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Review Article

Measuring the Volatility in Gold Prices of India during the Russia-Ukraine Crisis: Evidence from the TGARCH Model

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Abstract

Background: The Russia-Ukraine conflict has significantly impacted global financial markets, particularly commodity prices, with gold being a key asset. In India, gold holds cultural and economic importance, amplifying its relevance during geopolitical crises. **Objective:** This study aims to analyse the volatility in gold prices in India during the Russia-Ukraine crisis, focusing on asymmetries in gold price returns and the long-memory effects of the crisis on these prices. **Methods:** Daily gold price data (in rupees per gram) from January 1, 2021, to October 28, 2023, were used, totalling 1030 observations. A dummy variable representing the conflict period was introduced. The Augmented Dickey-Fuller (ADF) unit root test was applied to check for stationarity, and the Threshold GARCH (T-GARCH) model was employed to assess volatility and leverage effects. **Results:** The analysis found significant volatility in gold prices during the crisis. The T-GARCH model showed a leverage effect, with negative returns influencing future volatility more than positive returns. Unit root tests confirmed stationarity in the gold price series after the first difference. **Conclusion:** The study demonstrates that geopolitical crises like the Russia-Ukraine conflict contribute to volatility clustering in gold prices. The results emphasise the role of gold as a safe-haven asset, providing valuable insights for investors and policymakers, particularly in countries like India, where gold is culturally and economically significant.

Keywords: *Asymmetries; Gold Price; Russia-Ukraine Crisis; Volatility*

Introduction

The COVID-19 pandemic, a natural disaster, may have been humanity's greatest setback, with 5.95 million deaths as of 23 February 2022. Nevertheless, as of October 4, 2022, 7.65 million Ukrainians have become refugees in Europe as a result of the Russian military operation against Ukraine on February 24, 2022. Similar to the global epidemic, the current Russia-Ukraine conflict is causing economic suffering in nations all over the world (Bagchi & Paul, 2023; Pandey *et al*., 2023). As a result, the stock market and commodity prices are closely related (Naeem *et al*., 2022). International repercussions of the war between Russia and Ukraine have been felt. Oil, gas, platinum, gold, and silver are some of the primary commodities with significant price and supply fluctuations.

Global financial markets have seen a significant fluctuation in the price of commodities as a result of the prolonged conflict (Wang *et al.,* 2022; Iqbal *et al.,* 2023). The financial crisis that started in 2008, which had a direct impact on the markets for gold and oil, may be deemed to have caused this effect,

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which is the largest shift since that time. A proper connection between the G7, BRIC (Brazil, Russia, India, and China), and the five major commodities markets may be advantageous for investors in their decision-making processes during the crisis between Russia and Ukraine.

Literature Review

Sahay *et al*. (2025) examine the dynamic correlation and volatility spillovers between currency rates and stock markets during two significant global events, namely the COVID-19 pandemic and the Russian-Ukrainian War, with a focus on the BRICS economies. The study looks at time-varying correlations by using the DCC-EGARCH approach to analyse daily data from October 29, 2018, to August 31, 2022. The data is divided into pre-COVID, during COVID, pre-war, and during war sub-periods. The study examines possible differences in this link between natural catastrophes (like COVID-19) and man-made outbreaks (like the invasion of Russia and Ukraine) and seeks to identify changes in the exchange rate-stock market return nexus before and during these crises. The results show that, with the exception of Brazil, the relationship between stock markets and exchange rates is mostly unaffected by COVID-19 and the conflict between Russia and Ukraine. Interestingly, exchange rates only have long-term effects on the stock market. Because these events might not have a major impact on spillovers in these markets, the study shows that investors may discover short-term chances for diversification amid crises. The significant influence that the crises had on the BRICS countries' stock markets and exchange rates highlights the need for customised policy responses in these nations.

