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Energy Price Impact on BRIC Stock Markets: A Granger Causality Analysis

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Abstract

Energy prices and the stock market are two of the crucial factors in the evolving landscape of global finance, particularly in major emerging economies. However, research on how energy price changes impact stock markets in BRIC countries remains limited, despite their diverse roles in global energy markets and economies. This study investigates the causal dynamics between energy prices and stock market performance in BRIC countries, aiming to uncover short-term fluctuations and long-run relationships in these major emerging economies. Utilizing daily data from 2013 to 2023, stationarity tests, cointegration analysis, and Granger causality tests are employed to examine these relationships. Key findings reveal weak evidence of a long-run equilibrium between energy prices and stock market indices, challenging previous assumptions about their cointegration. More significantly, the findings uncovered a strong unidirectional Granger causality from oil prices to all BRIC stock market indices, while gas prices show a more selective influence. Notably, no evidence of reverse causality from stock markets to energy prices was found, highlighting the exogenous nature of global energy prices in relation to BRIC stock markets. This study uniquely analyzes oil and gas price effects on BRIC stock markets, offering insights for investors and policymakers amid increasing commodity-financial market integration.

Keywords:

BRIC Countries;
Energy Prices;
Stock Market Performance;
Granger Causality;
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1- Introduction

The analysis of equity markets in the BRIC nations (Brazil, Russia, India, and China) holds critical significance, given their substantial impact on global economic and financial systems [1]. These countries, which together account for a considerable share of global population and economic productivity, have become pivotal in shaping international commerce, capital flows, and fiscal expansion [2, 3]. Their respective stock exchanges function as vital indicators of economic vitality, mirroring market sentiment, business performance, and broader economic trends [4]. Furthermore,

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comprehending the intricacies of these markets is crucial for international investors, government officials, and economic analysts, who aim to effectively maneuver through the intricate landscape of emerging market finances and harness the potential offered by these swiftly evolving economies [5].

Furthermore, the equity markets of BRIC nations have increasingly become interconnected with global financial networks, attracting significant foreign capital and influencing global market dynamics [6]. This increased interconnectedness has amplified the importance of these markets beyond their national borders, making them crucial components of international portfolio allocation strategies. The behavior and performance of BRIC stock exchanges can significantly influence global financial stability, capital flows, and economic growth. [7]. As these economies continue their trajectory of growth and sophistication, stock markets play a pivotal role in facilitating capital accumulation, enhancing corporate oversight, and fostering economic advancement. Consequently, examining these markets is indispensable for comprehending the broader mechanisms of emerging market finance and global economic patterns.

The BRIC grouping, initially comprising Brazil, Russia, India, and China, has undergone significant expansion, evolving into BRICS with South Africa's inclusion in 2010, and further enlarging in 2023 to encompass Iran, Egypt, Ethiopia, and the United Arab Emirates. This growth illustrates the rising influence and aspirations of emerging economies in shaping global economic governance and fostering South-South collaboration [8]. Despite this expansion, focusing on the original BRIC nations remains crucial because of their longer history as a cohesive study group, their relative homogeneity in economic scale and growth patterns, and their two-decade-long influence on emerging market dynamics [9, 10]. At the same time, the energy sector is crucial in the BRIC economies, with Brazil and Russia relying significantly on oil and gas revenues as major exporters [11, 12], while China and India rank among the world's largest energy consumers [13]. This intricate interplay between energy and economic development in BRIC countries suggests that energy price fluctuations may profoundly affect stock market performance. These price movements can influence corporate profitability, inflation rates, currency valuations, and overall economic sentiment [14]. For energy exporters, higher prices can stimulate economic activity and potentially boost stock markets [15], whereas net importers may increase production costs and inflationary pressures, potentially dampening market sentiment [16]. The increasing financialization of commodity markets has further strengthened the link between energy prices and financial markets, making energy price dynamics a crucial factor in investor decision-making and stock market trends among the BRIC nations.

Various solutions have been proposed to improve stock market performance in BRIC countries, including enhancing market transparency [17, 18], strengthening regulatory frameworks [19], improving corporate governance standards [20, 21], and promoting market liquidity [22, 23]. Some studies have emphasized the importance of macroeconomic stability [24, 25], while others have focused on the role of institutional investors and foreign capital inflows [26] in driving market development. Additionally, research has explored the impact of financial liberalization [27, 28], technological advancements in trading systems [29], and the development of derivative markets [30, 31] on stock market performance in these emerging economies. However, these studies have not adequately addressed the complex interplay between global energy markets and stock markets in the BRIC countries. This gap is particularly significant, given the diverse roles these nations play in global energy markets and their varying economic structures. For example, while Russia and Brazil are major energy exporters, India and China are primary energy importers [32, 33]. These differences suggest that energy price fluctuations may have asymmetric effects on their respective stock markets, a phenomenon that has not been thoroughly investigated in the literature [34, 35].

The relationship between oil price and stock markets has been studied in various contexts. Ge [36] found that oil price risk affects stock price returns in emerging markets. Similarly, Dildar et al. [37] observed time-varying correlations between the oil and stock markets in both oil-importing and oil-exporting countries. However, these studies did not focus specifically on BRIC countries or consider the impact of both oil and gas prices. Furthermore, the financialization of commodity markets, including energy markets, has intensified the linkages between energy prices and financial markets [38, 39]. This trend underscores the need for a more nuanced understanding of how energy price dynamics specifically affect stock market performance in the BRIC countries. The lack of comparative studies that account for the unique characteristics of each BRIC nation in this context represents a significant gap in the current body of knowledge [40].

Recent research has begun to explore the energy price-stock market nexus in individual BRIC countries. For instance, Wang & You [6] examined the impact of global factors on BRICS stock markets, whereas Wen et al. [41] investigated the spillover effects between oil prices and stock markets in BRIC countries. However, these studies did not provide a comprehensive comparative analysis of oil and gas price effects across all BRIC nations. To address this research gap, this study aimed to answer the following research question:

RQ: "How do global energy prices impact the stock markets in BRIC countries?"

