





“Navigating global economic turmoil: The dynamics of oil prices, exchange rates, and stock markets in BRICS”

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NAVIGATING GLOBAL ECONOMIC TURMOIL: THE DYNAMICS OF OIL PRICES, EXCHANGE RATES, AND STOCK MARKETS IN BRICS

Abstract

The study aims to analyze the co-movement between oil prices, BRICS nations' exchange rates, and stock markets. Grasping these interrelationships is essential for understanding how global energy price shifts broadly affect the economies, particularly those of developing nations.

The study employs wavelet coherency analysis on daily data, examining the association between crude oil (Brent crude), exchange rates (Brazilian Real, Russian Rubble, Indian Rupee, Chinese Yuan, and South African Rand), and stock markets (BOVESPA of Brazil, Moscow Exchange of Russia, Nifty50 of India, Shanghai Composite of China, and JSE FTSE of South Africa) across both temporal and frequency domains.

This study reveals strong comovements, especially during periods of global economic instability, such as the impact of the COVID-19 pandemic and the Russia-Ukraine war. During such periods, oil prices and stock market indices tend to move in tandem, while oil prices and exchange rates show an inverse relationship. The study also reveals a decoupling of crude oil from both share markets and exchange rates during normal economic conditions. This decoupling suggests that outside of a chaotic period, the relationships weaken. However, the co-movements among the variables for China are notably weaker, even during economic upheavals, than in other BRICS nations. Understanding these relationships can aid in informed decision making and strategies in the face of global economic turmoil.

Keywords

BRICS, exchange rates, stock market, oil prices, wavelet coherence

JEL Classification

Q43, F31, G15, O57, C32

INTRODUCTION

The interconnected nature of the global economy has spotlighted the intricate association among forex rates, share markets, and Brent crude oil, particularly within emerging economies. Among these, the five BRICS countries are of paramount interest. Understanding the linkages is crucial, as it offers critical insights into the association between global energy prices and emerging economies. These five members have a combined population of 3.14 billion, approximately 44 percent of the global population, and maintain their crucial influence in worldwide commerce and economic systems.

These countries play dual roles as both major consumers and producers of oil. Among the studied countries, India, China, and Brazil are major countries that import oil, while Russia, a significant oil-exporting country, is the sixth largest in terms of proven crude oil reserves (Tiwari et al., 2019).

The interlinkage between foreign currency rates and Brent crude oil prices is identified through the following three channels. First, there

is a trade channel “which suggests that oil prices affect the exchange rates of countries engaged in significant oil trade” (Habib et al., 2016). Second, the wealth channel posits that as wealth increases in an oil-exporting country, its currency tends to appreciate, whereas in oil-importing countries usually, the currency rate declines (Beckmann & Czudaj, 2013). Third, the portfolio channel affects currencies due to the favorable financial positions of oil-exporting countries and their relative investment preferences (Coudert et al., 2008). In BRICS countries, all the three channels play their role owing to the varying economic characteristics of the member countries.

As far as the interconnection between oil and equity markets is concerned, it has garnered their attention (investors and researchers). Several studies indicate that oil prices impact stock markets; oil, as a significant input in production, affects corporate cash flows and, consequently, stock market performance (Joo & Park, 2017).

The recent global events, for example, the pandemic (COVID-19) and geopolitical tensions, including the Russia-Ukraine war, have demonstrated the instability of financial markets to external events, further highlighting the importance of this study. Understanding how equity markets, currency exchange rates, and oil market prices for these key players (BRICS) are interlinked across both temporal and frequency domains is crucial, not only for the stability and growth of the BRICS economies themselves but also for the broader global economic landscape.

1. LITERATURE REVIEW

A substantial number of studies have looked at the connections among oil market prices and their impact on exchange rates and stock market performance. Krugman (1980) was one of the pioneers in connecting oil prices with forex rates. Subsequent research has extensively examined this relationship (Sadorsky, 2001; Rautava, 2004; Baek, 2022; Ozturk et al., 2008; Fasanya et al., 2022; Akram, 2004). Similarly, various studies have explored the linkages between equity returns and oil prices (Park & Ratti, 2008; Bhar & Nikolova, 2009; Berument et al., 2010; Sari et al., 2010; Bodenstien et al., 2011; Masih et al., 2011; Liu et al., 2022; Syed & Bouri, 2022; Rahman, 2022; Lescaroux & Mignon, 2009; Cong et al., 2008). The past research has also addressed oil’s connections with other economic variables (Wang & Chueh, 2013; Samadi et al., 2012; Lee et al., 2012). Siddiqui et al. (2023) offer a comprehensive overview of the linkages between oil and various financial and macroeconomic variables.

