Global Shocks and the Oil–Equity Nexus: Time-Varying Correlations and Portfolio Diversification Implications

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ABSTRACT

The study examines the dynamic relationship between crude oil returns and stock market returns in major oil-importing economies across a range of global events using DCC-GARCH framework. The findings reveal that oil–equity relationships vary across trade conflict (the US–China trade war), a global health crisis (the COVID-19 pandemic), a macroeconomic shock (the global inflation surge), and armed conflicts (the Russia–Ukraine and US–Iran wars). These results have four main implications. First, oil–equity correlations exhibit contrasting patterns during trade conflict. Second, the global health crisis was associated with higher oil–equity correlations in the selected oil-importing countries. Third, oil–equity relationships differed across phases of the global inflation surge. Finally, positive oil–equity correlations strengthened during the armed conflicts examined, suggesting greater exposure to shared shocks and geopolitical uncertainty. These results provide useful insights for investors and portfolio managers seeking to improve asset allocation and portfolio diversification under changing market conditions.

Keywords: DCC-GARCH, Time-varying Conditional Correlations, Oil-equity Nexus, Global Events, Major Oil-importing Countries

INTRODUCTION

Crude oil plays a crucial role in the global economy, as it remains the world's most widely used energy resource and accounts for more than 90% of global transportation energy (Stanford University, 2026). Beyond transportation, crude oil and its refined products are also important for electricity generation and serve as essential feedstocks for a wide range of industrial processes (U.S. Energy Information Administration, 2023).

Global events can substantially influence the demand for and supply of crude oil, resulting in considerable volatility in international oil markets. Major events include oil price collapses, the US–China trade war, the COVID-19 pandemic, the Russia–Ukraine war, and recent geopolitical conflicts in the Middle East have disrupted global energy markets (Mohn, 2022). Imbalances between crude oil supply and demand can intensify energy crises. Supply disruptions arising from geopolitical conflicts, production cuts, transportation bottlenecks, and other constraints can create shortages and exert upward pressure on oil prices. Conversely, excessive production or weakening demand can generate an oil surplus, resulting in downward pressure on prices.

Fluctuations in crude oil prices can subsequently transmit to financial markets, particularly equity markets. One important transmission mechanism is the cost channel, whereby higher oil prices increase firms' production and operating costs, reduce expected profitability, and consequently exert downward pressure on stock prices (Filis et al., 2011; Cui et al., 2021). Consequently, substantial fluctuations in oil prices may expose investors and portfolio managers to greater investment risk while creating broader challenges for policymakers through increased financial and macroeconomic instability. Under such conditions, portfolio diversification becomes particularly important as a risk-management strategy.

Portfolio diversification refers to the allocation of wealth across different assets to reduce asset-specific or unsystematic risk (Lhabitant, 2017). Diversification is a central principle of Modern Portfolio Theory (MPT), which provides a framework for constructing portfolios that maximize expected returns for a given level of risk.

Under MPT, investors are generally assumed to be risk-averse and therefore prefer portfolios that offer lower risk for a given expected return.

The effectiveness of portfolio diversification depends considerably on the correlations among portfolio assets. When asset returns are strongly positively correlated, they tend to move in the same direction, limiting diversification benefits and maintaining relatively high portfolio risk. In contrast, negatively correlated assets provide stronger diversification benefits because losses in one asset may be offset by gains in another. Assets with little or no correlation also contribute to risk reduction because their returns move relatively independently, although the diversification benefit may be weaker than that achieved through negative correlation. Diversification can improve portfolio resilience during unexpected economic and geopolitical shocks.

These developments highlight the importance of understanding the relationship between oil price returns and stock market returns when designing investment strategies. Investors and portfolio managers require information on the strength, direction, and evolution of this relationship to determine whether equity markets and crude oil provide effective diversification opportunities during periods of energy-market stress. During an energy crisis, for example, losses in energy-dependent industries may potentially be offset by stronger performance in energy-producing sectors or commodity-related assets. Understanding these relationships may therefore contribute to more effective portfolio allocation and risk management.