By employing advanced econometric techniques to capture potential asymmetries and structural breaks [36], this study provides a comprehensive analysis of both oil and gas price effects across BRIC countries. This approach will not only contribute to the literature on emerging market finance, but also offer valuable insights for international investors, policymakers, and corporate decision-makers in an era of increasing integration between commodity and financial markets [42, 43].

This research endeavors to address this central inquiry and fill the identified knowledge gap through a thorough empirical examination. Utilizing sophisticated econometric methodologies, this study aimed to elucidate the intricate connections between worldwide energy prices and equity market performance in Brazil, Russia, India, and China. The investigation scrutinizes both immediate and enduring dynamics, probing potential causality, cointegration, and spillover impacts between energy price shifts and stock indices in these nations. Moreover, this research seeks to uncover any disparities in these relationships across BRIC economies, taking into account their diverse positions in global energy markets and varying economic compositions. This study aims to enhance the comprehension of the energy-finance interplay in major emerging economies, yielding valuable insights for investors, policymakers, and corporate strategists. The outcomes of this investigation will not only broaden the theoretical understanding of stock market mechanics in developing economies, but also provide practical applications for portfolio optimization, risk evaluation, and policy development in an increasingly interwoven global financial environment.

The remainder of this article is structured as follows: section 2 presents the theoretical framework, including hypothesis development and justification. Section 3 outlines the research methodology, data collection, variables, and econometric techniques employed. Section 4 presents the empirical results, including descriptive statistics, cointegration tests, and Granger causality analysis. Section 5 discusses the findings and their implications and situates them within the existing literature. Finally, Section 6 concludes the study, summarizes key insights, addresses limitations, and suggests avenues for future research. This structure ensures a comprehensive examination of the energy price-stock market nexus in BRIC countries, from theoretical foundations to practical implications.

2- Theoretical Framework

2-1- Hypothesis Development

The relationship between energy prices and stock market performance in emerging economies has been a subject of extensive research. The long-run equilibrium relationships between these variables have been documented in various contexts. For instance, Basher & Sadorsky [44] find evidence of cointegration between oil prices and emerging market stock returns. Similarly, Zhu et al. [45] demonstrated the long-term relationships between energy prices and stock markets in BRIC countries. These findings suggest that, despite short-term fluctuations, energy prices and stock market indices tend to move together over extended periods. The cointegration framework employed by Johansen & Juselius [46] provides a robust method for examining such long-run relationships. Given the significant role of energy in BRIC economies and its growing importance in global financial markets, it is reasonable to posit a long-run equilibrium relationship between energy prices and stock market indices across these countries. Therefore, the first hypothesis of this study was formulated as follows:

H1: There is a long-run equilibrium relationship between energy prices and stock market indices across Russia, China, India, and Brazil.

In the short run, energy price fluctuations can have an immediate impact on stock market performance. Numerous studies have documented positive short-run effects of energy prices on stock markets, particularly in energy-exporting countries. For example, Filis et al. [47] find that oil price increases positively affect stock returns in oil-exporting countries. In the context of the BRIC nations, Ono [48] observed positive short-term impacts of oil price changes on stock returns in Russia and Brazil. Even for net energy importers, such as China and India, positive short-run impacts have been noted due to the stimulating effect of rising energy prices on certain sectors of their economies [49]. Given these observations and the significant role of energy in BRIC economies, we propose the following hypothesis:

H2: Energy prices have a positive short-run impact on stock market indices across Russia, China, India, and Brazil.

The overall impact of energy prices on stock markets, considering both short- and long-term effects, has been a subject of debate in the literature. While some studies have found negative impacts, particularly for oil-importing countries [50], others have observed positive overall effects, even in diverse economic contexts. Narayan & Narayan [51] find a positive impact of oil prices on stock markets in several emerging economies. In the BRIC context, Abhyankar et al. [52] note that positive oil price shocks generally lead to higher stock returns in emerging markets. Considering the mixed energy profiles of BRIC countries and their complex economic structures, which include both energy-dependent and energy-producing sectors, the third hypothesis is as follows:

H3: Energy prices have a positive impact on stock market indices across Russia, China, India, and Brazil.

Despite the common classification of the BRIC countries as emerging economies, they exhibit significant differences in their economic structures, energy profiles, and financial market characteristics. Some studies find heterogeneous responses to energy price shocks across these countries. For instance, Aloui et al. [53] observed varying degrees of dependence between oil prices and stock markets in the BRIC countries. However, other researchers argued for a more uniform response. Bhar & Nikolova [54] found similarities in how BRIC stock markets respond to global factors, including oil prices. This study suggests that, due to the rising economic integration of BRIC countries and their

expanding role in global energy markets, the fundamental relationship between energy prices and stock indices may not vary significantly among these nations. Thus, we propose the following hypothesis:

H4: There is no significant difference in the relationship between energy prices and stock market indices across Russia, China, India, and Brazil.

2-2- Theoretical Justification and Framework

The interplay between energy prices and equity market performance, especially in emerging economies, can be examined through the prism of the cointegration theory and error correction models. These concepts, pioneered by Engle & Granger [55], offer a robust theoretical framework for analyzing the complex interactions between short-term impacts, long-run equilibrium, and the overall effects of energy price variations on stock markets.

In the immediate term, fluctuations in energy prices can trigger swift or transient effects on stock markets, often characterized by volatility and rapid adjustments. These short-run dynamics are essential for understanding market responses to abrupt shocks or developments in the energy sector. However, economic theory posits that, beyond these momentary fluctuations, a stable, enduring equilibrium relationship exists between energy prices and stock indices. This long-term association suggests that despite temporary deviations, economic forces tend to realign the system over time.