Agrawal and Rao (2023) introspected that the perception of the economy may change as a result of investors' psychological attitudes, whether positive or negative, towards the financial market. This study uses descriptive analysis to look at how investors behaved during COVID-19, the conflict in Russia and Ukraine, and the subprime mortgage crisis, among other crises. The results showed a conflict between investor psychology and three crises caused by pandemic pressure and psychological toughness. Investors' withdrawal of their financial assets as a result of negative emotions and distrust caused a fall in the financial market returns.

Bhattacharjee *et al*. (2023) try to assess how the Russia-Ukraine conflict has affected several Indian economic sectoral indices. This study's analysis was conducted using the event study approach. Event Day is the day that the declaration of war is made. Ten Indian economic sectors that are listed on the National Stock Exchange (NSE) make up the sample under study. Results cover the time from June 25, 2021, to March 28, 2022, or 167 days to 20 days after the declaration of war. In the post-event era, nearly every sector of the sample saw aberrant returns that were significantly positive. With the biggest inconsistent returns, the metal sector has been leading this group. The market quickly corrected itself, wiping out extraordinary profits even though Indian sectors saw overall favourable results.

Jareño *et al*. (2023) try to determine how the COVID-19 pandemic's several waves have affected the BRICS (Brazil, Russia, India, China, and South Africa) countries' term structure of interest rates, including their level, slope, and curvature. This study used the Time-Varying Parameter Vector Autoregression (TVP-VAR) method to determine the direction of spillovers among nations and components, as well as the extent to which they affect the connectivity system. The findings indicate that the level and curvature components of connectivity demonstrate connectedness that endures longer than the slope component, both in the first wave of the COVID-19 pandemic. China and India are net shock receivers, whereas Brazil and South Africa are net shock transmitters. Last but not least, attention was given to the most significant variations in the net dynamic connectivity between transmitters and receivers before and during the first COVID-19 pandemic crisis. The latter waves of the coronavirus pandemic had several additional effects.

After meticulously observing the available studies, it is noted that studies about the Indian context are rarely found. Moreover, the sample size in the existing studies is too small, which can result in a misleading prediction of the model. Additionally, it needs to be mentioned that applications of advanced econometric models like Fractionally Integrated Generalised Autoregressive Conditional Heteroskedasticity (FIGARCH) are also uncommon to obtain.

Based on the above research gaps, the authors decided to finalise the following objectives of the study: first, to study the asymmetries in gold prices in India due to the Russia-Ukraine crisis, and second, to study the long-memory effects of the Russia-Ukraine crisis on the gold price of India.

Research Methodology

Data Collection and Tools

This study is based on the daily closing prices of gold in India (Rs. per gram) along with a dummy variable constructed to address the issue of the Russia-Ukraine Crisis. The study period is from January 1, 2021, to October 28, 2023, with 1030 observations, where January 1, 2021, to February 23, 2022, represents the period before the conflict denoted by '0', and February 24, 2022, to October 28, 2023, is considered as the period during the crisis denoted by '1' (United Nations, 2022). The daily data on gold prices in India is collected from the website of Gold Price India. All the data are converted into corresponding natural log returns to eliminate the shortcomings associated with time-series data (Bagchi, 2015).

Different econometric tools like the ADF unit root test, the Threshold Generalised Autoregressive Conditional Heteroskedasticity (TGARCH) (1,1) model, and the FIGARCH model are used.

Augmented Dickey-Fuller (ADF) Unit Root Test

The ADF test is the extended version of the traditional Dickey-Fuller Test, which was applied to study the existence of unit roots in time-series data introduced in the year 1981. It employs the following regression model:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{k} \infty_i \Delta Y_{t-i} + \varepsilon_t \quad \text{..... (1)}$$

TGARCH Model

The authors employed the TGARCH (1, 1) model to pinpoint the asymmetric or leverage impact as well as to limit the convenience of asymmetric presentation and the ongoing existence of the leverage effect (Bagchi *et al*., 2020; Bagchi, 2016). An autoregressive component of the TGARCH models the volatility's persistence. This part represents the influence of previous squared returns on the conditional volatility that exists at the t-th time inside each regime (Barai & Samal, 2025).

