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DOES BULLION APPEAL AS A HEDGE OR A SAFE HAVEN FOR OIL WILD RIDE DURING THE RUSSIA-UKRAINE WAR? A WAVELET APPROACH

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Abstract. In this research, we empirically evaluate whether Indian bullion market instruments glitter as a hedge or a safe haven against oil volatility shock before and during the Russia-Ukraine war. The wavelet coherence mechanism is used to encapsulate the hedge or a safe haven potential over the time-frequency horizon. We find evidence that gold and silver act as a medium horizon investment hedge for crude oil during pre - and invasion periods. However, the results unveil that gold and silver act as a weak safe haven for crude oil during the turmoil period, partly consistent with the prior research findings. The results further show that there is a positive relationship between gold and oil at the beginning of the war and at intervals, 29/06/2022 to 15/07/2022, illustrating that gold acts as a diversifier for crude oil.

1. Introduction

On February 24, 2022, the world awakened with another crisis, the Russia-Ukraine war that has driven the global economy to a standstill. Amongst various adverse events such as Covid-19, global financial, European debt and Asian financial crisis, this is another throbbing episode that increased unprecedented shock and hurt the international financial market (Umar et al. 2022). Specifically, given the strong India's trade relations with Russia and Ukraine, making the conflict more vulnerable to the consequences and control of financial risk management more critical. Subsequently, it is a fact that the rise in the geopolitical risk on the country's real economy and financial market via direct and indirect channels has motivated investigations on this subject area.

Among the group of major crude oil exporters, Russia accounts for the second largest supplier of oil to the global market. For instance, Russia alone exports 48 percent of its oil to OECD and Europe, 42 percent to Asia and Oceania, 9 percent to non-OECD Europe and 1 percent to the United States (Sharma, 2022). Meanwhile, India also witnessed approximately 1 percent of Russia's crude oil. On that side, Ukraine produces one-third of sunflower oil and holds a share of half of global exports. China and the European Union are some of the top consumers of Ukraine sunflower oil, but a notable 31 percent of the demand is driven by the Indian market. India's integration and diversity are also reflected in agricultural and other products from Russia and Ukraine. Therefore, the impact of the conflicts between Russia and Ukraine will undoubtedly be felt by global economies, including India, because this has disrupted the oil supply, which happens to be the world's most traded and useful commodity (Adekoy et al. 2022). This scenario has led to a wild ride of crude oil, which increased to the highest in eight years (Adekoy

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et al. 2022). The oil market does not like uncertainty and crisis. However, the rising political tension between Russia and Ukraine forced an oil volatility shock to flare up across the global financial market, which in turn also increased the volatility in Indian asset prices. A surge in oil prices causes an economic slowdown, supply chain disrupts, a rise in inflation and high swings in investment. On the other side, under such turmoil, gold gains popularity as a safe investment asset that can act as a tool to hedge against inflation and market risk (Reboredo, 2013). In view of the relationship between gold and oil in an inflationary term, when there is an increase in oil prices, the general prices also go up and it can open up the spectrum for metals to hedge against inflation (Jaffe, 1989). The spike in oil prices cut down the economic growth, creating a ripple effect on investors' sentiment and forcing them to switch over to gold to protect their asset value. In particular, Banerji and Langley (2022) reported Russia's invasion of Ukraine switched investors to safe-haven assets (gold and government bonds) with a fear that it will keep rising. Owing to the start of the war, global gold prices went up by 1.7 percent and silver prices rose by 2.3 percent (Isaac, 2022). In India, at the end of the day of the invasion, gold prices surged by 4.7 percent and silver prices went up by about 5.84 percent. In this background, when there is a mounting panic around the financial markets due to the Russia-Ukraine conflict, the study stepped in to search whether Indian bullions (gold and silver) provide a safety net against the oil volatility shock.