Oil-importing economies are particularly vulnerable to external oil price shocks because higher energy prices can increase inflationary pressures, raise production and transportation costs, deteriorate trade balances, and constrain economic growth. This vulnerability provides the motivation for focusing on major oil-importing countries in the present study. Against this backdrop, this study examines how the interrelationship between oil price returns and stock market returns in major oil-importing economies across different global events and investigates whether the evolving correlations between these markets create or diminish portfolio diversification benefits for investors.

To address the research question, this study contributes to the portfolio management literature by examining the dynamic relationship between oil price returns and stock market returns in major oil-importing economies across a range of global events, including the oil price collapse, the US–China trade war, the COVID-19 pandemic, the global inflationary episode, the Russia–Ukraine war, and the onset of the US–Iran conflict. Although a substantial body of literature has investigated the oil–equity nexus, much of the existing evidence focuses on individual crisis episodes, particularly the COVID-19 pandemic (see Zhang & Hamori, 2021; Zhang et al., 2021; Ali et al., 2022) and the Russia–Ukraine war (see Adekoya et al., 2022; Umar et al., 2022; Huang et al., 2023). These studies generally show that the oil–equity relationship is time-varying, asymmetric, and sensitive to major external shocks. Filis et al. (2011), for example, demonstrate that both the source of oil price shocks and prevailing global economic conditions play important roles in shaping the oil–equity return relationship. However, relatively limited evidence systematically compares how the oil–equity return relationship in major oil-importing economies evolves across structurally different global events within a consistent empirical framework.

This study addresses this gap by examining the oil–equity return nexus in major oil-importing countries across different global events using a Dynamic Conditional Correlation DCC-GARCH (1,1) framework. The findings show that oil–equity return correlations vary considerably over time, differ across oil-importing economies, and respond differently to major global events. These results provide useful insights for investors and portfolio managers seeking to improve asset allocation and portfolio diversification under changing market conditions. For instance, oil–equity relationships differed across phases of the global inflation surge. Correlations initially declined, particularly for China and India. Subsequently, concerns about inflation, monetary tightening, and a potential economic slowdown may have weakened expectations for both oil demand and corporate earnings, contributing to stronger positive co-movement. For portfolio managers, the findings support reviewing oil allocations across different phases of macroeconomic stress, with allocation decisions informed by prevailing correlations, volatility, and investment objectives.

The remainder of the study is organized as follows. Section 2 describes the data and methodology. Section 3 presents and discusses the empirical findings, while Section 4 concludes the study.

DATA AND METHODOLOGY

Data

We employ daily closing prices of benchmark crude oil index (S&P GSCI WTI Index) and major equity indices from five oil-importing countries, including China (SSE Composite Index), India (NIFTY 50), Japan (NIKKEI 225), South Korea (KOSPI), and the U.S. (S&P 500). The five countries were selected as the world's leading gross crude oil importers based on the World Energy Review 2026 (Eni, 2026).[1] All the data are obtained from S&P Capital IQ. The sample period spans from 1st December 2014 to 31st March 2026, thereby covering the major global events examined in this study. The study considers six major global events. First, the oil price collapse (1 December 2014 to 29 February 2016) that captures the prolonged decline in crude oil prices and the early-2016 trough (U.S. Energy Information Administration, 2015). Second, the initial phase of the US-China Trade War is defined from 6 July 2018, when reciprocal tariffs were first implemented, to 15 January 2020, when the Phase One Trade Agreement was signed (Congressional Research Service, 2019; Office of the United States Trade Representative, 2020). Third, the early phase of the COVID-19 pandemic is examined from 1 January 2020 to 31 December 2021 (World Health Organization, 2020). Fourth, the global inflation surge is examined from 1 January 2021 to 31 December 2023, encompassing the acceleration and subsequent moderation of inflation (Ari et al., 2023; Ha et al., 2024). Fifth, the Russia–Ukraine war is considered from the onset of Russia's full-scale invasion on 24 February 2022 (United Nations, 2022), whereas the 2026 US–Iran conflict is examined from the commencement of US military operations against Iran on 28 February 2026 (U.S. Central Command, 2026). The daily price series are then transformed into logarithmic returns as follows:

$$R_t = \ln(P_t/P_{t-1})$$

where R_t is the return at the time t, P_t is the price at time t and is P_{t-1} is the price at t-1.