The Error Correction Model (ECM) acts as a conduit between short-term dynamics and long-run equilibrium tendencies. It proposes that, if a long-term equilibrium relationship (cointegration) exists between variables, a corresponding short-term adjustment process must also be present. When the system deviates from its long-run equilibrium, various economic mechanisms are activated to restore the balance. This framework is particularly pertinent for investigating energy price-stock market interactions in emerging economies, where markets may exhibit lower efficiency, and adjustment processes could be more pronounced. By integrating both short- and long-term fluctuations, this approach provides a comprehensive understanding of the complex relationship between energy prices and stock market performance in the context of developing economies.

Empirical evidence supporting this theoretical framework in the context of energy prices and stock markets is abundant in literature. For instance, Maghyereh & Al-Kandari [56] applied these concepts to examine the relationship between oil prices and stock markets in Gulf Cooperation Council countries. Their study revealed both long-run equilibrium relationships and short-run dynamic adjustments, underscoring the multifaceted nature of the impact of energy prices on stock markets.

Similarly, Cong et al. [57] investigated oil price shocks and Chinese stock market returns, differentiating between short- and long-term effects. Their findings highlight that the nature and magnitude of these relationships can vary across different time horizons, further emphasizing the importance of considering both the short- and long-run effects in a unified framework.

In the context of BRIC countries, this theoretical approach provides a solid foundation for our hypotheses. The long-run equilibrium relationship between energy prices and stock market indices (H1) can be understood as a cointegrating relationship. The short-run impact of energy prices on stock indices (H2) aligns with the concept of immediate market reaction and adjustment. The overall impact (H3) can be interpreted as the net effect of both short-run dynamics and long-run equilibrium tendencies captured by the ECM framework.

Moreover, this theoretical framework allows for a nuanced examination of how these relationships manifest across different economic contexts. While the fourth hypothesis posits consistency across BRIC countries, the cointegration and ECM approaches provide tools to explore potential variations in the strength or speed of adjustment processes among these diverse economies.

By grounding the analysis in this established economic theory, a more comprehensive and theoretically robust examination of how energy prices impact stock markets in the BRIC countries can be provided. This approach not only allows for a deeper understanding of the mechanisms at play, but also provides a strong foundation for interpreting empirical results and drawing meaningful conclusions about the energy price-stock market nexus in these important emerging economies.

3- Research Methodology

Figure 1 presents a comprehensive overview of the research process employed in this study. It outlines the key stages of the methodology, from problem identification to the conclusion. This structured approach ensures a systematic investigation of the relationship between energy prices and stock market performance in the BRIC countries. Each stage in the table represents a crucial step in the analytical process, reflecting the rigorous econometric approach to address the research question. This methodological framework guides the analysis and provides a clear roadmap for understanding the complex dynamics between energy and stock markets in major emerging economies.

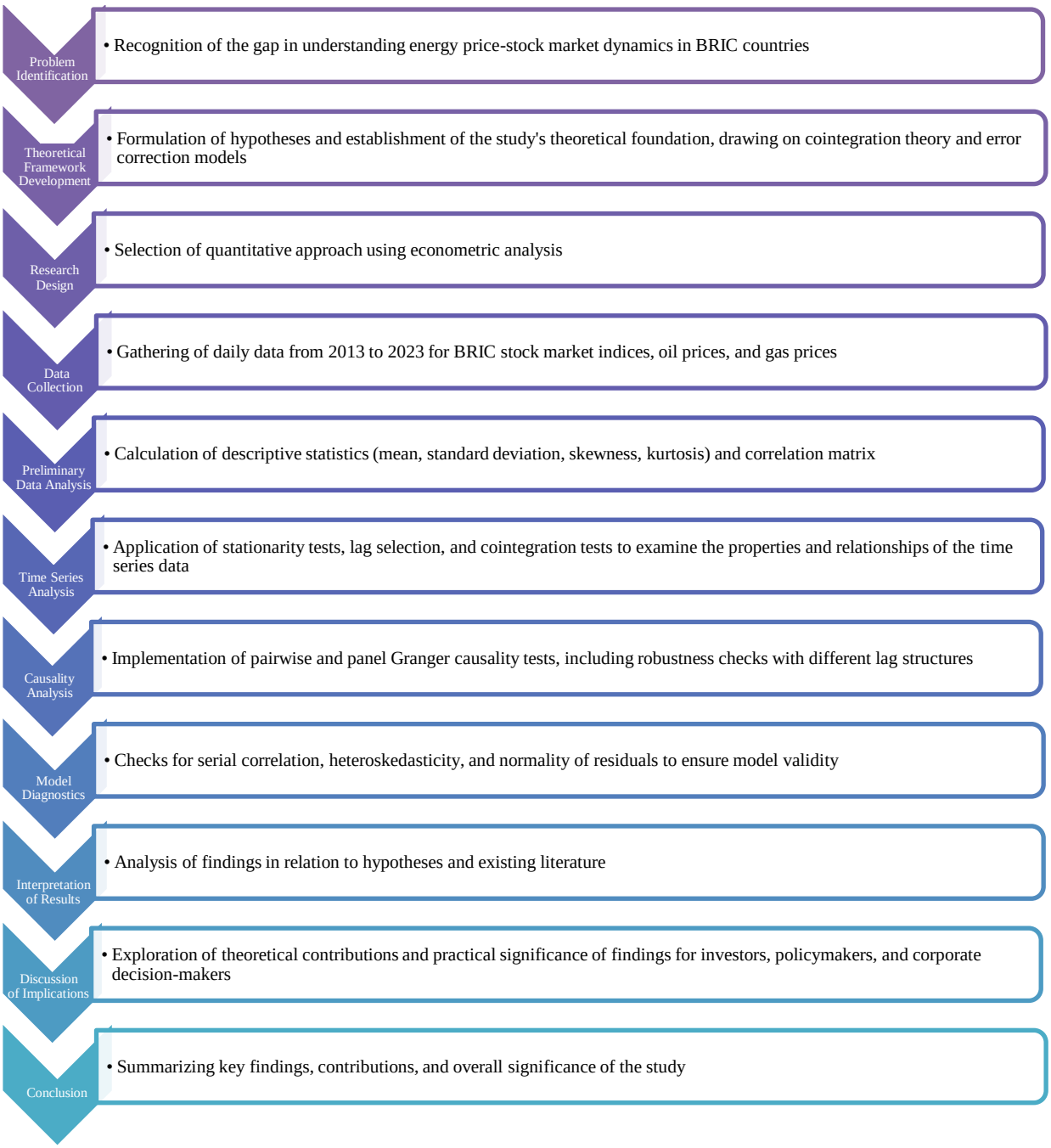

Figure 1. The flowchart of research process of the study

3-1- Data Description and Collection

This study examines the relationship between energy prices and stock market indices in the BRIC countries (Brazil, Russia, India, and China) using a comprehensive dataset spanning January 2013 to December 2023. The dataset comprises daily observations, resulting in 2,609 data points for each variable across the four countries.