2. Literature Review

The extent to which gold can be considered as a hedge against the sterling dollar and yen-dollar is the first approach made by (Capie et al. 2005). After that, Baur and Lucey (2010) conducted an empirical analysis and tested the role of gold as a safe haven against bonds and stocks along with focusing on a hedge. Looking at the market conditions, they identified the two possible market regimes (normal and market distress regimes) and with that, they coined the two well-known concepts, the hedge and safe haven. The asset can be identified as a hedge (weak or strong hedge) when it is glowing and negatively correlated with the other assets during a normal market scenario. While an asset can be considered a safe haven when it is negatively related to other assets during market distress time. Baur and Lucey (2010) also put forth that when the asset is positively but not perfectly correlated with another asset, that asset can be considered a diversifier to the investors. Historically, with this backdrop, a substantial amount of research throws light on explaining the potentiality of gold as a hedge and safe haven against stock (Baur and McDermott, 2010; Hood and Malik, 2013) and exchange rate (Capie et al. 2005; Ciner et al. 2013). Expanding upon the related literature, Mensi et al. (2023) confirm the findings of diversification benefits and hedging effectiveness of precious metals such as gold, silver, palladium and platinum to the S&P 500 index. Moreover, Mensi et al. (2022), demonstrate the strong hedge property of precious metals against major currencies during Covid-19. Majumder (2022) finds evidence of hedging capabilities in favour of a group of commodities, cryptocurrencies, gold and silver, but in light of the Covid crisis, neither gold nor cryptocurrencies qualify as a safe haven asset against the Indian equity market. However, the central aim of this research is to validate our search for a hedge and safe haven of Indian bullion market instruments against oil volatility shock before and during the escalating panic of the Russia-Ukraine war.

In recent years, few studies have evaluated the relationship and hedge/safe haven property of gold against the oil movement. To briefly summarize their results, Reboredo (2013) used weekly US dollar quoted prices and examined whether gold performs the role of a hedge and safe haven when crude oil price changes. The author found due to significant and positive dependency, gold did not exhibit its hedging characteristics. However, tail independence proved that gold could be treated as a safe haven asset against oil price fluctuations. Under the GARCH-EVT Wavelet framework, Wang et al. (2022) reported the London and New York gold market hedging intensity for oil across time horizons. Gold also provides a safe haven to investors against extreme oil price movement. Śmiech and Papież (2017), applying the rolling regression approach

for the empirical analysis, argued that gold cannot be a hedge against oil price volatility in all sub-periods. Under the DCC-MIDAS method, Liu and Lee (2022) document that gold is well-fitted as a diversifier rather than a hedge for oil. Under economic uncertainty, in the long run, gold acts as a safe haven asset for the oil market participants. Madani and Ftiti (2021) identified the time-varying dependency during calm and turmoil periods between two sets, gold-oil and gold-currency. Across the period 2017-2019, the author claimed that gold was found to be a weak hedge for oil and a strong hedge for currency. Gold also performs as a strong safe haven against the oil price movement but shines only on a short time scale. Alternatively, the findings of Liu et al. (2020) highlight that crude oil functions as a safe haven and hedges against major US-denominated currencies. The study also noted a low and negative correlation between the oil and currency markets during a crisis period. Mensi et al. (2021) also reported the distinct features of oil. It can be a diversifier and a weak safe haven for precious metals such as gold, silver, platinum and palladium. In the context of the Covid pandemic, Hunt (2006) suggests that gold is a safe haven instrument compared to bitcoin for the global crude oil market. More specifically, using the VARM-GARCH model, Jaffe (1989) validated the gold hedging effectiveness and significant safe haven against oil price risk during the market panic period. Although gold exhibits strong, safe haven attributes during the war against main commodities exported by Russia but, the hedging strategy value is relatively low, ranging from 0.8 percent to 19 percent (Ustaoglu, 2023). Ming et al. (2023) ascertained that in both hedge and safe haven perspectives safe haven currencies overpowered the gold on crude oil.

Having known that the demand for risk management has increased due to the wild ride of oil, there is a quest whether the Indian bullion market instruments (gold and silver) perform in favour of investors or not. Our main contributions to the emerging literature distinguish themselves by closely evaluating the dependency between the Indian bullion market assets and oil prices before and after the invasion of the war. The potential of gold to shed for investors in the oil market due to the Russia-Ukraine war has not received any attention. We identified the normal period (before the invasion) and the extreme period (invasion) to explore the hedge and safe haven latent of gold and silver for oil market swing in a different time scale.