Table 1 presents the descriptive statistics of the return series. Crude oil records the highest mean return (0.17%) and standard deviation (2.76%) among all series. These statistics indicate that it generated the highest average return while also exhibiting the greatest volatility over the sample period. This relatively high volatility is consistent with the view that crude oil prices are particularly sensitive to global events and disruptions in energy markets (Smales, 2021). Among the equity markets, the S&P 500 records the highest mean return of 0.04860%, whereas the NIKKEI 225 exhibits the highest volatility, with a standard deviation of 1.43%. This suggests that the Japanese equity market experienced greater return fluctuations than the other equity markets examined during the sample period.

Additionally, all return series exhibit negative skewness, indicating asymmetric distributions with longer left tails and a greater tendency toward large negative returns. Among the series, the KOSPI records the most negative skewness (-1.62), suggesting a relatively greater exposure to extreme negative return movements and market downturns. Furthermore, all series display kurtosis values greater than 3, indicating leptokurtic distributions characterized by fat tails and a higher likelihood of extreme return observations. Taken together, the negative skewness and excess kurtosis suggest that the return distributions deviate from normality and are subject to substantial downside risk and extreme market fluctuations.

Table 1: Descriptive Statistics

	WTI	NIKKEI 225	SSE	NIFTY 50	KOSPI	S&P 500
Mean	0.17198	0.04661	0.01642	0.04133	0.04256	0.0486
Std. Dev.	2.76462	1.43405	1.40977	1.10155	1.33265	1.20663
Skewness	-0.2172	-0.5268	-0.79058	-0.67012	-1.61625	-0.746
Kurtosis	21.8827	8.51214	7.59975	9.42758	29.56775	15.5173

[1] Between 2015 and 2025, the average daily gross crude oil imports of China, the United States, India, South Korea, and Japan were 10.248, 6.460, 4.647, 2.727, and 2.616 million barrels, respectively. According to the World Energy Review 2026, these countries accounted for 24.7%, 13.2%, 11.6%, 5.9%, and 5.1% of global crude oil imports, respectively (Eni, 2026). These substantial import volumes provide the basis for selecting the five countries to examine the relationship between crude oil returns and equity returns.

No. of Obs.	2322	2322	2322	2322	2322	2322

Bivariate DCC-GARCH (1,1)

We use Bivariate DCC-GARCH (1,1) framework in our study to capture volatility clustering and dynamic correlations effectively. The model can capture dynamic changes in correlations and allows an evaluation of diversification benefit under different market conditions. The persistence and impact of shocks on correlation dynamics indicated by main parameters such α1 and β1. The Bivariate DCC-GARCH model implements a two steps process. First, the symmetric GARCH (1,1) model is estimated to analyze the volatility clustering among the series as follow (Bollerslev, 1986):

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (1)$$

where σ_t^2 denotes the conditional variance of series at time *t*, ω is a constant and non-zero value, α and β measure the impact of recent shocks and persistence of volatility, respectively. Both α and β must be either greater or equal to zero and satisfies the condition $\alpha + \beta \leq 1$. ε_{t-1}^2 is lagged squared residuals.

Following Bollerslev et al. (1988), we obtain the conditional volatilities, H_t from a multivariate GARCH (1,1) model:

$$vech(H_t) = C + A_1 vech(u_{t=1}u'_{t=1}) + B_1 vech(H_{t-1}) \quad (2)$$

where A_1 and B_1 are the coefficient matrix that capture ARCH and GARCH effects, respectively. $u_{t=1}$ is the vector of residuals at time $t-1$.