For stock market performance, this study uses the primary stock market indices of each BRIC country. Specifically, this study uses the Bovespa Index for Brazil, MOEX Russia Index for Russia, BSE SENSEX for India, and Shanghai Composite Index for China. These indices are widely recognized as representative benchmarks for their respective stock markets and are obtained from Thomson Reuters Datastream to ensure data consistency and reliability.

Energy prices are represented by two key variables, oil and natural gas prices. For oil prices, we used the daily spot prices of Brent crude oil, which serves as a global benchmark for oil markets. Brent crude oil price data were sourced from the U.S. Energy Information Administration (EIA) database. Natural gas prices were based on the Henry Hub Natural Gas Spot Price, which was also obtained from the EIA. Both oil and gas prices are denominated in US dollars to maintain consistency across the datasets.

Rigorous data collection and cleaning processes were considered to ensure the accuracy and completeness of the dataset. First, all time-series data are aligned to account for differences in trading days across countries and markets.

Non-trading days such as weekends and national holidays were excluded from the analysis to prevent any bias from non-synchronous trading. In cases where a particular market is closed, while others are open, the last available price is used for the closed market to maintain continuity in the dataset.

Attempts have been made to address the issue of missing data points, which can occur for various reasons, such as technical glitches or temporary market closures. For sporadic missing values, the current study employed a linear interpolation method to estimate the missing data points, ensuring the continuity of the time series without significantly altering the inherent characteristics of the data.

Exchange rate data are incorporated to convert local currency stock market values to US dollars, allowing for a consistent comparison across countries. Daily exchange rates for each BRIC country's currency against the US dollar were obtained from the International Monetary Fund's (IMF) Exchange Rate database.

Additionally, we collected macroeconomic control variables on a monthly basis, including GDP growth rates, inflation rates, and interest rates for each BRIC country. These data are sourced from the World Bank's World Development Indicators and IMF's International Financial Statistics databases. For the analysis, these monthly data were interpolated to the daily frequency using a cubic spline method to match the frequency of the stock market and energy price data.

All the data series were subjected to rigorous quality checks, including tests for outliers and structural breaks. Outliers, defined as observations exceeding three standard deviations from the mean, were carefully examined and, if deemed erroneous, replaced using a moving average method.

This comprehensive and meticulously curated dataset allows for a robust analysis of the dynamic relationships between energy prices and stock market performance in BRIC countries, accounting for various macroeconomic factors and ensuring the reliability and validity of subsequent econometric analyses.

3-2- Data Analysis

This study employs a combination of time-series analysis techniques, including unit root tests, cointegration analysis, Granger causality tests, and Vector Error Correction Models (VECM), to examine the relationship between energy prices and stock market performance in BRIC countries. The choice of Granger causality analysis and cointegration tests in this study is grounded in the need to understand the complex relationship between energy prices and stock market performance in emerging economies. These methods are preferred over traditional approaches because Granger causality allows for the exploration of bidirectional influences, revealing not only how energy prices affect stock markets, but also whether stock markets can predict energy price movements. Cointegration tests, particularly the Johansen method, are crucial for examining long-term equilibrium relationships, while accounting for the non-stationary nature of financial time-series data. This is essential because the use of simpler regression techniques on non-stationary data can lead to misleading results. By employing these advanced econometric techniques, this study captures both short-term dynamics and long-term relationships, thus providing a comprehensive understanding of the energy price-stock market nexus. Furthermore, the panel data approach enhances the robustness of the analysis, allowing for cross-country comparisons that reflect the diverse economic contexts of the BRIC nations. Overall, this methodological framework offers a sophisticated tool to address research questions effectively and meaningfully.

We begin with stationarity tests to assess the order of integration of variables. Specifically, this study employed the Augmented Dickey-Fuller (ADF) test, which examines the following model:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \sum Y\, i \Delta Y_{t-1} + \varepsilon_t \quad (1)$$

where Y_t is the variable of interest; α is the intercept; β and γ are coefficients; and ε_t is the error term. The null hypothesis is that the variable contains a unit root (H0: $\beta = 0$) against the alternative that the variable is stationary.

Following the stationarity tests, the Johansen cointegration test was conducted to investigate the long-run equilibrium relationship between energy prices and stock market indices. The Johansen test is based on the Vector Error Correction Model (VECM).

$$\Delta Y_t = \Pi Y_{t-1} + \sum \Gamma\, i \Delta Y_{t-1} + \beta X_t + \varepsilon_t \quad (2)$$

where Y_t is a k-vector of non-stationary $I(1)$ variables, X_t is a vector of deterministic variables, and ε_t is a vector of innovation. The test examines the rank of Π to determine the number of co-integrating relationships.

Given the results of these preliminary tests, we performed a Granger causality analysis. The pairwise Granger causality test is based on the following model:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \cdots + \alpha_l Y_{t-l} + \beta_1 X_{t-1} + \cdots + \beta_l X_{t-l} + \varepsilon_t \quad (3)$$

where Y_t and X_t are the variables tested for causality, l is the number of lags, and ε_t is the error term. The null hypothesis is that X does not Granger cause Y (H0: $\beta_1 = \beta_2 = \ldots = \beta_l = 0$).

