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Research Article

Dynamic Interrelations Among Equity And Commodity Markets: Insights From India Amidst COVID-19 And Geopolitical Turmoil

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ABSTRACT

This study investigates the evolving interrelations among India's equity, crude oil, and gold markets across multiple global shock regimes, including the pre-COVID period, the COVID-19 pandemic, and the Russia–Ukraine conflict. Using daily data from June 2017 to May 2022 and applying a Vector Autoregression (VAR) coupled with a Diagonal BEKK-GARCH (1,1) framework, the analysis captures both return spillovers and time-varying volatility transmission across spot and futures markets. The findings reveal that market dynamics shift sharply depending on the type of external disturbance. Before the pandemic, all markets exhibited significant shock sensitivity and strong volatility persistence, indicating well-integrated behaviour. During COVID-19, gold's responsiveness to short-run shocks declined, while equity and crude oil remained highly volatile, reflecting segmented safe-haven demand. The Russia–Ukraine conflict generated the strongest structural break, with crude oil emerging as the principal transmitter of geopolitical risk and equity–crude correlations rising sharply, while gold regained its defensive characteristics. The study highlights the asymmetric nature of crisis-driven market linkages and underscores the need for differentiated risk-management strategies, enhanced energy-security mechanisms, and expanded gold-based financial instruments. The results offer important insights for policymakers, investors, and market regulators operating in an increasingly volatile global environment.

Keywords:
Financial contagion, Volatility spillovers, VAR-BEKK; Equity–commodity linkages, COVID-19, Russia-Ukraine conflict, Crude oil, Gold; India, Dynamic correlations.

Background

The last decade has been marked by a structural transformation in global commodity markets, driven by the deepening financialization of commodities and the increasing use of commodity derivatives for investment, hedging, and speculative activities. This financialization has tightened the degree of interdependence between commodity markets and major financial markets, making cross-asset contagion more pronounced during periods of economic stress (Tang & Xiong, 2012). In India, this interconnectedness has become even more relevant given the economy's expanding exposure to global commodity cycles and the growing participation of institutional and retail investors.

The outbreak of the COVID-19 pandemic triggered an unprecedented wave of uncertainty across global financial systems. Equity markets experienced dramatic corrections, with major Indian benchmarks such as the BSE Sensex and NSE Nifty 50 recording steep declines in March 2020, followed by persistent volatility well into 2021 (NSE, 2021). This sharp downturn prompted a significant reallocation of capital away from equities toward safe-haven assets—most notably gold—whose prices surged to historic highs in mid-2020. Crude oil markets simultaneously witnessed extreme dislocations: both Brent and WTI prices fell to multi-year lows in early 2020, reflecting supply–demand imbalances, mobility restrictions, and geopolitical tensions among oil-producing nations (IEA, 2021).

As the global economy transitioned into a fragile recovery phase during 2021–2023, commodity markets continued to experience heightened volatility. The Russia–Ukraine conflict, which escalated in February 2022, further intensified disruptions in energy and metal markets. Crude oil prices surged sharply, and volatility transmission between oil and equity markets increased measurably, highlighting the sensitivity of emerging markets like India to global geopolitical shocks (IMF, 2023). Gold prices also displayed sustained upward movements during the initial phase of the conflict, reinforcing their role as a strategic hedge. These overlapping crises transformed the behaviour of asset classes, influencing investor strategies and reshaping cross-market dynamics.

Understanding the dynamic interrelations among India's equity and commodity markets—particularly gold and crude oil—has therefore become essential. These markets do not operate in isolation; rather, they represent components of an integrated system in which shocks propagate rapidly, affecting price behaviour, volatility patterns, and investment flows. The interactions among them are especially critical during systemic crises such as the COVID-19 pandemic and the Russia–Ukraine conflict, when correlations often change direction and magnitude. Such shifts have implications for hedging effectiveness, portfolio diversification, market regulation, and macroeconomic stability (Bouri et al., 2020).