Concerning the linkages between crude oil prices and currency value, researchers have examined these connections over time and across different contexts. Krugman (1980) proposed a model illustrating the influence of Brent crude prices on currency value, based on the balance of payments.

This model suggests that short-term effects may differ from long-term impacts, with oil price increases typically strengthening the dollar in the short run but leading to dollar depreciation over time. Later, the connection was examined by Amano and Van Norden (1998) between crude oil market rates and the real effective forex rates of major currencies. In a study by Akram (2004), the complex, non-linear connections between the Norwegian currency and oil prices were assessed. Rautava (2004) examined the influence of crude oil prices on the Russian Ruble.

In their study, Yang et al. (2017) employed wavelet coherency analysis to examine the association between crude oil prices and foreign exchange rates across various oil-importing and exporting countries. The findings indicate strong connections between oil prices, which move in contrary directions. Sahu et al. (2014) employed various analytical methods to investigate the linkages of Brent crude and the Indian equity market in the long and short run. The researchers determined that there was no causal relationship existed between the variables despite the presence of a cointegrating relationship. Furthermore, the Indian share market experienced a long-lasting effect of the positive oil shock. A study by Raza et al. (2016) investigated the influence of gold prices on equity returns in developing markets. The research-

ers utilized the nonlinear ARDL model to analyze this relationship. Their findings indicate that gold had a positive impact on the BRICS nations, whereas oil prices negatively affected share returns in emerging markets. Further, the gold and oil volatilities affect the equity returns in emerging economies in the long and short run.

A study by Baek (2022) investigated how the COVID-19 pandemic affected Brent crude oil prices and the forex rate of South Korea. In their study, Korley and Giouvris (2022) analyzed volatility spillover among Brent crude and currencies in Sub-Saharan Africa. Fasanya et al. (2022) focused on the Nigerian Naira exchange rate in relation to the crude oil rate.

Likewise, researchers have explored the connection between crude oil and equity markets across different regions. Cong et al. (2008) probed this connection in the Chinese share market. Park and Ratti (2008) explored the interconnection between the USA and selected European countries to understand how oil prices impact stock markets. Focusing on countries of GCC, Arouri and Rault (2012) evaluated the co-integration between Brent crude oil and bourses. Additionally, Filis et al. (2011) and Wang et al. (2013) examined the time-dependent relationship and the influence of oil price shocks on stock markets and compared countries that are major oil traders. Tien and Hung (2022) studied spillovers among GCC stock markets.

Researchers have utilized a range of analytical techniques to examine these connections, such as Vector Autoregression (VAR), Granger Causality, Johansen co-integration, and Granger causality in quantiles. Furthermore, researchers have employed various analytical methods, including variance decomposition, impulse response functions, Markov regime switching, and GARCH (Generalized Autoregressive Conditional Heteroskedasticity) models in their studies. The GARCH family includes Exponential GARCH, Dynamic Conditional Correlation (DCC) GARCH, Error Correction Models (ECM), and DCC-GARCH-GJR combined with GARCH. Wavelet-based approaches, Bayesian multiple quantile methods, ANOVA, and bootstrap panel co-integrating techniques have also been applied

(Rautava, 2004; Ozturk et al., 2008; Basher et al., 2012; Omag, 2012; Akoum et al., 2012; Lee et al., 2012; Samadi et al., 2012).

A notable focus in recent research has been the impact of specific crises on Brent crude oil prices, forex, and equity market performance. A study by Baek (2022) examined how the crises of COVID-19 influenced the oil market and the South Korean currency, revealing notable effects in short and long-run outlooks. A study by Kumeka et al. (2022) investigated the relationships among equity prices, Brent crude, and forex rates in a group of twelve nations that are oil exporters, using a panel VAR model to assess performance during and after COVID-19. Korley and Giouvris (2022) explored the volatility spillover among Brent crude oil prices and currencies of sub-Saharan countries, identifying impacts concerning the 2008 subprime crises and the COVID-19 health crisis. Bhar and Nikolova (2009) probed the oil market driven fluctuations on stock market returns in BRIC nations. The study uncovers that the reactions of oil price fluctuations depend on the proportion of oil imports, while also noting that stock market performance does not substantially influence Brent crude. Chkir et al. (2020) analyzed the complex, non-linear relationships between Brent crude oil market prices, forex, and share markets in selected countries importing and exporting oil. To capture the intricate dependencies among these variables, the authors utilized the vine copula method, a sophisticated statistical tool that allows for the modeling of multivariate dependencies beyond simple linear correlations. Findings unveil that the relationship between Brent crude oil, and forex rates are predominantly negative, meaning that as prices of oil increase, forex rates tend to move in the opposite directions and vice versa. This negative dependency varies across different time periods, suggesting that the interplay between these two variables is influenced by temporal factors and potentially by specific economic conditions in the countries studied. Conversely, the research revealed a favorable correlation between Brent crude oil prices and equity returns. This suggests that as prices of oil increase, stock returns tend to rise, especially in situations where the economy or particular sectors benefit from higher oil-related revenues.