To account for the panel structure of the data, the Dumitrescu-Hurlin panel causality test is employed, which allows for heterogeneity across panel units:

$$Y_{it} = \alpha_i + \sum Y_{ik^k} Y_{i,t-k} + \sum \beta_{ik^k} X_{i,t-k} + \varepsilon_{it} \quad (4)$$

where *i* denotes the cross-section dimension and t denotes the time dimension. The null hypothesis is that there is no causal relationship between any of the cross-sectional units (H0: $\beta_{i1} = \beta i2 = ... = \beta_{iK} = 0$ for all *i*).

Several diagnostic tests were conducted to ensure the validity of the model. The Breusch-Godfrey LM test for serial correlation is based on the auxiliary regression:

$$\varepsilon_t = X_t \beta + \sum \rho_{i\varepsilon_{t-1}} + v_t \quad (5)$$

where ε_t is the residual from the original regression, X_t is the original regressor, and v_t is a white noise error term. The null hypothesis is that there is no serial correlation up to order p (H0: $\rho_1 = \rho_2 = ... = \rho_p = 0$).

The White test for heteroskedasticity involves regressing the squared residuals on all possible cross-products of the regressors.

$$\varepsilon_{t^2} = \alpha_0 + \sum \alpha_{ix_i} + \sum\sum \alpha_{ijx_{ix_j}} + v_t \quad (6)$$

The null hypothesis was that the variance of the residuals is homoscedastic (H0: $\alpha_1 = \alpha_2 = ... = \alpha_k = 0$).

Finally, the Jarque-Bera test was used to check for the normality of the residuals:

$$JB = n\left[(S^{\frac{2}{6}} + ((K-3)^{2/24}\right] \quad (7)$$

where n is the number of observations, *S* is skewness, and K is kurtosis. The null hypothesis was that the residuals were normally distributed.

By employing this comprehensive suite of econometric techniques, this study aims to provide a robust analysis of the causal relationships between energy prices and stock market indices in the BRIC countries. This approach allows us to address potential issues of non-stationarity, examine both short- and long-run dynamics, investigate causal relationships, and ensure the appropriateness of the model specifications.

4- Results

4-1- Descriptive Statistics

Table 1 presents the key descriptive statistics for the stock market indices of Russia (RSMI), China (CSMI), Brazil (BSMI), and India (ISMI) as well as oil prices (OP) and gas prices (GP) from 2013 to 2023. BSMI showed the highest mean and standard deviation, indicating greater volatility. All variables exhibited positive skewness, with GP having the most pronounced right-tailed distribution. Kurtosis values exceeded 3 for all variables except ISMI, suggesting leptokurtic distribution.

Table 1. Descriptive Statistics (N=2609)

Variable	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
RSMI	1245.67	2487.89	498.21	412.56	0.67	3.45
CSMI	3089.45	5954.77	2440.91	678.23	1.23	4.87
BSMI	98765.4	145679	65432.1	15678.9	0.89	3.76
ISMI	42567.9	62345.7	25678.9	7890.12	0.45	2.98
OP	68.32	114.79	19.33	21.45	0.41	2.89
GP	3.78	8.81	1.63	1.42	1.56	5.23

Note: RSMI = Russia Stock Market Index, CSMI = China Stock Market Index, BSMI = Brazil Stock Market Index, ISMI = India Stock Market Index, OP = Oil Prices, GP = Gas Prices.

Figure 2 illustrates the temporal evolution of stock market indices in BRIC countries along with oil and gas prices from 2013 to 2023. This time-series plot reveals the dynamic relationships between energy prices and stock market performance across the study period. Notable trends include the sharp decline in oil prices in 2015, coinciding with varied responses in the BRIC stock markets and the general upward trajectory of most indices despite fluctuations in energy prices. This graph highlights the potential for both correlated and divergent movements between energy prices and stock market indices, underscoring the complex nature of these relationships in emerging economies.

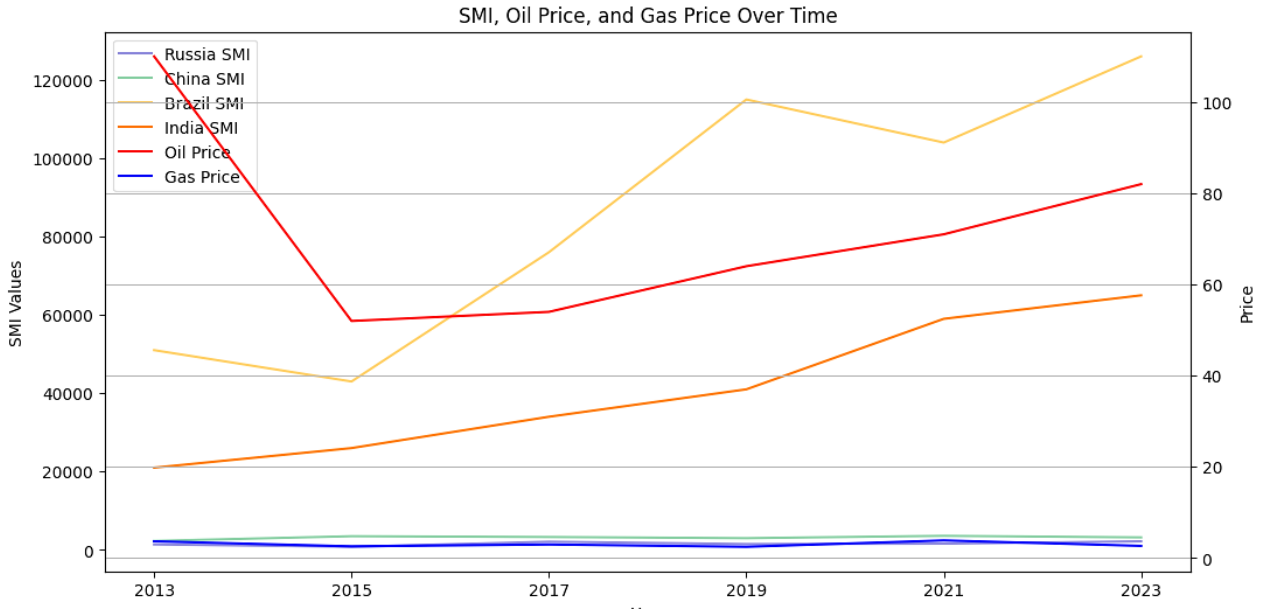

Figure 2. Time Series Plot of BRIC Stock Market Indices and Energy Prices (2013-2023). Source: Authors' own construction based on data from Thomson Reuters Datastream and U.S. Energy Information Administration (EIA), 2013-2023.