3. Data and Methodology

3.1. **Data Description.** We used daily price data for bullion market instruments (gold and silver) and crude oil from the MCX India website (denominated in Indian Rupee). The continuous returns for gold, silver and crude oil prices are computed by using the natural logarithm equation; Rt = *ln* (Pt / Pt-1)*100. The analysis was carried out for two sub-periods, 24/06/2021 to 23/02/2022 (pre-Russia-Ukraine war) and 24/02/2022 to 24/10/2022 (during the Russia-Ukraine war).

3.2. **Estimation Strategy.** Identifying the hedge or a safe haven potential of gold across multiple time horizons can encapsulate certain hidden information that can be highly relevant to the market participants who may seek more information about gold.

A wavelet approach, through its distinct wavelet transform function, is useful to decompose the time series in different time spaces and frequencies. To brief up wavelet, it is constructed on the following mother wavelet function;

$$\Psi^*_{\tau,S}(t) = \frac{1}{\sqrt{|S|}}\Psi\left(\frac{t-\tau}{S}\right), \quad s,\tau \in \mathbb{R}, \quad S \neq 0 \tag{1}$$

Above, $\frac{1}{\sqrt{|S|}}$ and S is a normalization and scaling factor.

There are different types of wavelet specifications and depending upon the purpose, the researcher extensively used it. By recalling Baur and Lucey (2010) definitions of hedge and safe haven, wavelet coherence can be a powerful tool to identify the interaction between two-time series at a time-frequency scale. Torrence and Compo (1998) and Grinsted et al. (2004) stated that it is the ratio of the cross-spectrum to the product of each series and depicts the

relationship (negative or positive) between a time series at a time-frequency horizon. The cross-wavelet coherence function explains the covariance between two time series, y(t) and x(t), in a time-space and at a frequency horizon. Simply, it is a function of Wχ $y(\nu, s)$ = W$\chi(\nu, s)$ Wy (ν, s). The wavelet coefficient equation can also be expressed in the following form;

$$R^2(\tau, S) = \frac{\left|S\left(\frac{1}{S}W_{\chi y}(\tau, S)\right)\right|^2}{S\left(\frac{1}{S}|W_{\chi}(\tau, S)|^2\right) S\left(\frac{1}{S}|W_{y}(\tau, S)|^2\right)'} \tag{2}$$

Where *R2* and S function as a wavelet squared coherence and a smoothening operator across time and scale. However, this equation also resembles the equation of the traditional correlation coefficient. The wavelet coherence value ranges between 0-1 (zero represents no correlation and one represents a higher correlation).

Another important part of this approach is wavelet coherence phase differences. This wavelet phase angle will reveal how the two series detect the relationship on a coherence map by clearly exhibiting their phase angle arrows on a coherence plot. The right arrow points out the two series are in phase (positive relationship) and the left arrow signifies the series are out of phase (negative relationship). The phase difference equation of Torrence and Webster (1999) is as follows;

$$\rho_{\chi y}(\tau, S) = \tan^{-1}\left(\frac{\mathrm{Im}\left[S\left(\frac{1}{S}W_{\chi y}(\tau, S)\right)\right]}{\mathrm{Re}\left[S\left(\frac{1}{S}W_{\chi y}(\tau, S)\right)\right]}\right), \quad \rho_{\chi y} \in [-\pi, \pi] \tag{3}$$

In the equation (3) Im and Re, picture the imaginary component of the wavelet coefficient.

4. Results and Discussion

The descriptive statistics of daily log returns of gold, silver and crude oil for the pre-invasion and invasion periods are shown in Table 1. Crude oil offers investors the highest positive daily returns of 0.14 percent from 24/06/2021 to 23/02/2022. During the invasion period from 24/02/2022 to 24/10/2022, it is 0.02 percent for the highest level of risk, ranging between 2.25 - 3.45 percent. The gold was also found to provide positive returns for a moderate risk but worsened the bullion market by providing negative daily returns during the Russia-Ukraine war. For gold and silver during a pre-invasion and for gold during the invasion period, the test statistics of Jarque-Bera reject the hypothesis that the return series are not normally distributed. The gold shows a positive skewness and thereby projects the probability of earning positive returns in the future. During the pre-invasion period, in the case of silver and for both periods, crude oil is found to have negative skewness.