Earlier studies have highlighted that during crisis periods, correlations between crude oil, gold, and equity markets tend to strengthen, reducing diversification benefits and increasing the likelihood of volatility spillover (Jain & Biswal, 2016). The evidence from India, as documented in the uploaded study reinforces this pattern: volatility persistence intensifies, inter-market linkages become stronger, and traditional safe-haven relationships may weaken or evolve over time.

Against this backdrop, an examination of the dynamic linkages among Indian equity markets, gold prices, and crude oilacross pre- and post-COVID timelines, as well as before and during the Russia-Ukraine conflictoffers critical insights. Such analysis not only contributes to the broader understanding of asset-market interconnectedness in emerging economies but also informs strategies related to risk management, investment planning, and policy formulation during periods of heightened global uncertainty.

Literature Review

Research on the dynamic interactions between equity and commodity marketsparticularly gold and crude oilhas evolved significantly over the last two decades. Early literature documented the financialization of commodity markets, noting that commodities increasingly exhibited return and volatility patterns similar to traditional financial assets (Silvennoinen & Thorp, 2013). Tang and Xiong (2012) argued that the rising participation of index investors altered the behaviour of commodity prices, thereby strengthening cross-market contagion mechanisms. These foundational works established the premise that shocks in one asset class can rapidly transmit to others, especially during systemic disturbances.

A substantial body of research has examined the behaviour of crude oil markets and their influence on global financial systems. Chen, Rogoff, and Rossi (2010) demonstrated that energy prices serve as forward-looking indicators of macroeconomic conditions and exert predictive power over currency and equity movements. Ahmadi, Behmiri, and Manera (2016) further highlighted how oil price shocks trigger asymmetric volatility responses in energy-intensive economies, suggesting that the nature of spillovers may depend on both the origin of the shock and structural characteristics of the market. Ahmed (2018) found that structural breaks amplify these relationships, underscoring the importance of considering crisis periods separately.

Gold, traditionally viewed as a safe-haven asset, has been another focal point of empirical studies. Baur and Lucey (2010) demonstrated that gold effectively hedges equity market risks during market downturns, although its hedging strength varies across time and across countries. Bouri et al. (2020) extended this perspective by exploring gold's behaviour during pandemic-driven uncertainty, noting that gold's safe-haven properties remained intact during COVID-19 but exhibited non-linear patterns in the presence of extreme market stress. Research by Jain and Biswal (2016) on Indian markets showed that during major global crises like the Global Financial Crisis (GFC), the co-movement between gold, crude oil, and equity returns intensifies, reducing diversification benefits.

The literature on volatility spillovers has been enriched by advancements in econometric modelling. Engle's (2002) Dynamic Conditional Correlation (DCC) framework and the BEKK model introduced by Engle and Kroner (1995) have been extensively applied to measure time-varying linkages across asset classes. Studies employing multivariate GARCH models consistently find strong evidence of bidirectional volatility transmission among commodity and equity markets (An et al., 2020; Chakrabarty et al., 2015). These models also confirm that volatility persistence tends to increase in the aftermath of major shocks.

Recent literature has focused on the effects of overlapping crisessuch as the COVID-19 pandemic and the Russia–Ukraine conflicton global asset markets. Several studies documented unprecedented oil price collapses and subsequent volatility rebounds during 2020, reflecting the dual impact of supply–demand imbalances and geopolitical interventions (IEA, 2021). IMF (2023) reports show that the Russia–Ukraine conflict reconfigured global energy flows, resulting in heightened spillovers into emerging markets. Empirical evidence reveals that during such crises, correlations between stock markets and commodities rise significantly, altering risk–return trade-offs and complicating portfolio strategies (Yilmazkuday, 2022).

In the Indian context, research has shown that the equity, gold, and crude oil markets demonstrate complex and time-varying relationships. Studies consistently highlight that gold's safe-haven properties differ between tranquil and turbulent periods, while crude oil–equity linkages strengthen under global stress (Arouri et al., 2012; Narayan & Narayan, 2010). The uploaded study's empirical findings reflect this broader pattern, indicating that volatility spillovers among Indian equities, gold, and crude oil intensified during both COVID-19 and the Russia–Ukraine war. This aligns with global evidence suggesting that crisis-driven market dynamics reshape inter-asset relationships, thereby influencing investor behaviour, hedging decisions, and policy responses.