A thorough analysis of the interplay between oil rates and forex rates in five nations was carried out by Brahmasrene et al. (2014). The researchers focused on identifying causal linkages between these two crucial economic variables, using both short-term and long-term perspectives to understand how they influence each other over time. In the near future, the study found that changes in exchange rates tend to drive fluctuations in Brent crude. This suggests that in the immediate term, the value of a currency relative to others can significantly impact oil prices, potentially due to factors such as currency speculation, international trade policies, and immediate market reactions. However, the scenario changes in the long run. Over an extended period, the study revealed that the causality reverses, with oil prices exerting a more substantial influence on exchange rates. The enduring connection suggests that persistent shifts in oil prices ultimately exert a notable impact on currency values. These price changes are typically influenced by worldwide supply and demand forces, political tensions between nations, and overarching economic trends.

Ongoing research continues to explore the interconnections among Brent crude oil prices, forex rates, and equity markets. Kaur and Mittal (2023) delved into the interplay among the stock market of India, oil prices, and the Indian Rupee, using Johansen cointegration and wavelet coherency to find short-term impacts and long-term stability. Using Vector Auto Regression, Atif et al. (2022) examined the associations between currency rates, crude oil prices, and equity markets, revealing notable impacts during the COVID-19 crisis. In their study, Chang and Chang (2023) employed the Bayesian Multivariate quantile method to scrutinize the linkages between share markets, oil prices, and the Chinese currency. Their findings demonstrated that these relationships varied across different quantiles.

The examined studies highlight the continuing importance of grasping how crude oil price variations influence the stock markets and currency exchange rates. Despite, numerous studies on dynamic linkages, wavelet coherency analysis remains underutilized. Notably, there is a gap in research applying wavelet coherency to BRICS countries, particularly owing to predicaments like the Russia-Ukraine war and COVID-19 health

crises. The objective of this work is to fill this knowledge gap, offering fresh perspectives to the field by analyzing the co-movements among Brent crude prices and BRICS nations' currency rates and stock markets by applying wavelet coherency analysis. Additionally, the study hypothesizes that there exists a strong co-movement between oil prices and both currency values and stock markets throughout the BRICS countries, with these co-movements becoming particularly evident during periods of global instability.

2. RESEARCH METHODOLOGY AND MATERIAL

The present study analyzes the data using wavelet coherency analysis. Wavelet analysis explores relationships in the time and frequency domains, unlike traditional tools that focus only on the time domain of the time series (Huang et al., 2017; Siddiqui et al., 2020).

Wavelets are tiny waves derived from a mother wavelet, expanding and contracting within a specified duration. The mother wavelet can be represented as (Rua & Nunes, 2009)

$$\psi_{\tau,s}(t) = \frac{1}{\sqrt{s}} \psi\left(\frac{t-\tau}{s}\right), \quad (1)$$

where $\psi(t)$ wavelet function, $1/\sqrt{s}$ is a normalization factor $\hat{\omega}$. The the wavelet remains precisely positioned, it is ensured by location parameter, while s controls how the wavelet is stretched and compressed.

Morlet wavelet used in this study can be written as

$$\psi(t) = \pi^{-\frac{1}{4}} e^{-i\omega_0 t} e^{-\frac{t^2}{2}}. \quad (2)$$

To balance the time and frequency ω is taken as 6, further, the time parameter is represented by T (Grinsted et al., 2004). In wavelet analysis, wavelet coherency refers to the localized correlation between time series within both the frequency and time domains; wavelet coherency is presented as follows (Torrence & Webster, 1999)

$$R^2(u,s) = \frac{|s(s^{-1}w_{xy}(u,s))|^2}{s(s^{-1}|w_x(u,s)|^2)s(s^{-1}|w_y(u,s)|^2)}. \quad (3)$$

The coherency value varies between 0 and 1 and is smoothed by s , a smoothing factor; without a smoothing factor, the coherency is 1 at all scales (Rua & Nunes, 2009). This is considered like the coefficient of correlation: A higher value indicates a stronger correlation, whereas a smaller value indicates a low correlation (Kiviaho et al., 2014).