Table 1. Summary Statistics of Bullions and Crude Oil

Variables	Mean Return	Std. Deviation	Skewness	Kurtosis	Minimum	Maximum	Jarque-Bera
Pre-Invasion period (24/06/2021 to 23/02/2022)							
Gold	0.04	0.63	0.21	4.88	-2.40	1.97	25.83**
Silver	-0.04	1.14	-0.18	4.36	-4.09	3.06	13.93**
Crude oil	0.14	2.25	-1.46	10.59	-13.59	5.79	462.67**
Invasion Period (24/02/2022 to 24/10/2022)							
Gold	-0.03	0.74	0.20	6.83	-3.13	3.26	104.62**
Silver	-0.12	1.51	0.13	4.59	-4.55	6.14	18.46**
Crude oil	0.02	3.45	-0.41	3.68	-12.96	7.72	8.01**

The unconditional correlation between bullion and crude oil is presented in Figure 1 using a heatmap. The correlation takes values between 0 to + - 1. The colour coding in a heatmap from light blue to dark blue colour shows a negative correlation and from light red to dark red colour represents a positive correlation. The first plot in Figure 1 unveils that the relationship between gold and crude oil is positive and significant during the pre-Russia-Ukraine war. And silver and

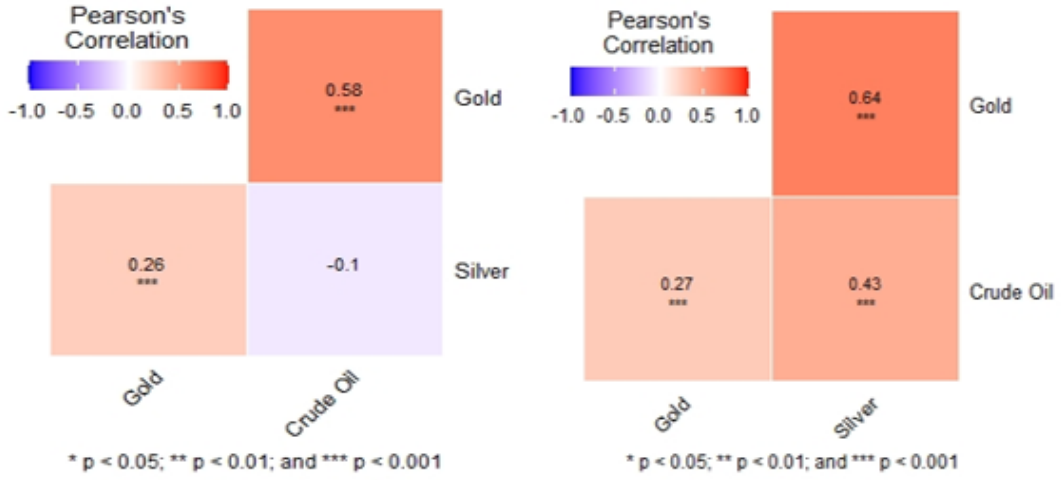

FIGURE 1. Pearson's correlation coefficients between bullions and crude oil, pre- and during the Russia-Ukraine war.

the crude oil correlation coefficient is insignificant and is negatively correlated. From 24/02/2022 to 24/10/2022, the second plot in Figure 1 exhibits a positive and significant relationship of gold and silver with crude oil. This positive correlation could be the signal of having a diversifier attribute of gold and silver against oil volatility during the invasion period.