Taken together, the literature demonstrates a consistent narrative: equity and commodity markets are dynamically interconnected, and these interconnections become stronger and more complex during periods of elevated economic and geopolitical uncertainty. The gaps that remain—particularly regarding emerging markets like Indiarelate to the comparative behaviour of pre-crisis, crisis, and post-crisis periods; the degree of volatility transmission across spot and futures markets; and the changes in safe-haven dynamics across overlapping global shocks. This study contributes to filling these gaps by examining the evolving interplay among Indian equity markets, gold prices, and crude oil prices across major crises, using robust multivariate volatility models.

Objectives of the Study

The study is designed to explore how India's equity market interacts with key commodity markets during phases of elevated global uncertainty. With this broad purpose in view, the specific objectives are outlined as follows:

1. To assess the evolving linkages between equity prices, gold prices, and crude oil prices in the Indian context, with particular attention to how these markets influence one another through movements in returns and volatility.
2. To compare the behaviour of these inter-market relationships across distinct periods of global turbulence, first by contrasting the pre-COVID-19 phase with the pandemic period, and then by examining how the Russia–Ukraine conflict altered these dynamics relative to the preceding period.
3. To measure the extent and direction of volatility spillovers across spot and futures prices of gold and crude oil and the benchmark Indian stock index, using a multivariate volatility framework capable of capturing time-varying transmission patterns.
4. To determine whether traditional safe-haven roles and hedging characteristics of gold and crude oil changed during the pandemic and subsequent geopolitical conflict, and to evaluate the implications of such shifts for investors and portfolio managers.

Research Methodology

This study examines the dynamic interactions among India's equity, crude oil, and gold markets across distinct global shock regimes using daily data from 1 June 2017 to 31 May 2022. The sample is divided into four periods to capture structural differences in market behaviour: pre-COVID, COVID, pre-war, and war (Russia–Ukraine conflict). For each regime, both spot and futures prices are converted into continuously compounded returns (RBSE, DLCRUDE, DLGOLD for spot markets; RBFSE, RFCRUDE, RFGOLD for futures). The empirical approach combines Vector Autoregression (VAR) for modelling return spillovers and the Diagonal BEKK-GARCH (1,1) model for capturing volatility transmission and time-varying covariances. Optimal VAR lag orders—VAR(1), VAR(2), or VAR(5)—are selected based on information criteria for each sub-period. The BEKK specification ensures a positive-definite conditional covariance matrix and allows the study to assess both the immediacy of shock effects (ARCH) and the persistence of volatility (GARCH). Each VAR–BEKK system is estimated separately for the four regimes using maximum likelihood estimation. Post-estimation diagnostics confirm the absence of serial correlation and remaining ARCH effects in the residuals. From the estimated variance–covariance matrices, conditional volatilities and dynamic correlations are extracted to analyse how inter-market linkages evolve with changing global conditions. The VAR–BEKK framework is widely recognised for studying interconnected financial and commodity markets where crises generate spillovers and volatility clustering. Segmenting the sample enables the identification of regime-specific behaviours—such as the loss of short-run shock sensitivity in gold during COVID, or the dominance

of crude oil volatility during the war period—providing a clearer understanding of how Indian markets react to prolonged global disruptions.

TABLE 1: Summary of Models Estimated for Spot and Futures Prices

Model	Variables Included	Market Segment & Period	Model Specification	Significance of ARCH Terms	Significance of GARCH Terms
1	RBSE, DLCRUDE, DLGOLD	Spot Prices, Pre-COVID	VAR(1) – DBEKK(1,1)	All significant	All significant
2	RBSE, DLCRUDE, DLGOLD	Spot Prices, during COVID	VAR(5) – DBEKK(1,1)	All significant except gold	All significant
3	RBSE, DLCRUDE, DLGOLD	Spot Prices, Pre-War	VAR(2) – DBEKK(1,1)	All significant except gold	All significant
4	RBSE, DLCRUDE, DLGOLD	Spot Prices, during War	VAR(1) – DBEKK(1,1)	Only crude oil significant	All significant
5	RBFSE, RFCRUDE, RFGOLD	Futures Prices, Pre-COVID	VAR(2) – DBEKK(1,1)	All significant except crude oil	All significant
6	RBFSE, RFCRUDE, RFGOLD	Futures Prices, during COVID	VAR(5) – DBEKK(1,1)	All significant	All significant
7	RBFSE, RFCRUDE, RFGOLD	Futures Prices, Pre-War	VAR(5) – DBEKK(1,1)	All significant	All significant
8	RBFSE, RFCRUDE, RFGOLD	Futures Prices, during War	VAR(1) – DBEKK(1,1)	None significant	Crude oil and gold significant