The TGARCH (1,1) model, as propounded by Zakoian (1994), is represented as follows:

$$y_t = \sigma_t + \varepsilon_t \text{ ..... (2)}$$

$$\sigma_t = \alpha_0 + \sum_{t=1}^{q} \{\alpha_i^+ y_{t-1}^+ - \alpha_i^- y_{t-1}^-\} + \sum_{j=1}^{p} \beta_j \sigma_{t-j} \text{ ..... (3)}$$

Where, α_i^+ , α_i^- , I = 1,…,q, and β_j , j = 1,…,p is a series of real scalars (α+i) and (α−i). Furthermore, for any t, $\mathbb{E}[\epsilon_t]$=0 and $Var[\epsilon_t]$=1 indicate that ϵ_t is i.i.d. and independent of y_{t-1}. Bollerslev's (1987) model serves as the foundation for σ_t. But if σ_t is not positive, it is difficult to conclude. For this reason, Zakoian (1994) offers the following specific positivity conditions:

$$\alpha_0 > 0,\ \alpha_t^+ \geq 0\ ,\ \alpha_t^- \geq 0\ ,\ \beta_j \geq 0\ \forall i, j \text{ .....(4)}$$

Significance of the Study

When the entire world is trying to recover from the effects of the post-pandemic COVID-19 crisis since May 2023, the crisis between Russia and Ukraine is another setback to the global economy in the form of geopolitical tensions (United Nations, 2023; Bagchi *et al*., 2020; Ding, 2011). Gold is certainly expected to be affected following its exposure in the global market. So, the authors do believe that this study will provide pioneering findings in the context of studying the asymmetries of the crisis on the gold

price from the perspective of India, which will supplement the existing studies (Bhattacharyay *et al*., 2022). Here lies the uniqueness of the study.

Results

Descriptive Statistics

Table 1: Descriptive Statistics of Russia-Ukraine Crisis and Gold Prices

	Russia-Ukraine Crisis	Gold Price
Mean	0.5941	0.0001
Median	1	0
Maximum	1	0.0286
Minimum	0	-0.037
Std. Dev.	0.4912	0.0065
Skewness	-0.3835	-0.2602
Kurtosis	1.1471	6.3939
Jarque-Bera	172.5956	505.9959
Probability	0.00*	0.00*
Sum	612	0.1932
Sum Sq. Dev.	248.365	0.0447
Observations	1030	1030

**Significant at 1% level*

Table 1 denotes the results of the descriptive statistics of the variables of the study, namely, the Russia-Ukraine crisis and the gold price of India. The crisis (dummy) increased to a maximum value of 1 and decreased to a minimum value of 0 during the study period. On the contrary, the gold price in India increased to 0.0286 at its highest and reached a low of -0.037. Both variables are found to be non-normal in nature.

Augmented Dickey-Fuller (ADF) Unit Root Test

Table 2: ADF Unit Root Test of Russia-Ukraine Crisis and Gold Prices

At Trend and Intercept				
	At Level		At First Difference	
Variables	***t*-Statistic**	**Prob.***	***t*-Statistic**	**Prob.***
Russia-Ukraine Crisis	-1.7724	0.7176	-32.05018	0.00*
Gold Prices	-31.0754	0.00*	-24.29331	0.00*

**Significant at 1% level*

The results of the unit root test, as can be found in Table 2, show that at both the level and first difference, gold prices in India are significant at a 1% level, indicating the data is stationary in nature. On the contrary, the Russia-Ukraine crisis suffers from the problem of the unit root at the level, but, at first difference, it is stationary in nature and does not possess a unit root.

T-GARCH (1,1) Model

Table 3: T-GARCH Model of Gold Prices and Russia-Ukraine Crisis

Dependent Variable: Gold Prices		
Parameters	**Coefficient**	**Prob.**
Constant (ω)	0.0003	0.1369
ARCH Effect (α)	0.6505	0.008*
GARCH Effect (β)	0.651	0.0154*
Leverage Effect (γ)	0.7561	0.00*

**Significant at 1% level*

Volatility in financial markets frequently responds to positive and negative shocks in various ways. Table 3 denotes the constant term, which estimates the constant volatility within the framework, which is found

to be insignificant within the TGARCH model. However, ARCH effects are found to be significant at a 1 per cent level, indicating the presence of volatility within the gold prices due to the Russia-Ukraine crisis. Likewise, the GARCH effects are also noted to be statistically significant, denoting the presence of variance in volatility, and the positive coefficients confirm that periods of high volatility tend to be followed by periods of high volatility. A considerable leverage impact is shown by the optimistic and extremely statistically significant coefficient value of 0.7561.