Then, we incorporate the GARCH (1,1) specification under the DCC process introduced by Engle (2002) to analyze the dynamic conditional correlation between two series. The conditional variance-covariance matrix of residuals from a Bivariate DCC-GARCH is as follows:

$$H_t = D_t R_t D_t \quad (3)$$

The conditional variance for each return series is estimated using a GARCH (1,1) specification:

$$h_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1} \quad (4)$$

where $\omega_i > 0$, α_i and β_i are non-negativity of variances with $\alpha_i + \beta_i < 1$ imposed to ensure covariance stationarity under the standard GARCH assumptions. The dynamic conditional correlation matrix is obtained as:

$$R_t diag(Q_t)^{-\frac{1}{2}} Q_t diag(Q_t)^{-1/2} \quad (5)$$

where Q_t is the evolving covariance matrix of the standardized residuals, defined as:

$$Q_t = (1 - a - b)\bar{Q} + a(u_{t-1}u'_{t-1}) + bQ_{t-1} \quad (6)$$

Here, $u_t = D_t^{-1}\varepsilon_t$ represents the standardized residuals, $\bar{Q}$ is their unconditional covariance matrix, and a and b capture the effects of past shocks and correlation persistence, respectively. The parameters satisfy both a and $b \geq 0$ and $a + b < 1$.

For a bivariate system, the dynamic conditional correlation between series return I and j is expressed as:

$$\rho_{ij,t} \frac{q_{ij,t}}{\sqrt{q_{ii,t}q_{jj,t}}} \quad (7)$$

The DCC-GARCH parameters are estimated using the quasi-maximum likelihood approach, allowing the conditional correlations to adjust to changing market conditions over time.

Table 2 presents estimated parameters of the DCC-GARCH (1,1) models under the assumption of a multivariate normal distribution. The ARCH (α_i) and GARCH (β_i) coefficients are statistically significant across all return series, with their sums remaining below unity. These results support the stationarity of the conditional variance processes. Similarly, the sums of the DCC parameters (α_{DCC} and β_{DCC}) are below unity, indicating stable and mean-reverting conditional correlation dynamics. Both DCC parameters are statistically significant across the return series, except for the α_{DCC} parameter associated with the KOSPI.

Table 2: Bivariate DCC-GARCH (1,1) model

	Intercept (ω_i)	ARCH (α_i)	GARCH (β_i)	α_{DCC}	β_{DCC}
SSE	0.0287***	0.07890***	0.9100***	0.0401**	0.8364***
WTI	0.2322***	0.1034***	0.8665***		
NIFTY 50	0.0358***	0.0848***	0.8843***	0.0224*	0.8696***
WTI	0.2322***	0.1034***	0.8665***		
NIKKEI 225	0.1875**	0.1633***	0.7541***	0.0158*	0.8823***
WTI	0.2322***	0.1034***	0.8665***		
KOSPI	0.0348	0.0999*	0.8875***	0.0045	0.8598***
WTI	0.2322***	0.1034***	0.8665***		
S&P 500	0.0257***	0.1597***	0.8393***	0.0320*	0.9204***
WTI	0.2322***	0.1034***	0.8665***		

Note: Statistical significance is marked by ***, **, and * corresponding to the 1%, 5%, and 10% significance levels, respectively. The bivariate DCC-GARCH between the crude oil (WTI) and the respective major equity index is estimated using a DCC-GARCH (1,1) specification under a multivariate normal distribution.

EMPIRICAL FINDINGS

Figure 1 illustrates the time-varying conditional correlations between crude oil returns and equity returns in five selected oil-importing countries. Overall, the conditional correlations for all the selected countries remained weakly positive, ranging from 0.01 to 0.28 across the global events examined, except for S&P500. These low positive correlations suggest that combining crude oil and the corresponding equity indices into a portfolio may offer diversification benefits. However, the extent of these benefits varies across countries and events.

Most of oil-equity correlations show increasing trend during the oil price collapse period and peak around at the middle of the period. The findings suggest that the interrelationship between crude oil and equity indices are strengthened during oil price collapse period. Nevertheless, their relatively low correlations suggest that some diversification potential remained. Correlations subsequently declined from late 2016 to 2018. This decline coincided with the production restraint agreement reached by OPEC in late 2016 and its implementation from January 2017, although the correlation estimates alone cannot establish the contribution of these developments.