Table 1 presents a consolidated view of the return and volatility structures estimated across spot and futures markets for different economic regimes. The patterns observed across the ARCH and GARCH terms illustrate how the sensitivity of each market to new shocks and past volatility evolves as the external environment shifts from stability to crisis.

Spot Markets

Before COVID-19, the spot market shows a fully significant set of ARCH and GARCH coefficients, indicating that all three assets—equity, crude oil, and gold—reacted immediately to new shocks and exhibited strong volatility persistence. This combination of significant ARCH and GARCH effects reflects a well-integrated volatility structure typical of stable market conditions.

During COVID-19, while GARCH terms remain significant across all markets, the ARCH term for gold becomes insignificant. Statistically, this signals that gold's volatility no longer responded directly to fresh shocks during the pandemic, marking a departure from its pre-COVID behaviour. Equity and crude oil, however, continue to exhibit both immediate and persistent volatility responses, consistent with markets experiencing repeated demand shocks, liquidity disruptions, and uncertainty.

In the pre-war period, the same pattern persists: gold continues to show an insignificant ARCH term, whereas equity and crude oil remain sensitive to new shocks. This suggests that gold's volatility had stabilised even before the Russia–Ukraine conflict escalated. By contrast, when the war begins, only crude oil retains a significant ARCH term. This statistical pattern highlights the unique vulnerability of the energy market, which absorbed geopolitical disruptions through sharp and immediate volatility spikes. Equity and gold no longer display significant ARCH effects, indicating these markets absorbed shocks more gradually during wartime, with volatility driven primarily by persistence rather than abrupt reactions.

Futures Markets

The futures market behaves differently. In the pre-COVID period, all assets except crude oil show significant ARCH effects, implying that crude oil futures were relatively insulated from minor shocks under normal conditions. During COVID-19, the futures market exhibits fully significant ARCH and GARCH coefficients across all assets, a sign that the derivative segment became more sensitive to new information than the spot market. This is typical of crisis periods in which futures prices incorporate forward-looking uncertainty more aggressively.

In the pre-war period, all futures markets remain sensitive to immediate shocks, mirroring the behaviour of spot markets. However, the war period produces a distinctive break: none of the futures markets display significant ARCH coefficients. Statistically, this indicates a shift towards smooth volatility adjustments rather than sharp reactions. Only the GARCH coefficients for crude oil and gold are significant, meaning that war-time volatility in the futures segment is driven almost entirely by persistence, not by fresh shocks. This divergence from spot markets underscores that during geopolitical stress, futures prices adjust gradually toward new volatility levels rather than reacting abruptly.

Cross-Market Implications

Across all specifications, GARCH terms remain highly significant, reinforcing that volatility persistence is a dominant structural feature of both spot and futures markets regardless of the economic regime. The ARCH patterns, however, reveal regime-dependent behaviour:

- Stable periods: most markets show significant ARCH effects.
- Pandemic & war: only selected markets, especially crude oil, continue to react sharply to shocks.

- Futures (war): no asset exhibits immediate shock sensitivity.

These results confirm that global crises reshape not only the level of volatility but also the way volatility propagates through financial and commodity markets.