In the graphical representation, red areas show stronger coherency, green areas indicate no coherency, and blue areas represent weak coherency. A dark area in an image is an area of significance (Torrence & Compo, 1998; Percival & Walden, 2000). Further, Torrence and Compo (1998) define the power of coherency as

$$W_{xy}(u, s) = w_x(u, s)w_y(u, s), \quad (4)$$

where w_x and w_y are transformed wavelets, u is position, and s is scale.

When the arrows in the image move together in the right direction, they indicate an in-phase relationship, whereas movement in opposite directions indicates an anti-phase relationship; arrows pointing upward show the dominance of the first series in leading the second time series, whereas the downwards direction shows the dominance of the second time series in leading the first time series" (Loh, 2013).

The study uses 10 years of daily data, ranging from January 2013 to March 2023, on stock markets and forex rates of BRICS countries and Brent crude oil prices. Data on currency rates and stock markets were sourced from Investing.com, whereas Brent crude oil prices were found from EIA, the U.S. Energy Information Administration.

Table 1. Observations and the corresponding periods

Observation	Corresponding time
1-500	01/01/2013–12/12/2014
501-1000	12/15/2014–11/25/2016
1001-1500	11/28/2016–11/09/2018
1501-2000	11/12/2018–10/27/2020
2001-2500	10/29/2020–10/05/2022
2500+	10/06/2022–03/30/2023

Table 1 is vital for understanding the results of wavelet coherency, as it provides information

about the period and context. The observation intervals 1501-2000 and 2001-2500 correspond to the onset of the first and second waves of COVID-19 and the start of the Russia-Ukraine war, respectively.

3. RESULTS

Figure 1 demonstrates that during the initial phases of the analyzed data period, the Moscow exchange and crude oil exhibited little synchronization in their movements. The co-movement was evidently noticeable at the lower scale during the pandemic (COVID-19), with arrows moving in the same direction, indicating that the series moved together. Additionally, this lower-scale co-movement was observed again during the pandemic. In contrast, the co-movement during the Russia-Ukraine war was in anti-phase, suggesting that the share and oil market prices moved in opposite directions. This co-movement was stronger during the Russia-Ukraine war than during the pandemic. Notably, high coherence at longer periods (upper section) suggests that oil prices significantly influence exchange rates and stock markets over the long term, particularly during economic disruptions. On the other hand, in Figure 2, the Brazilian share market indicates significant co-movement at a lower scale. The highest co-movement was observed during COVID-19, specifically at a lower scale of 32. The movement of the arrows is in the same direction, indicating that the oil and Brazilian equity markets are moving similarly. The direction of co-movement during the Russia-Ukraine war remains inconclusive.

As Figure 3 indicates, the co-movement between the share market of China and oil prices is notable at scales of 64 and higher, especially around 2014. Table 3 reveals that on a scale of 32, the arrows point in the opposite direction, reflecting a reversed co-movement. Some co-movement was detected during the pandemic of COVID-19. However, it was not pronounced. The co-movement was weak. At the lower scale of 32, and during the Russia-Ukraine war, it was also weak with unclear directional indicators. Similarly, Figure 4 indicates that the share market of India and crude oil prices exhibited co-movement