4.1. **Wavelet Coherency and Bullions as a Hedge.** Wavelet coherence is a localized frequency decomposition that enables the capture of asset dependency at a different timescale. In this section, we report the results of the hedging attributes of bullion (gold and silver) against oil at each time period and for frequency horizon. Figure 2, shows the evolution of the correlation from 24/06/2021 to 23/02/2022 (pre-invasion period). Figure 3 exhibits the co-dependency during the invasion period (24/02/2022 to 24/10/2022) over frequency band in days (04, 08, 16 and 32 days). The horizontal axis symbolizes the time period and the vertical axis refers to frequency. In the cone surface, the warmer red colour signifies higher coherency and the colder blue shade outside the significant areas represents the region with less dependency. Baur and Lucey (2010), the asset can be referred to as a hedge when it is uncorrelated or negatively correlated with another on average. On aggregate, the results indicate that the co-dependency between (gold and silver) and crude oil is moderate, which can be witnessed by the predominance of cold (blue) colouring across the region for both periods (pre- and invasion periods). In Figure 2 (i), individually at a shorter period of upto 08 days, a brief red-coloured contour signifies some evidence of coherency between gold and crude oil. During pre-invasion, between 20/08/2021 to 15/12/2021, the high coherency (warmer red region), arrows facing right (east), signifies a positive correlation between gold and oil at a period greater than 16 days. Between silver and oil, a pocket of high coherency is visible at a shorter horizon upto a period of 08 days and in between 16 to 32 days frequency band from 20/08/2021 to 15/11/2021. Between 03/01/2022 to 18/01/2022, captured the south face arrows for about 04 days, indicating that silver leads the crude oil. Overall, the less co-dependency, particularly at 08 to 16 days, suggests that gold and silver exhibit the medium horizon investment hedge for crude oil.

In Figure 3 (i and ii), substantially large coherency patches are found during the Russia-Ukraine war period. However, the results are slightly similar to that of a pre-war period, where the evidence of more coherency exists upto a short horizon (upto 16 days), with the exception of a few large coherency plots at a longer horizon. Another set of evidence observed that at the beginning of the war (24/02/2022 to 25/04/2022), a significant coherency plot informs the close dependency of gold and silver to oil volatility shock. However, after 24/04/2022, a blue

colouring inside the plot at an above 08 days scale signifies less coherency. This indicates that the Indian investors benefited from the medium to longer horizon hedge of gold and silver for crude oil. The findings are in line with the analysis of Bredin et al. (2015), which claimed that gold serves as a hedge for long horizons and Mensi et al. (2022) document precious metal is a strong hedge against major currencies.

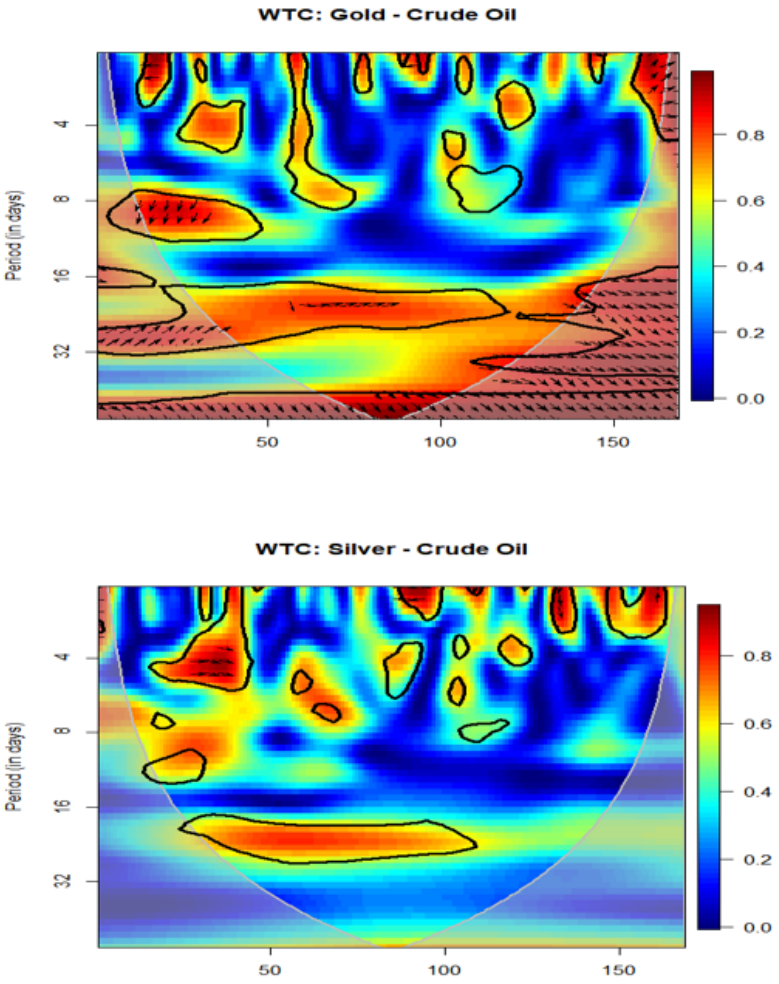

FIGURE 2. (i and ii). Wavelet coherence between the bullion (gold and silver) and crude oil for a pre-Russia-Ukraine war period.