During the US–China trade war, changes in oil–equity correlations were particularly pronounced for the SSE Composite, NIFTY 50, and S&P 500. Unlike the S&P 500, the SSE Composite and NIFTY 50 exhibited similar dynamics, with correlations declining during the initial phase of the conflict. One possible explanation is that weaker trade and growth expectations placed downward pressure on oil prices, while lower energy costs partly cushioned equity markets in China and India, both major net oil-importing economies. In 2019, however, correlations increased sharply for all three indices. This pattern is consistent with escalating trade tensions exposing oil and equity markets to common concerns over global economic activity (International Energy Agency, 2019).

For the COVID-19 pandemic, the conditional correlations exhibit increasing trend for most equity indices, with a pronounced rise near the onset of the crisis. This pattern may reflect the combined effects of mobility restrictions, weaker economic activity, and heightened investor risk aversion. Lockdowns reduced oil demand, placing downward pressure on crude oil prices, while deteriorating earnings expectations and increased

uncertainty weighed on equity prices. These simultaneous declines may explain the stronger positive correlations. Our findings are consistent with Prabheesh et al. (2020), which reports positive oil-equity correlations in net oil-importing countries during the pandemic. Stronger co-movement suggests that the diversification benefits of holding crude oil alongside equities may diminish during a global health crisis.

At the beginning of the global inflation surge, oil–equity correlations declined, particularly for the SSE Composite and NIFTY 50. A possible explanation is that the reopening of economies supported a recovery in oil demand that outpaced supply, raising oil prices and adding to inflationary pressures (Troderman, 2022). For oil-importing economies, higher energy costs may reduce corporate profitability and weigh on equity valuations, allowing oil and equity returns to move in opposite directions. From around mid-2021, however, correlations began to rise. One possible interpretation is that concerns about inflation, prospective monetary tightening, and weaker growth increasingly influenced both markets (Guénette et al., 2022). Deteriorating growth expectations could weigh on anticipated oil demand and corporate earnings simultaneously, strengthening positive oil–equity co-movement.

Positive oil-equity correlation also strengthened during the periods identified as the Russia-Ukraine and US-Iran Wars. This pattern may reflect greater exposure to global common shocks originated from these wars, which are negative oil-supply shocks (Ewing et al., 2018) and geopolitical uncertainty (Nerlinger & Utz, 2022; Miketta et al., 2026). However, oil supply disruptions alone do not necessarily explain stronger positive correlations, as higher oil prices can adversely affect equities in oil-importing economies. The observed co-movement may therefore reflect the combined influence of supply concerns, changing demand expectations, and investor risk sentiment. Higher positive correlations indicate reduced diversification potential during these periods, although they do not establish that diversification benefits disappeared entirely.

