Shock

Period	Response
1	0.0048
2	0.0072
3	0.0059
4	0.0031
5	0.0012

The initial response shows a sharp increase in capital market volatility during the first two periods following the energy shock. Subsequently, the response gradually weakens and approaches zero, indicating that the shock is strong but not permanent in the short term.

Variance Decomposition Results

Variance decomposition is used to measure the relative contribution of global energy crisis shocks in explaining variations in capital market volatility over a given time horizon.

Table 7. Variance Decomposition of Stock Market Volatility

Period	Explained by Own Shock (%)	Explained by Energy Shock (%)
1	92.6	7.4
3	81.3	18.7
5	73.9	26.1
10	68.2	31.8

The variance decomposition results indicate that the contribution of energy shocks to capital market volatility increases over time. In the medium term, global energy crises explain more than 30 percent of the variation in capital market volatility, confirming the important role of energy as a source of systemic uncertainty

Discussion

The results of the VAR and VECM analyses provide strong empirical support for the research hypothesis that global energy crises have a significant effect on capital market volatility through short-term dynamic mechanisms and long-term equilibrium relationships. These findings indicate that energy shocks are not merely temporary, but are integrated into financial market dynamics as a persistent source of macroeconomic uncertainty. Support for this hypothesis is consistently reflected in the initial responses of capital market volatility, the existence of cointegration among variables, and the adjustment mechanisms identified in the VECM model.

In the short term, the impulse response function results show that capital market volatility responds positively and significantly to global energy crisis shocks. This initial response reflects the rapid reaction of market participants to uncertainty triggered by energy price surges, supply disruptions, and heightened geopolitical risks. These findings are consistent with macroeconomic shock transmission theory, which states that energy price fluctuations, as fundamental inputs in economic activity, directly affect investor expectations and market risk perceptions (Broadstock & Filis, 2020; Smales, 2019). Thus, increased volatility in the early periods following an energy shock can be understood as asset price adjustments to new information that raises systemic uncertainty.

Nevertheless, the impulse response pattern also shows that the impact of energy shocks on capital market volatility is temporary in the short term. The heightened volatility response in the initial periods gradually declines and approaches zero in subsequent periods. This pattern indicates that capital markets have adaptive capacity to external shocks once information has been fully internalized. This finding is consistent with studies emphasizing that financial markets tend to experience volatility spikes immediately after energy shocks, but that these effects weaken over time as market mechanisms adjust (Bhatia & Basu, 2020; Zhang et al., 2021).

More substantive support for the research hypothesis emerges from the long-term analysis through cointegration tests and VECM estimation. The presence of one cointegration vector indicates that capital market volatility and global energy crises have a long-term equilibrium relationship. This finding confirms that the two variables do not move independently, but are bound by a structural relationship that reflects fundamental linkages between energy markets and financial markets. This result is consistent with literature showing long-term relationships between energy price fluctuations and stock market dynamics, particularly in the context of global uncertainty and macroeconomic shocks (Wang & Wang, 2019; Liao et al., 2021).

The negative and statistically significant error correction term coefficient provides additional evidence supporting the validity of the final research hypothesis. The error correction term indicates that capital market volatility systematically adjusts to deviations from long-term equilibrium caused by energy shocks. The magnitude of the adjustment coefficient reflects the speed at which capital markets correct imbalances resulting from global energy pressures. This finding is consistent with financial economics theoretical frameworks stating that capital markets, although highly sensitive to external shocks, tend to return toward long-term equilibrium through gradual adjustment mechanisms (Glandon et al., 2023).

The variance decomposition results further strengthen empirical support for the research hypothesis. In the short term, variations in capital market volatility are dominated by internal market shocks, reflecting the inherent characteristics of financial systems. However, as the time horizon increases, the contribution of global energy crisis shocks to variations in capital market volatility rises significantly. In the medium term, energy shocks explain a substantial proportion of capital market volatility fluctuations. This pattern confirms that the influence of energy on financial markets is not merely reactive, but accumulative and increasingly relevant in medium- to long-term dynamics, as also shown in studies on spillovers and connectedness across energy and financial markets (Coskun & Taspinar, 2022; Razi et al., 2025).

Overall, the empirical findings of this study consistently support the hypothesis that global energy crises are an important determinant of capital market volatility. The combination of rapid short-term responses, long-term equilibrium relationships, and significant adjustment mechanisms indicates that global energy shocks function as a source of systemic uncertainty integrated into financial market dynamics. These results reinforce the literature that positions energy crises as a key macroeconomic factor in explaining capital market volatility, particularly during periods of high global uncertainty (Broadstock & Filis, 2020; Nusair & Al-Khasawneh, 2023; Lin et al., 2025).

Accordingly, this discussion directly supports the final research hypothesis and confirms that the VAR–VECM analysis is an appropriate approach for capturing the complexity of the relationship between global energy crises and capital market volatility. These findings have important implications for investors and policymakers in understanding and responding more comprehensively to the transmission of energy shocks to financial market stability.

CONCLUSIONS

This study concludes that global energy crises have a significant impact on capital market volatility through short-term dynamic mechanisms and long-term equilibrium relationships. Based on the results of the VAR and VECM analyses, capital market volatility is shown to respond rapidly to global energy shocks, reflecting increased uncertainty and adjustments in investor expectations in response to changes in macroeconomic conditions. This initial response is temporary, yet sufficiently strong to confirm that capital markets are highly sensitive to shocks originating from the energy sector.

Furthermore, the cointegration test results indicate the existence of a long-term equilibrium relationship between global energy crises and capital market volatility. This finding confirms that the linkage between energy markets and financial markets is not incidental, but rather reflects a sustained structural relationship. The VECM estimation shows that capital market volatility systematically adjusts to deviations from long-term equilibrium triggered by energy shocks, as indicated by a negative and statistically significant error correction term. This adjustment mechanism demonstrates that although energy shocks increase volatility in the short term, capital markets tend to return toward equilibrium in the long run.

The variance decomposition results further reinforce this conclusion by showing that the contribution of global energy crisis shocks to variations in capital market volatility increases as the time horizon extends. In the short term, capital market volatility is largely explained by internal market shocks, but in the medium to long term, global energy crises become an increasingly dominant source of uncertainty. These findings indicate that the influence of energy on capital markets is not only reactive, but also cumulative and shapes volatility dynamics in a sustained manner.

Overall, the empirical findings of this study support the final hypothesis that global energy crises are an important determinant of capital market volatility. The main contribution of this study lies in the clear distinction between short-term and long-term dynamics in explaining the transmission of energy shocks to financial markets through the VAR–VECM approach. From a practical perspective, the results imply that investors and policymakers need to incorporate energy market dynamics as a key factor in risk management and the formulation of capital market stabilization policies, particularly during periods of high global uncertainty.

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