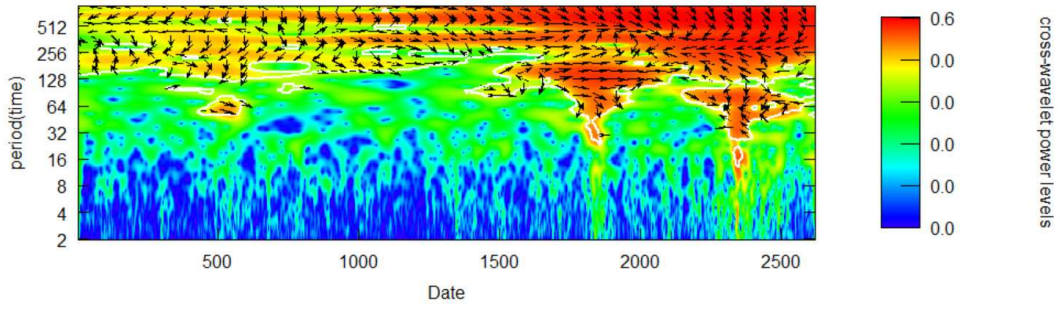


Figure 1. Brent crude oil prices and Moscow Exchange

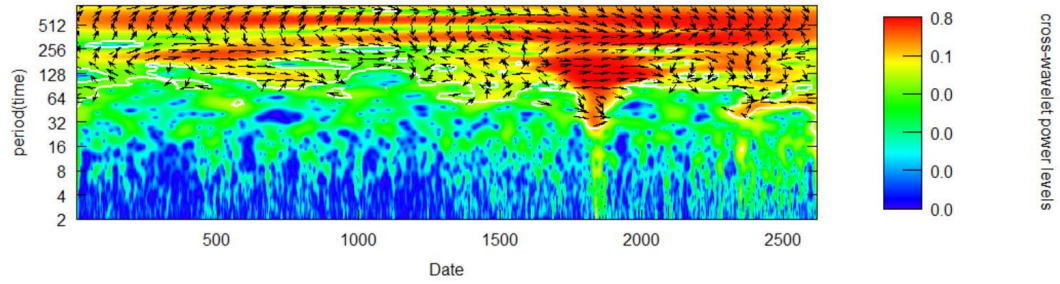


Figure 2. Brent crude oil prices and BOVESPA

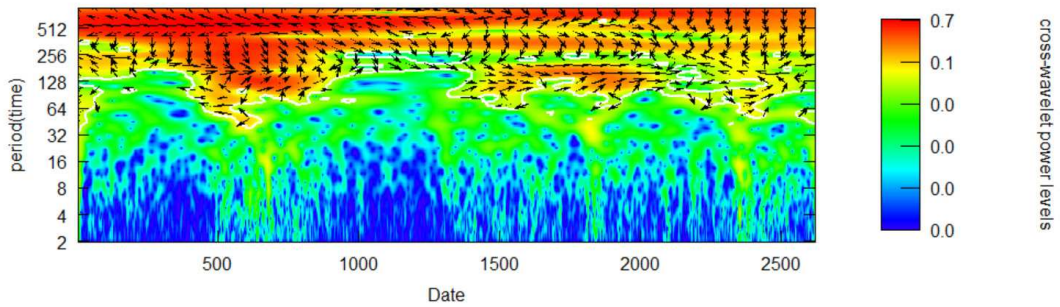


Figure 3. Brent crude oil prices and Shanghai Composite of China

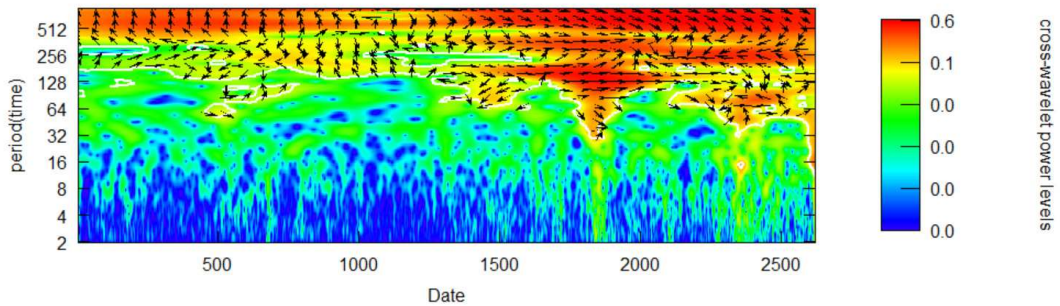


Figure 4. Brent crude oil prices and NSE India

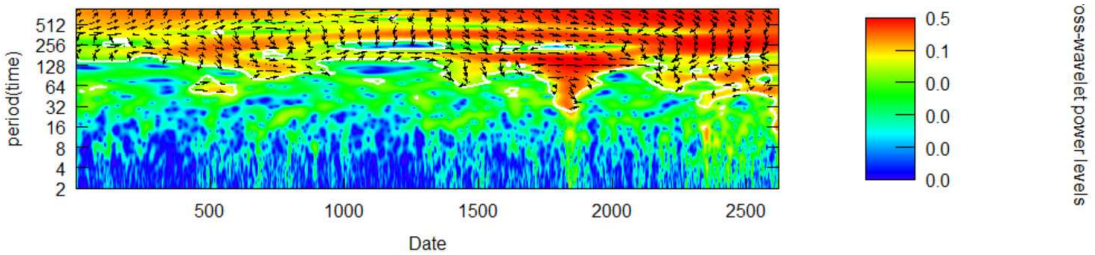


Figure 5. Brent crude oil price and FTSE JSE 100

during the pandemic, with no significant movement before this period. The arrows point right, suggesting that both series move together, with the equity share market leading the crude oil prices. For the duration of the Russia-Ukraine war, co-movement was present but with unclear direction. Co-movement during the pandemic was stronger compared to the war period. Further, Figure 5 shows that stronger linkages between the South African share market and Brent oil were observed only for the duration of the pandemic and the Russia-Ukraine war. The arrows pointing right indicate a synchronized association where they move together. However, during the Russia-Ukraine war, the co-movement was weaker compared to the pandemic, with an unclear direction of the arrows.

4. BRENT CRUDE OIL PRICES AND FOREX RATES

Figure 6 illustrates the association between the Russian Ruble and oil prices. A notable shift in their co-movement is evident, with a significant correlation at higher scales of 128 and above, though it is also present at the lower scale of 32. During 2013 and 2014, the co-movement at higher scales was influenced by the exchange rate and exhibited an anti-phase linkage. Throughout the COVID-19 crisis, the synchronization at the lower scale of 32 became more evident, largely influenced by fluctuations in the Russian Ruble. This dynamic changed during the Ukrainian crisis, where the co-movement increased and was led by oil prices. Figure 7 reveals the co-movement at lower scales amid the Brazilian real and crude oil prices. The strongest correlation was observed during the COVID-19 pandemic, with arrows indicating an anti-phase