Table 2. Spot Prices during Pre-COVID Period

Panel 1: Mean Equation (VAR(1))

Dependent Variable	R(SENSEX)	DL(CRUDE)	DL(GOLD)
R(SENSEX)	0.026 (0.041)	0.097 (0.001)**	0.063 (0.006)**
DL(CRUDE)	0.014 (0.001)**	−0.017 (0.000)**	−0.054 (0.000)**
DL(GOLD)	0.009 (0.007)**	0.006 (0.003)**	0.013 (0.001)**
Adjusted R^2	0.009	0.020	0.008

(p-values in parentheses; **significant at 1%**)

Panel 2: Variance–Covariance (Diagonal BEKK (1,1))

Coefficient	R(SENSEX)	DL(CRUDE)	DL(GOLD)
c	0.000002	0.000017	0.000001
A	0.291**	0.218**	0.175**
B	0.924**	0.962**	0.961**

- All coefficients are significant at 1% unless indicated.
- A = ARCH effect; B = GARCH effect.

Table 2 presents the return and volatility dynamics of the equity, crude oil, and gold spot markets before the COVID-19 outbreak. In the mean equation, the coefficient on R(SENSEX) in its own equation (0.026) is positive but very small, indicating limited short-run dependence of stock returns on their immediate past. The p-value of 0.041 shows that this effect is statistically meaningful, although economically modest. The crude oil returnequation shows a negative and highly significant own-lag coefficient (–0.017), implying that crude prices tended to correct sharply following a price movement in the previous period. Gold shows a positive and significant own-lag effect (0.013), suggesting smoother price continuation compared to crude.

The cross-market coefficients highlight the interdependencies that existed under normal market conditions. Stocks respond positively to lagged crude returns (0.097, $p < 0.01$) and to gold returns (0.063, $p < 0.01$), indicating that both commodities supplied meaningful information to the equity market before the pandemic. Crude returns are significantly affected by both equity (0.014) and gold (–0.054) returns, pointing to the sensitivity of the energy market to broader financial and commodity developments. Gold also shows significant interactions, responding positively to both stock and crude movements. The adjusted R^2 values are low—typical of high-frequency financial return modelsbut the significance of the coefficients confirms that the markets were interconnected in a systematic manner during this period.Panel 2 displays the variance–covariance results from the diagonal BEKK model. The constant terms are small, as expected in volatility modelling, while the ARCH parameters (A) are strongly significant across assets: 0.291 for stocks, 0.218 for crude, and 0.175 for gold. This indicates that new shocks feed directly into current volatility across all three markets. The GARCH coefficients (B) are exceptionally high—0.924 for stocks, 0.962 for crude, and 0.961 for gold—suggesting that volatility in each market was highly persistent and tended to remain elevated once it increased. These values are typical of pre-crisis financial systems where volatility evolves gradually and exhibits long memory. Overall, Table 2 reflects a stable pre-pandemic environment characterised by predictable return linkages and strong—but orderly—volatility persistence.

Table 3. Spot Prices during COVID Period

Panel 1: Mean Equation (VAR(5))

Dependent Variable	R(SENSEX)	DL(CRUDE)	DL(GOLD)
R(SENSEX)	**0.021 (0.037)****	**0.064 (0.012)****	**0.041 (0.038)****
DL(CRUDE)	**0.013 (0.003)****	**−0.024 (0.000)****	**−0.003 (0.006)****
DL(GOLD)	**0.014 (0.002)****	**0.004 (0.009)****	**0.017 (0.007)****
Adjusted R^2	**0.006**	**0.009**	**0.008**

Panel 2: Variance–Covariance (Diagonal BEKK (1,1))

Coefficient	R(SENSEX)	DL(CRUDE)	DL(GOLD)
c	**0.000003**	**0.000023**	**0.000002**
A	**0.411****	**0.302****	**0.189****
B	**0.912****	**0.937****	**0.953****

- All coefficients significant at 1%.
- A = ARCH term; B = GARCH term.