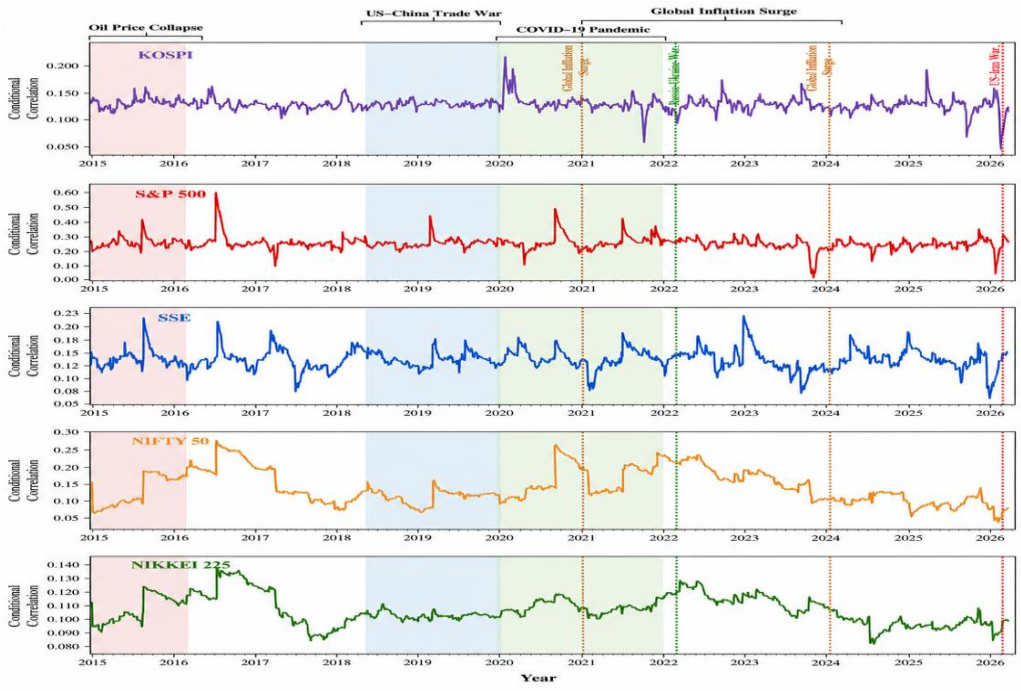

Fig. 1 Dynamic conditional correlations between crude oil returns and equity returns in KOSPI (Korea major equity index), S&P 500 (U.S. major equity index), SSE (China major equity index), NIFTY 50 (India major equity index), and NIKKEI 225 (Japan major equity index) using DCC-GARCH (1,1) under multivariate student t distribution framework. The sample period covers from 1st December 2014 to 31st March 2026.

CONCLUSION

This study examines the dynamic conditional correlations between crude oil returns and equity returns in five oil-importing countries across major global events using the DCC-GARCH (1,1) framework. The findings reveal that oil–equity relationships vary across trade conflict (the US–China trade war), a global health crisis (the COVID-19 pandemic), a macroeconomic shock (the global inflation surge), and armed conflicts (the Russia–Ukraine and US–Iran wars). These results have four main implications.

First, oil–equity correlations exhibit contrasting patterns during trade conflict. Correlations for the SSE Composite and NIFTY 50 initially declined following the onset of the US–China trade war. One possible explanation is that weaker global trade and growth expectations depressed oil prices, while lower energy costs partly cushioned equities in China and India. However, correlations increased substantially as trade tensions escalated, suggesting stronger exposure to common economic risks. For portfolio managers and investors, these findings suggest that crude oil may offer diversification benefits during the early stages of trade conflict, although these benefits may diminish as tensions intensify.

Second, the global health crisis was associated with higher oil–equity correlations in the selected oil-importing countries. Heightened investor risk aversion and adverse oil-demand shocks arising from pandemic-related mobility restrictions may explain this pattern. Weaker economic activity weighed on both oil demand and corporate earnings, strengthening co-movement between oil and equity returns. The findings suggest that holding crude oil alongside equities may offer less protection during a global health crisis.

Third, oil–equity relationships differed across phases of the global inflation surge. Correlations initially declined, particularly for China and India. This pattern may reflect rising oil prices during the recovery from pandemic-related restrictions, alongside pressure on equity valuations from higher production costs. Subsequently, concerns about inflation, monetary tightening, and a potential economic slowdown may have weakened expectations for both oil demand and corporate earnings, contributing to stronger positive co-movement. The observed increase in correlations from around mid-2021 highlights the importance of assessing how these influences evolved over time. For portfolio managers, the findings support reviewing oil allocations across different phases of macroeconomic stress, with allocation decisions informed by prevailing correlations, volatility, and investment objectives.

Finally, positive oil–equity correlations strengthened during the armed conflicts examined, suggesting greater exposure to shared shocks and geopolitical uncertainty. Although oil supply disruptions may have influenced market dynamics, they alone cannot explain stronger positive co-movement in oil-importing economies. Changing demand expectations and investor sentiment may also have contributed. These findings suggest that the diversification potential of adding crude oil to equity portfolios may decline during armed conflict.

Conflicts of Interest:

The authors declare no conflicts of interest.

Data Availability Statement:

The dataset is available from the corresponding author upon request. These data were derived from S&P Capital IQ.

Authors statement:

All authors contributed equally to this paper.

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