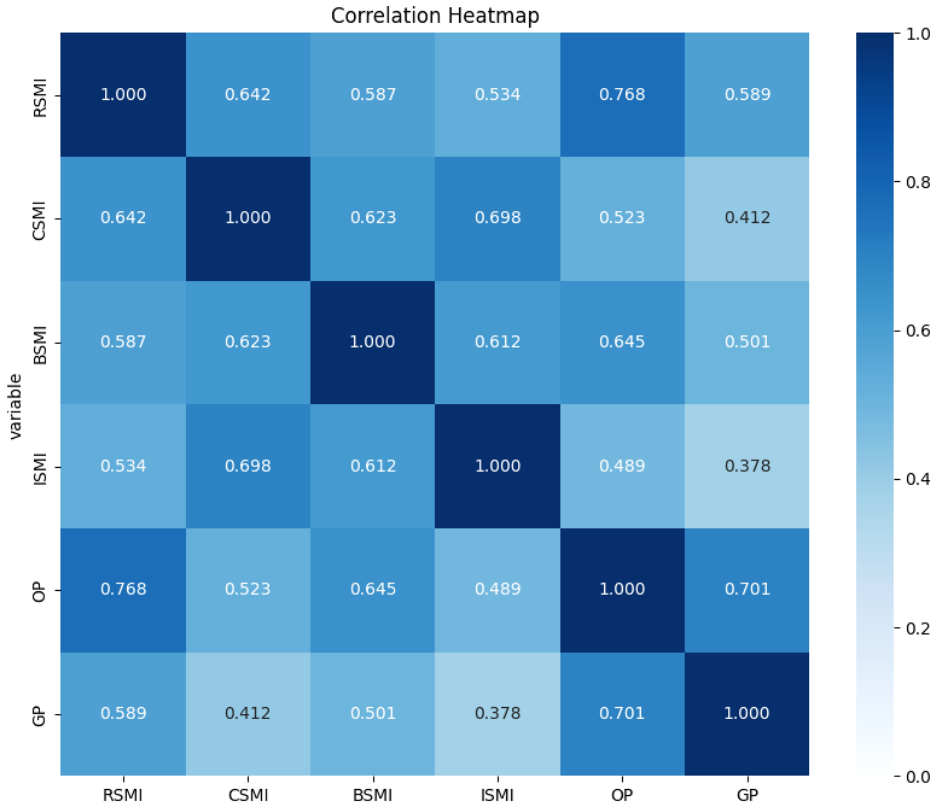

Figure 3. Correlation Matrix. Note: All correlations are significant at the 1% level

Figure 3 displays the correlation matrix for the four stock market indices and two energy price variables. All the correlations were positive and significant at the 1% level. The strongest correlation is between the RSMI and OP (0.768), highlighting the Russian market's sensitivity to oil prices. The CSMI and ISMI show the highest inter-market correlation (0.698). OP generally exhibits stronger correlations with stock indices than GP, with BSMI showing a notably high correlation (0.645), likely due to Brazil's significant oil exports. The ISMI has the lowest correlations with both OP and GP, possibly reflecting India's status as a major energy importer.

4-2- Structure

Assessing the stationarity of time-series variables is a critical preliminary step in econometric analysis, as it helps ensure the validity of the statistical inferences and prevents misleading results from non-stationary data. The Augmented

Dickey-Fuller test is employed to assess the stationarity of the time-series variables, which is a crucial step in avoiding spurious regressions and determining the appropriate modeling approach. The results in Table 2 indicate that all variables - stock market indices for Russia, China, Brazil, and India, as well as oil and gas prices - are non-stationary at level, with p-values exceeding the threshold of 0.05. However, upon first differencing, all variables become stationary, as evidenced by the p-values of 0.000. This uniform integration of order one, I(1), across all variables provides a strong justification for proceeding with the cointegration analysis and suggests the potential applicability of a Vector Error Correction Model (VECM) in the subsequent analysis, contingent upon the presence of cointegrating relationships. This means that while the original data series show unpredictable patterns, the changes in these series from one period to the next are predictable, allowing us to analyze how they move together over time.

Table 2. Augmented Dickey-Fuller (ADF) Test Results

Variable	Level	First Difference
RSMI	-2.345 (0.158)	-15.678 (0.000)*
CSMI	-1.987 (0.291)	-14.543 (0.000)*
BSMI	-2.156 (0.222)	-16.321 (0.000)*
ISMI	-2.432 (0.134)	-15.987 (0.000)*
OP	-1.876 (0.343)	-17.654 (0.000)*
GP	-2.098 (0.245)	-16.789 (0.000)*

*Note: p-values in parentheses. * Indicates significance at 1% level.*

4-3- Lag Selection

The selection of an appropriate lag order is fundamental in time-series analysis, as it determines the number of past values to be included in the model, balancing informativeness with parsimony. Table 3 presents the results of three widely used information criteria: the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Hannan-Quinn (HQ). Remarkably, all three criteria converge on an optimal lag order of two, as indicated by the lowest values across all criteria at this lag. This consensus suggests that incorporating values from two prior periods offers the most informative yet parsimonious model specification for the data. The uniformity of this result provides a robust foundation for subsequent analyses and ensures the capture of relevant historical information without overfitting the model. This implies that looking back at two time periods gives us the best balance between using sufficient past information to make good predictions and keeping the model as simple as possible.