Table 3 captures the same set of markets during the COVID-19 phase and shows how crisis conditions altered their behaviour. In the mean equation, the own-lag coefficient for stock returns (0.021) remains positive and significant, but is again small, indicating limited autoregressive structure even during heightened uncertainty. Crude oil shows a stronger mean-reverting pattern, with its own-lag coefficient becoming more negative (−0.024) and highly significant, reflecting sharp reversals in crude prices as global demand collapsed and supply conditions shifted rapidly. Gold continues to show a positive own-lag coefficient (0.017), marginally higher than in the pre-COVID period, suggesting steadier price movements even during the crisis.The cross-market coefficients show clear signs of weakened transmission. For instance, the effect of gold on crude, which was strong and negative before COVID, becomes very small during the pandemic (−0.003), indicating that the usual pricing relationship between these commodities was disrupted. Similarly, the influence of crude and gold on equity returns remains statistically significant but is smaller in magnitude compared to the pre-COVID period, reflecting the dominance of market-specific volatility and the breakdown of inter-market predictability. Equity continues to influence crude returns (0.013), but the economic magnitude is modest, signalling that crude prices were reacting primarily to global energy shocks rather than signals from domestic financial markets. The adjusted R^2 values remain low, consistent with the turbulent conditions and the difficulty of capturing return movements through linear structures during a crisis.In Panel 2, the diagonal BEKK estimates show pronounced changes in volatility behaviour. The ARCH coefficients rise substantially across all markets (0.411 for stocks, 0.302 for crude, and 0.189 for gold), indicating that COVID-era shocks had an immediate and stronger impact on market volatility compared to the pre-pandemic phase. The GARCH parameters remain high—0.912, 0.937, and 0.953 respectively—showing that volatility persistence remained a defining feature, but these values also reflect longer periods of elevated volatility rather than gradual adjustments. The combination of higher ARCH effects and strong GARCH persistence suggests that volatility during COVID-19 was driven by both frequent new shocks and prolonged market stress. These statistics collectively highlight how the pandemic disrupted normal return transmission channels while amplifying volatility cycles across equity and commodity markets.

Table 4. Conditional Correlation of Spot Prices in the Pre-War Period

Observation Index	ρ(BSE–Crude)	ρ(BSE–Gold)	ρ(Crude–Gold)
Early period	−0.15 to +0.20 (oscillating)	Near zero throughout	Near zero throughout
Mid period	−0.30 to +0.10 (volatile swings)	Near zero	Gradual upward drift
Late period	+0.45 to +0.72 (persistent rise)	Near zero	+0.65 to +0.78 (stable positive)

- The **BSE–Crude** correlation line shows high-frequency oscillations early on, dipping as low as approximately −0.3 and rising to about +0.2, before trending upward and stabilizing above +0.45 in the latter part of the sample.
- The **BSE–Gold** correlation remains essentially flat and indistinguishable from zero.
- The **Crude–Gold** correlation begins close to zero but gradually rises, eventually stabilizing between +0.65 and +0.78.

The pre-war period is characterised by a clear divergence in how the three markets co-moved. The correlation between equity and crude oil begins with considerable instability, alternating between negative and positive values. This pattern is typical of normal market conditions in which equity prices respond to a mix of domestic growth prospects, global cues, and energy price fluctuations that do not always move in a consistent direction. As the period progresses, the correlation shifts toward sustained positive territory, settling above +0.45. This steady rise suggests a tightening linkage between the equity and energy markets as the pre-war phase approached, possibly reflecting stronger dependence of corporate valuations on global energy trends. In contrast, the equity-gold correlation stays near zero for the entire period, indicating that gold maintained its role as an asset largely detached from stock market developments. This behaviour is consistent with gold acting more as a portfolio diversifier than as a cyclical asset responding to equity movements. The crude-gold correlation begins close to zero but gradually strengthens, reaching moderately high positive levels in the latter portion of the sample. Statistically, this implies that gold prices became increasingly sensitive to shifts in the crude oil market as global uncertainty accumulated before the geopolitical shock. The upward trend signals an underlying reconfiguration of commodity-market expectations, with investors pricing in broader macroeconomic risks that affect both energy and precious metals simultaneously.

Table 5. Conditional Correlation of Spot Prices During the War Period

Observation Index	ρ(BSE–Crude)	ρ(BSE–Gold)	ρ(Crude–Gold)
Start of war	+0.32	−0.28	+0.05
Mid-war	+0.48	−0.20	+0.12
Late-war	+0.68 to +0.82	−0.14 to −0.05	+0.22 to +0.28

- The BSE–Crude correlation line rises steadily across the war window, reaching levels above +0.75.
- The BSE–Gold correlation remains slightly negative but trends toward zero.
- The Crude–Gold correlation increases gently from borderline zero to the low positive range.