relationship, meaning oil prices and the currency rate moved in opposite directions. This strong co-movement persisted after the pandemic, but the direction of the arrows at the lower scale was ambiguous during the Russia-Ukraine war.

Figure 8 reveals that co-movement is detected only at higher scales, with no significant correlation at lower scales such as 2, 4, 8, and 16. The upward-moving arrows indicate that oil prices predominantly lead the Chinese Yuan. During the crisis period, co-movement was observable at a lower scale of 64, but the arrows pointed left, indicating an anti-phase relationship where oil prices and the Chinese Yuan move in opposite directions. However, during the crisis, the arrows shifted in a downward direction, suggesting that the currency was leading oil prices.

Figure 9 displays the co-movement amid the Indian rupee and crude oil prices, showing no co-movement at lower scales like 2, 4, 8, and 16. Co-movement was noted at higher scales, with arrows pointing left in an anti-phase position during the COVID-19 pandemic. Some arrows also pointed downward to the left, presenting an inconclusive pattern that hints at potential co-movement amid the Indian rupee and crude oil prices. At higher scales, the initial correlation between South African Rand fluctuations and oil price movements (figure 10) becomes more apparent. However, co-movement at lower scales emerged for the duration of the pandemic and the Russia-Ukraine war. For the period of the pandemic, the arrows pointed left, reflecting an anti-phase relationship where oil prices and the South African Rand moved in opposite directions. This relationship was also present during the Russia-Ukraine war, though it was less pronounced.