Notes: Figure 2 (i and ii) shows wavelet coherence between the bullions (gold and silver) and crude oil for a pre-Russia-Ukraine war period. The horizontal and vertical lines represent time and period in days (frequency band), respectively. Horizontal line up to 50, 50 to 100, 100 to 150 and above 150 represent a timeline of the data from 24th June to 3rd September 2021, 3rd September to 17th November 2021, 17th November 2021 to 27th January 2022 and 27th January to 23rd February 2022. The cone shape white line in the plot indicates the affected area. The thick black contours around the red colouring are coherence significant at a 5% level. In the coherence plot, the right arrows (east) signify positive correlation or in-phase behaviour, and the left (west) depict negative or out-of-phase correlation. The north and south, south-east and north-east arrows indicate the first variable leads the second one. The south-west and north-west picture out the second variable lead the first. Wavelet coherence takes the values between 0 (a lower level of dependency between bullions and crude oil) and 1 symbolizes (a higher level of co-dependency).

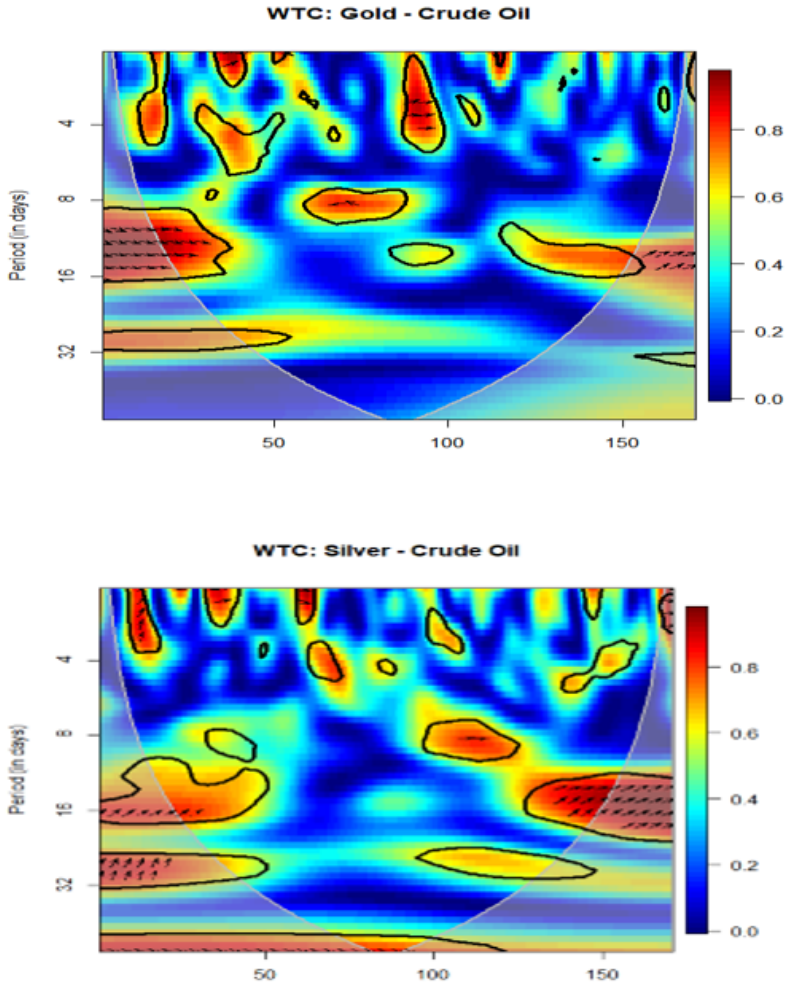

FIGURE 3. (i and ii). Wavelet coherence between the bullions (gold and silver) and crude oil during the Russia-Ukraine war period.