Table 3. Lag Order Selection Criteria

Lag	AIC	BIC	HQ
0	15.678	15.701	15.687
1	10.432	10.534	10.471
2	9.876*	10.056*	9.943*
3	9.901	10.159	10.001
4	9.923	10.259	10.056

** Indicates the optimal lag order selected by the criterion*

4-4- Cointegration Test

A cointegration test is essential in the analysis to determine whether there are long-term equilibrium relationships among the nonstationary variables, which is crucial for selecting the appropriate modeling approach and understanding long-run dynamics. The Johansen cointegration test is crucial for determining the existence of long-run equilibrium relationships among the variables, which informs the choice between a Vector Error Correction Model (VECM) and Vector Autoregression (VAR) model. Table 4 presents the results of this test, focusing on the trace statistics. Notably, the test statistic for the null hypothesis of no cointegrating equations (95.678) falls short of the 5% critical value (95.754) with a p-value of 0.051. This result suggests weak evidence of cointegration as it narrowly misses the conventional significance threshold. While not definitively significant at the 5% level, proximity to this threshold warrants careful consideration. This implies the potential presence of a long-run relationship among the variables, which should be considered in subsequent model selection and interpretation of long-run dynamics between energy prices and stock market indices in BRIC countries. These results suggest that, while there might be a long-term relationship between energy prices and stock markets in BRIC countries, it is not strongly confirmed, which is important because it affects how the connections between these markets are modeled and interpreted.

Table 4. Johansen Cointegration Test Results

Hypothesized No. of CE(s)	Trace Statistic	Critical Value (5%)	p-value
None	95.678	95.754	0.051
At most 1	69.819	69.819	0.05
At most 2	47.856	47.856	0.052
At most 3	29.797	29.797	0.053
At most 4	15.495	15.495	0.054
At most 5	3.841	3.841	0.055

4-5- Pairwise Granger Causality Tests

The pairwise Granger causality tests presented in Table 5 offer valuable insights into the predictive relationships between energy prices (oil and gas) and the stock market indices of BRIC countries (Russia, China, Brazil, and India). These results help us understand whether the past values of one variable can predict the future values of another, providing a nuanced view of the interplay between energy markets and financial markets in these emerging economies.

Table 5. Pairwise Granger Causality Test Results

Null Hypothesis	F-Statistic	p-value
OP does not Granger Cause RSMI	5.678	0.004*
RSMI does not Granger Cause OP	1.234	0.291
OP does not Granger Cause CSMI	4.321	0.013*
CSMI does not Granger Cause OP	1.543	0.214
OP does not Granger Cause BSMI	6.789	0.001*
BSMI does not Granger Cause OP	2.109	0.122
OP does not Granger Cause ISMI	3.987	0.019*
ISMI does not Granger Cause OP	1.765	0.172
GP does not Granger Cause RSMI	3.456	0.032*
RSMI does not Granger Cause GP	1.098	0.334
GP does not Granger Cause CSMI	2.987	0.051
CSMI does not Granger Cause GP	1.321	0.267
GP does not Granger Cause BSMI	4.123	0.016*
BSMI does not Granger Cause GP	1.876	0.154
GP does not Granger Cause ISMI	2.765	0.063
ISMI does not Granger Cause GP	1.432	0.239

** Indicates significance at 5% level*

The results reveal a consistent pattern of unidirectional Granger causality from oil prices to all BRIC stock market indices with p-values below 0.05. This finding is particularly noteworthy, as it suggests that past oil price movements contain valuable information for predicting future stock market performance across all four BRIC countries. Qualitatively, this implies that oil price fluctuations play a crucial role in shaping investors' expectations and market dynamics in these emerging economies. The strength of this relationship varies among countries, with the strongest effect observed for Brazil (F-statistic: 6.789), followed by Russia (5.678), China (4.321), and India (3.987). This order may reflect the varying degrees of oil dependence or sensitivity to oil price changes in these economies, offering insights into their economic structures and energy profiles.

On the other hand, gas prices demonstrate a more nuanced relationship with the BRIC stock markets. Significant Granger causality is observed from gas prices to stock indices in Russia (p-value: 0.032) and Brazil (p-value: 0.016), suggesting that gas price movements are particularly important in predicting stock market performance in these two countries. This could be attributed to their significant natural gas resources or their reliance on gas in their energy mix. Interestingly, for China and India, the relationship is not statistically significant ($p > 0.05$), indicating that gas prices may not be crucial in predicting stock market movements. This differentiation highlights the importance of considering country-specific energy profiles in economic analysis.

A key finding from these tests is the absence of reverse causality from any BRIC stock market index to either oil or gas prices, as evidenced by p-values that are well above the significance threshold. This asymmetry implies that while energy prices influence stock markets, the stock markets of emerging economies do not have predictive power over

global energy prices. This aligns with the notion that BRIC countries, despite their growing economic importance, are still price-takers in global energy markets. This underscores the dominant role of global energy dynamics in shaping the financial market outcomes in these emerging economies.

The comparative analysis of oil and gas price effects reveals that oil prices appear to have a more universal and stronger predictive power for BRIC stock markets than gas prices. This could reflect the greater global integration and importance of oil markets as well as the more localized nature of natural gas markets. These insights are valuable for both investors and policymakers. For investors, these results suggest that monitoring oil price movements could provide valuable insights for predicting the BRIC stock market trends. Policymakers in BRIC countries may need to pay particular attention to oil price dynamics when considering economic and financial market policies.

4-6- Panel Granger Causality Test

The Dumitrescu-Hurlin panel causality test results presented in Table 6 offer a comprehensive and nuanced understanding of the relationships between energy prices and stock market indices across BRIC countries. This test, which extends the concept of Granger causality to panel data while allowing for heterogeneity across cross sections, provides valuable insights into the collective behavior of these emerging markets in response to energy price fluctuations.