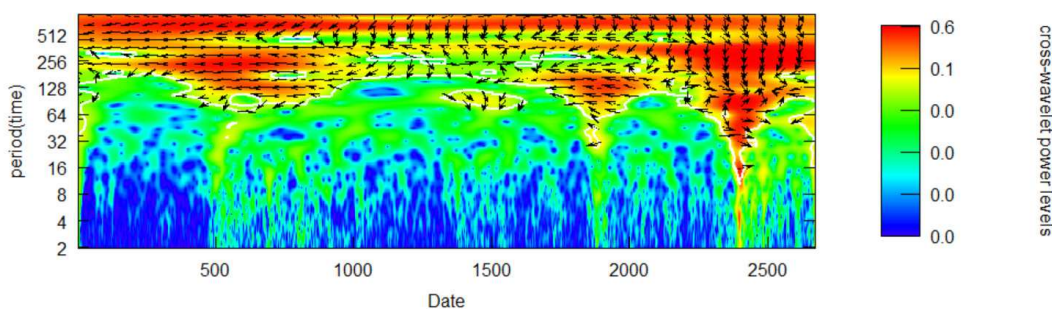


Figure 6. Brent crude oil prices and Russian Ruble

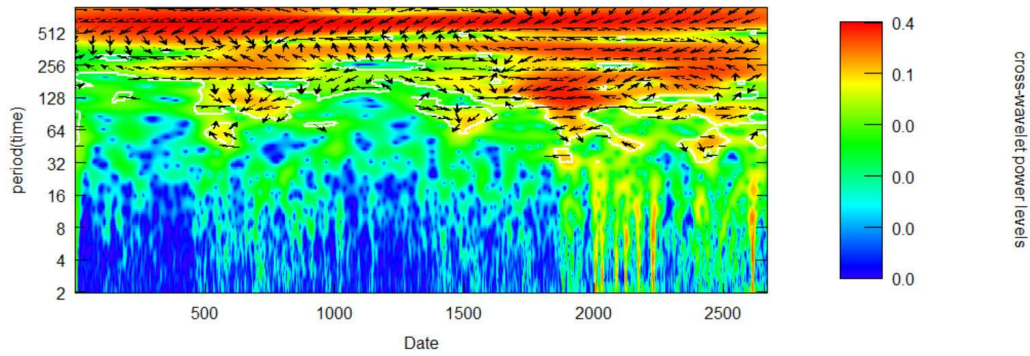


Figure 7. Brent crude oil prices and Brazilian Real

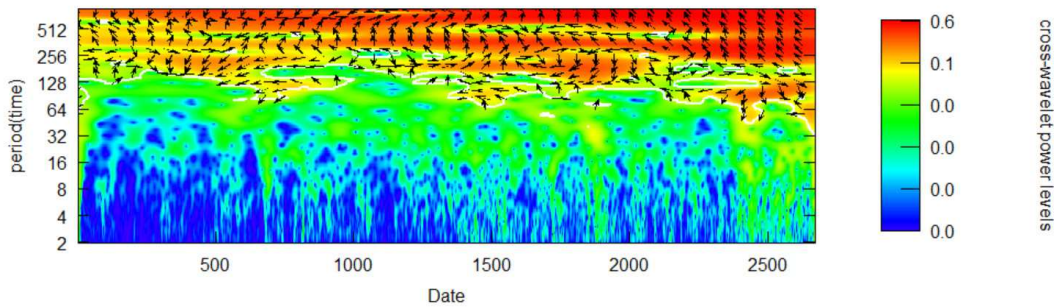


Figure 8. Brent crude oil prices and Chinese Yuan

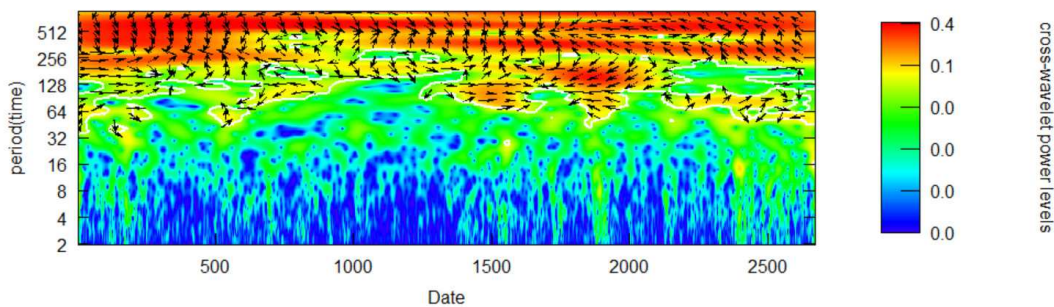


Figure 9. Brent crude oil prices and Indian INR

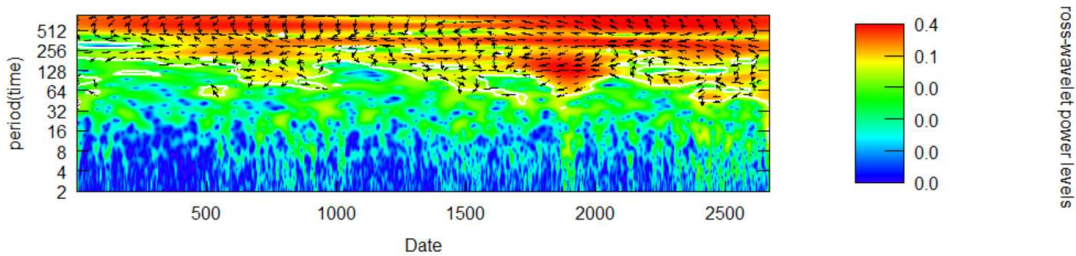


Figure 10. Brent crude oil prices and South African Rand

5. DISCUSSION

This study investigates the intricate interlinkages among oil prices and forex rates and oil prices and equity markets in the BRICS. The analysis employs both temporal and frequency domain approaches. It applies wavelet coherency analysis to ten-year daily data and provides a comprehensive examination of these interconnections.