The war period reveals a remarkably different correlation structure compared to the pre-war phase. The most striking feature is the pronounced strengthening of the BSE–Crude relationship. Correlation rises from approximately +0.30 at the onset of the conflict to over +0.75 toward the end of the sampling window. This sharp upward trend highlights how geopolitical tensions tightened the link between equity valuations and global energy markets. During war-driven shocks, crude oil becomes a dominant macroeconomic variable, influencing inflation expectations, corporate cost structures, and investor sentiment more directly than in normal periods.The equity–gold relationship, which was essentially flat before the war, becomes mildly negative during the conflict. Although the magnitude is small, the direction indicates that gold functioned as a defensive asset while equities were adjusting to heightened geopolitical uncertainty. Investors appear to have partially reallocated portfolios toward gold during periods of sharp equity volatility, leading to the observed weak negative correlation.The crude-gold correlation, which showed a strong increase before the war, behaves more conservatively during the conflict. It rises modestly into the +0.20 to +0.28 range but remains far below the crude–equity correlation. This suggests that crude oil became the primary conduit of geopolitical risk, with gold responding only indirectly. Gold's limited correlation with crude indicates that while both markets were influenced by global uncertainty, investors viewed them as serving distinct rolescrude oil as a barometer of supply-chain risk and macroeconomic pressure, and gold as a store of value.

Discussion

The results of the VAR and BEKK estimations reveal clear regime-dependent differences in how India's equity, crude oil, and gold markets respond to global uncertainty. These findings are consistent with international evidence suggesting that market connectedness intensifies during crises and weakens during stable periods (Diebold & Yilmaz, 2012; Bouri et al., 2020). This study extends that evidence to the Indian context and shows that the nature of the global shockpandemic-driven versus geopoliticalalters both return spillovers and volatility transmission in a systematic manner.

During the pre-COVID period, all three spot markets display significant ARCH and GARCH terms (Table 2, Panel 2), with ARCH values of 0.291 for equity, 0.218 for crude, and 0.175 for gold, and GARCH coefficients exceeding 0.92 across assets. This combination indicates that markets were highly sensitive to new information while also exhibiting strong volatility persistence. Such behaviour aligns with previous studies documenting stable but interconnected pre-crisis commodity–equity linkages (Sadorsky, 2012; Basher et al., 2018). Conditional correlations reinforce this stability: equity–crude correlations oscillate around zero in the early part of the pre-war sample but later stabilise above +0.45, while gold remains essentially uncorrelated with equity. This suggests that before COVID-19, gold retained its traditional role as a diversification asset, as also reported by Reboredo (2013).

The dynamics change meaningfully during the COVID period. Although GARCH terms remain highly significant (all above 0.93, Table 3, Panel 2), the gold market loses its significant ARCH effect, indicating reduced sensitivity to daily shocks. This behaviour mirrors findings by Conlon & McGee (2020), who show that gold's volatility became less reactive during COVID-19 as investors treated it as a longer-horizon hedge. Conversely, crude oil exhibits sharp mean reversion (own-lag coefficient −0.024) and heightened sensitivity to market shocks, consistent with the unprecedented collapse in global oil demand reported in 2020. The equity–crude correlation remains moderately positive, whereas equity–gold remains close to zero, signifying segmented behaviour between financial and safe-haven assets.

In the pre-war period, the structure of interdependence begins to shift. Although ARCH terms for gold remain insignificant, crude and equity continue to show strong short-run volatility responses. Importantly, the crude–gold correlation increases progressively, ultimately rising to the +0.65 to +0.78 range (Figure 5). This upward drift suggests that investors were gradually pricing geopolitical risk into both commodities even before the outbreak of war. Similar patterns of rising commodity co-movements ahead of geopolitical tension are noted by Zhang & Broadstock (2018) in the context of global energy markets.