Discussion

The discovery of non-normality in the distribution of gold price returns implies that the returns deviate from a typical normal distribution, which is frequently observed in time series data related to finance (Ding, 2011). This non-normality, which shows that dramatic price changes happen more frequently than would be expected from a normal distribution, usually results from fat tails and data asymmetry. Investor mood becomes extremely unpredictable during geopolitical crises like the conflict between Russia and Ukraine, leading to abrupt changes into safe-haven assets like gold (Iqbal *et al.*, 2023). The departure from normalcy is explained by these abrupt and erratic price fluctuations. The market nervousness, panic trading, and speculative activity that surfaced as investors responded to sanctions, global inflationary pressures, and economic disruptions due to conflict are essentially captured by the non-normality (Bagchi & Paul, 2023).

The ARCH effects suggest that whereas calm times showed consistently low volatility, times of significant price volatility were followed by even higher volatility. This outcome reflects the increased uncertainty surrounding global commodities markets in the context of the Russia-Ukraine crisis (Sahay *et al.*, 2025). The crisis affected investors' expectations and risk appetite for gold by causing sharp swings in the oil, gas, and currency markets. As a result, the substantial ARCH effect shows that the Indian gold market responded strongly to news from around the world, with short-term shocks causing ongoing volatility (Bhattacharjee *et al.*, 2024).

It is also noteworthy to mention that the GARCH effects demonstrate that the Indian gold market's volatility is not simply a response to sudden shocks but also has a long memory, which means that once volatility rises, it takes a long time to subside (Barai & Samal, 2025). Financial markets exhibit this persistence during times of crisis, when currency swings, inflation expectations, and geopolitical unpredictability keep investors vigilant for a long time. The crisis further exacerbated this ongoing volatility pattern by disrupting commerce and foreign exchange rates for India, which imports a significant amount of its gold (Pandey *et al.*, 2023).

The asymmetries suggest that negative news raises market uncertainty more than positive news lowers it, which is in line with the behavioral finance theory that investors react more strongly to negative information (Agrawal & Rao, 2023). The magnitude further indicates that gold prices were very sensitive to unfavourable market developments during the Russia-Ukraine conflict, supporting gold's function as a safe-haven investment during tumultuous times (Bhattacharyay *et al.*, 2022).

Conclusion

The empirical findings confirm that there is sufficient evidence of volatility clustering in the Indian gold prices due to the Russia-Ukraine crisis. It is so because global market volatility brought on by heightened geopolitical tensions may prompt investors to seek out safe-haven possessions like gold. The unexpected increase in demand may cause Indian gold prices to jump in the short term and become more volatile. Moreover, it needs to be mentioned that in countries like India, gold is not only relevant for its investment and reserves factor but also relevant for its cultural and religious aspects.

Recommendations

The findings help understand the volatility of the Russia-Ukraine crisis on the gold prices of India and encompass a multidimensional methodology where investors, policymakers, researchers, academicians, and corporates have a judgment to make on the implications in their area. The investors

can decide on their risk tolerance attitude along with the divergence of risks and choose the right investment option.

The policymakers can decide on the policies about the market, assess the gold reserves for future exigencies, and mitigate cross-border risks along with ensuring stability in the geopolitical environment. The researchers and academicians have ample opportunities to collect empirical data for analysing the same and providing innovative findings for the larger society and the interested stakeholders.

Furthermore, corporates can decide on their risk-management approaches by studying the overall market, complying with the legal framework, and long-term financial forecasting.

Conflict of Interest

The authors affirm that there are no conflicting objectives.

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