Notes: Figure 3 (i and ii) shows wavelet coherence between the bullions (gold and silver) and crude oil during the Russia-Ukraine war period. Horizontal lines up to 50, 50 to 100, 100 to 150 and above 150 show the timeframe from 24th February to 5th May 2022, 5th May to 14th July 2022, 14th July to 23rd September 2022 and 23rd September to 24th October 2022.

4.2. **Wavelet Coherency and Bullions as a Safe Haven.** A claim of whether the Indian bullion instruments acted as a safe haven for crude oil during the Russia-Ukraine war is detailed in this section. The thorough explanation by Baur and Lucey (2010), an asset is a safe haven when it is negatively or uncorrelated with another asset only in certain periods, i.e., turmoil or crisis periods. In particular, to provide risk reduction benefits or gold as a safe haven asset to investors, Figure 3 (i) should exhibit patches of coherency with west-facing arrows. This is highly undetected during the war period, except for a few arrows facing west at the 08-day frequency over a period between 20/05/2022 to 31/05/2022. In contrast to the coherency between gold and crude oil, the east-facing arrows at the beginning of the war (08-16 days period) and between 29/06/2022 to 15/07/2022 at a shorter horizon signify the positive relation. This implies that gold served as a better crude oil diversifier during that period. This finding is consistent with other studies where Mensi et al. (2023) also claimed that precious metal futures are diversifiers for US stock and gold is a diversifier for main commodities exported

by Russia Ustaoglu (2023). This characteristic indicates a significant benefit for investors and portfolio managers articulating portfolio strategies. However, in Figure 3 (ii), on average, during the invasion period and at a frequency band, the coherency between silver and crude oil is negligible with the exception of a few coherence pockets. We note no arrows point towards the west, but in a 'red droplet', a few of them facing north (at the beginning of the war) and arrows facing east at a 16 days frequency band, reflecting the silver leads the crude oil and the positive relations. Thus, during the war turmoil, the evidence of negligible negative co-dependency exhibits gold and silver weak safe haven attributes against the oil volatility shock. The findings are partly consistent with Jaffe (1989); Hunt (2006); Wang et al. (2022). The most important reason the bullions did not perform as a strong hedge and a safe haven for a long horizon was that the Indian market recovered quickly from the catastrophe.

5. Conclusion

This research assessed the hedge and safe haven attributes of two Indian bullion market instruments (gold and silver) against oil volatility. Using a novel wavelet coherence approach, we extend the previous literature by investigating the co-dependency between the assets over the time-frequency horizon during the pre- and Russia-Ukraine war periods. The findings of the paper report that the predominance of colder (blue) colouring on the surface of Figure 2 and Figure 3, particularly above a period of 08 days, signifies less coherence. This is indicative of a medium-horizon gold and silver investment hedge for crude oil. Some restricted evidence of coherence pockets across the time period and upto 08 days frequency signifies the short-run coherency. Between gold and oil upto the 08 to 16 days frequency band, the study also noted some east-facing arrows at the beginning of the war and for an interval from 29/06/2022 to 15/07/2022. This illustrates a positive relationship and indicates that gold acts as a diversifier for crude oil. During the turmoil period, we demonstrate a less negative co-dependency between Indian bullions (gold and silver) and crude oil, which is a sign of a weak safe haven and this is partly consistent with the prior research findings.

The results offer the implications for Indian investors for asset allocation, diversification and risk management in a period of crude oil market volatility. They can obtain the benefits of gold and silver as a hedge and safe haven potential displayed on a time scale against oil rides during a similar episode in the future. Nonetheless, policymakers can also articulate a sound crisis management policy to avoid risk.

The scope of the present study is confined to only two Indian bullions (gold and silver) and crude oil. Also, we emphasized only the Russia-Ukraine war. However, future studies can be extended to other bullions against different classes of financial assets. A good set of comparative analyses can also be added by taking a different financial crisis to enrich the extant literature. Nevertheless, in this research, by using a novel methodological approach i.e., wavelet coherence, we tested the bullions a hedge or a safe haven performance on a time-frequency horizon during the turmoil period.

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