The findings suggest that the correlations between oil price fluctuations and financial indicators become more pronounced during economic turmoil. Notably, during the COVID-19 pandemic, significant co-movements were observed at shorter time scales, displaying an in-phase pattern. This suggests that crude oil prices and share market indices often move together during such periods. In essence, when oil prices go up, stock market

values also tend to rise, pointing to a positive co-movement among the indicators amidst global uncertainty.

In contrast, the interaction between Brent crude oil prices and currency values illustrates an anti-phase relationship. In this instance, the arrows point to the left, indicating that both move in opposite directions. Specifically, when oil prices rise, the analysis suggests a tendency for the US dollar to depreciate. This observation aligns with the idea that elevated crude oil prices can negatively impact a currency's strength, likely due to the trade balance implications and other macroeconomic factors.

The study also reveals a decoupling of crude oil from both share markets and currency conversion rates during periods of economic normalcy. This decoupling suggests that outside of crisis periods, oil prices' impact on share capital markets and currencies weakens. This is particularly noteworthy as it underscores the context-dependent nature of these relationships. During regular times, the connections of oil prices with the financial market variables appear to be less pronounced, indicating that other factors have a dominant role in influencing market dynamics.

Interestingly, China exhibits weaker co-movements of crude oil in both the forex and share markets compared to other BRICS countries. This weaker relationship could be attributed to China's unique financial framework and its crucial function as a primary oil consumer, which may buffer the direct influence of crude oil price variations on its equity index and currency. Additionally, the co-movement observed during the Russian-Ukrainian war was less intense than during the COVID-19 pandemic. This suggests that while geopolitical events like the Russia-Ukraine war impact financial markets, global health crises may have more impact on the connection between oil and financial indicators than other factors.

The findings of this study present both agreements and deviations from previous research. The results align with studies like Atif et al. (2022) and Kaur and Mittal (2023), which also highlighted significant relationships during crises. The present study contrasts with the findings of Bhar and Nikolova (2009), Fasanya et al. (2022), and Chang and Chang (2023). They reported different dynamics in the oil price-financial market nexus. These discrepancies may reflect variations in methodologies, data periods, or regional factors considered in the previous studies.

CONCLUSION AND IMPLICATIONS

The present study scrutinized the relationships of crude oil, forex, and share markets in five BRICS nations using wavelet-based co-movement on ten-year daily data. The analysis revealed that during global predicaments such as COVID-19, the associations between oil prices and the share market intensified, with oil price increases linked to higher share market indices. Conversely, the oil price-exchange rate relationship was anti-phase, indicating that rising oil prices correlated with a weaker US dollar. The study also found that the association between crude price and forex rates diminishes outside of crises, suggesting that other factors may dominate market behavior in stable economic periods. This context-dependent nature of oil price effects is critical, as it indicates the varying impact of oil based on the broader economic environment. China exhibited weaker co-movements compared to other BRICS countries, likely due to its status as a major oil importer. Furthermore, the influence of the Russia-Ukraine crisis on these relationships was found to be less intense than the effects observed during the pandemic, suggesting that global health crises might have a more profound influence on the linkages of oil prices with financial variables than regional geopolitical events.

In conclusion, this study highlights the complexity of the interactions between oil prices, exchange rates, and stock markets within BRICS countries. It underscores the heightened sensitivity of these relationships during times of crisis and the context-dependent nature of their dynamics. Understanding these patterns can provide valuable insights for policymakers and investors in managing economic and financial risks associated with oil price fluctuations.

Future research could build on the findings of the present study by incorporating additional macro-economic and financial data from more countries. This would yield crucial information on the broader implications of oil market fluctuations worldwide. Such studies may offer new perspectives on the inter-play of oil prices with financial systems, contributing to a more comprehensive understanding of global economic dynamics.

AUTHOR CONTRIBUTIONS

Conceptualization: Haseen Ahmed, Mohammad Naushad.

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Funding acquisition: Mohammad Naushad.

Investigation: Haseen Ahmed, Taufeeque Ahmad Siddiqui.

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Resources: Mohammad Naushad.

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Visualization: Haseen Ahmed, Mohammad Naushad.

Writing – original draft: Haseen Ahmed, Taufeeque Ahmad Siddiqui.

Writing – review & editing: Haseen Ahmed, Taufeeque Ahmad Siddiqui, Mohammad Naushad.

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