The war period exhibits the sharpest structural break. Only crude oil retains a significant ARCH effect in spot markets (Table 1, Model 4), meaning crude became the primary channel through which geopolitical risk was transmitted to India's financial system. Equity and gold, by contrast, show volatility driven entirely by persistence, not by immediate shocks. The conditional correlation between BSE and crude oil rises steadily from approximately +0.32 at the start of the conflict to over +0.80, indicating a deepening dependency of Indian equities on global energy prices (Figure 6). This behaviour is consistent with the empirical evidence that geopolitical conflict amplifies equity–oil connectedness, as documented by Qin et al. (2021) and Mensi et al. (2022). Meanwhile, the equity–gold correlation turns mildly negative (around −0.20 to −0.14), confirming gold's countercyclical behaviour and its renewed safe-haven characteristics during war conditions.

Futures markets display similar regime-dependent patterns. Pre-COVID futures exhibit significant ARCH effects for all assets except crude oil (Table 1, Model 5), suggesting that pre-crisis crude futures absorbed shocks more smoothly than spot crude. During COVID, all futures contracts show significant ARCH and GARCH responses, indicating heightened forward-looking uncertainty, which is consistent with literature

showing derivative markets react more intensely during crisis periods (Batten et al., 2017). Under war conditions, futures markets lose all ARCH significance, with only the GARCH components for crude and gold remaining significant (Table 1, Model 8). This suggests that the war introduced sustained but not shock-driven volatility an important contrast with the spot market, where crude oil remained shock sensitive. Overall, the empirical evidence indicates that the type of global shock fundamentally shapes how Indian markets interact. Pandemic-related uncertainty weakened cross-market transmission and enhanced gold's stabilising role, whereas geopolitical shocks strengthened equity–oil connectedness and re-established gold as a defensive hedge. These insights complement and extend prior work on crisis-driven market integration (Adekoya &Oliyide, 2021; Salisu et al., 2022), demonstrating that Indian markets respond asymmetrically to different categories of global risk.

Policy Implications

The findings offer several important policy insights for India's financial and commodity landscape. The sharp increase in equity–crude co-movement during the war period underscores the need for stronger national energy-risk management, including diversification of import sources, expansion of strategic reserves, and deeper development of commodity-based hedging instruments. Persistent volatility across all regimes, with GARCH values consistently exceeding 0.90, suggests that regulators such as SEBI should integrate crisis-sensitive monitoring tools and dynamic margining frameworks to limit amplification of market-wide shocks, in line with recommendations from market stability research (Batten et al., 2017). The study also highlights gold's continued stabilising role during both the pandemic and the conflict, indicating scope for expanding gold-linked financial products—such as sovereign gold bonds, ETFs, and digital goldto provide accessible hedging avenues for households and institutional investors. Finally, the asymmetric behaviour of markets across pandemic and geopolitical regimes suggests that investors and policymakers should adopt scenario-specific strategies rather than uniform diversification approaches. Portfolio allocation and macroeconomic communication strategies must be responsive to the type of global shock, as pandemics tend to weaken inter-market transmission while geopolitical conflicts intensify it, particularly through the energy channel.

Conclusion

This study examined the dynamic relationships among India's equity, crude oil, and gold markets across four major regimespre-COVID, COVID, pre-war, and war—using a VAR–BEKK framework on daily data from 2017 to 2022. The results show that market interactions shift sharply depending on the nature of the global shock. Before COVID-19, all three markets displayed strong sensitivity to new information and high volatility persistence, consistent with findings from earlier global studies (Diebold & Yilmaz, 2012; Basher et al., 2018). During the pandemic, gold's immediate shock responsiveness weakened, while equity and crude oil exhibited elevated volatility, aligning with evidence that gold acted as a stabiliser (Conlon & McGee, 2020). The Russia–Ukraine conflict produced the most pronounced structural break, with crude oil becoming the primary transmitter of geopolitical risk and equity–crude correlations rising steeplyreflecting patterns documented in recent conflict-related research (Qin et al., 2021; Mensi et al., 2022).Overall, the study shows that health-driven and geopolitical shocks influence Indian markets differently: pandemics weaken cross-market linkages, whereas wars intensify them, particularly through the energy channel. These asymmetric responses imply that policy and investment strategies must adapt to the type of crisis rather than applying a uniform approach.

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