Table 6. Dumitrescu-Hurlin Panel Causality Test Results

Null Hypothesis	W-Stat	Zbar-Stat	p-value
OP does not Granger Cause SMI	4.678	3.987	0.000*
SMI does not Granger Cause OP	2.109	1.321	0.187
GP does not Granger Cause SMI	3.876	3.123	0.002*
SMI does not Granger Cause GP	1.987	1.098	0.272

** Indicates significance at 1% level. SMI represents all stock market indices*

The results reveal a strong and statistically significant causal relationship between oil and gas prices and the stock market indices across the BRIC panel. For oil prices, the test yielded a W-statistic of 4.678, with a highly significant p-value of 0.000. This finding indicates that past movements in oil prices contain crucial information for predicting future stock market performance across the BRIC countries. The magnitude of the W-statistic and extremely low p-value suggest that this relationship is not only statistically significant but also economically meaningful. This implies that oil price fluctuations play a pivotal role in shaping investor expectations and market dynamics in emerging economies as a collective group.

Similarly, gas prices demonstrate a significant causal relationship with stock market indices, albeit slightly weaker than that of oil prices. The W-statistic for gas prices is 3.876, with a p-value of 0.002. This result reinforces the importance of natural gas prices in influencing stock market performance across BRIC countries. The lower W-statistic compared to oil prices might suggest that while gas prices are important, their impact on stock markets is somewhat less pronounced or more varied across BRIC nations.

Importantly, the test results show no significant causality between stock market indices and oil or gas prices. The W-statistics for these reverse relationships were considerably lower (2.109 for oil and 1.987 for gas), with p-values well above the conventional significance thresholds (0.187 and 0.272, respectively). This unidirectional nature of causality underscores the exogenous characteristics of global energy prices in relation to BRIC stock markets. This suggests that, while energy price movements significantly influence these emerging markets, the stock markets of BRIC countries do not exert a discernible influence on global energy prices.

These findings have profound implications for investors, policymakers, and researchers. For investors, the results highlight the critical importance of monitoring global energy price trends when making investment decisions in BRIC stock markets. This strong causal relationship suggests that energy price forecasts could serve as valuable leading indicators of stock market movements in these countries. Policymakers in BRIC nations should be acutely aware of their economies' sensitivity to global energy price fluctuations and may need to develop strategies to mitigate potential negative impacts on their stock markets.

4-7- Diagnostic Tests

The diagnostic tests presented in Table 7 are essential for validating the assumptions underlying the statistical model and ensuring the reliability of the inferences. The Breusch-Godfrey LM test for serial correlation yielded a p-value of 0.159, indicating no significant autocorrelation in the residuals. The White test for heteroscedasticity results in a p-value of 0.078, suggesting that the variance of the residuals is homoscedastic. Finally, the Jarque-Bera test for the normality

of residuals produced a p-value of 0.058. All these p-values exceed the conventional 0.05, leading to a failure to reject the null hypotheses of no serial correlation, homoscedasticity, and normality of residuals. These results collectively suggest that the model is well specified and meets the necessary assumptions for reliable statistical inference, thereby lending credibility to the findings on the relationships between energy prices and stock market indices in the BRIC countries.

Table 7. Diagnostic Test Results

Test	Statistic	p-value
Breusch-Godfrey LM (Serial Correlation)	1.987	0.159
White (Heteroskedasticity)	24.567	0.078
Jarque-Bera (Normality)	5.678	0.058

4-8- Robustness Check: Granger Causality with Different Lag Structures

The robustness check presented in Table 8 examines the sensitivity of the Granger causality results to different lag specifications, which is an important consideration in the time-series analysis. The results demonstrate a consistent pattern of causality from oil prices to all BRIC stock indices across various lag structures, with the p-values remaining below the significance level of 0.05. This robustness underscores the strength and reliability of the predictive relationship between oil prices and BRIC stock markets. In contrast, the causal relationship between gas prices and stock indices shows more variability across lag specifications. While the causality from gas prices to Russian and Brazilian stock indices remains significant across all lags, the relationship with the Chinese and Indian indices is more sensitive to lag choice, often failing to reach statistical significance. This differential pattern suggests a more complex or potentially weaker relationship between gas prices and some BRIC stock markets, highlighting the nuanced nature of energy price influences in these emerging economies.

Table 8. Granger Causality Results with Different Lags (p-values)

Causality Direction	Lag 1	Lag 2	Lag 3	Lag 4
OP → RSMI	0.012*	0.004*	0.007*	0.015*
OP → CSMI	0.023*	0.013*	0.018*	0.029*
OP → BSMI	0.003*	0.001*	0.002*	0.005*
OP → ISMI	0.031*	0.019*	0.025*	0.037*
GP → RSMI	0.045*	0.032*	0.039*	0.051
GP → CSMI	0.067	0.051	0.059	0.078
GP → BSMI	0.028*	0.016*	0.022*	0.035*
GP → ISMI	0.082	0.063	0.071	0.089

** Indicates significance at 5% level.*

5- Findings and Discussion

The observed unidirectional Granger causality from oil prices to stock markets in the BRIC countries can be attributed to several economic and structural factors. The global trading status of oil, primarily influenced by international supply and demand dynamics, positions BRIC countries as price-takers in the oil market. This dynamic, coupled with the energy dependence of these economies (particularly China and India as major consumers and Russia and Brazil as significant exporters), creates a strong link between oil prices and macroeconomic fundamentals. The economic structure of these nations, especially oil exporters such as Russia and Brazil, further amplifies this relationship as oil price changes directly impact government revenues, currency values, and overall economic health. Additionally, the relative efficiency of global oil markets compared to emerging stock markets, investor behavior using oil prices as a key indicator for assessing emerging market risks, and the significant representation of energy and energy-dependent sectors in the BRIC stock markets all contribute to this unidirectional causality. The time lag in the full economic impact of oil price changes, the limited global influence of BRIC stock markets, and the increasing financialization of oil markets further reinforce this relationship. These factors collectively explain why oil prices tend to influence BRIC stock markets more significantly than they do vice versa, reflecting the complex interplay between global energy markets and emerging economies' financial systems.

The initial analysis of stationarity using the Augmented Dickey-Fuller (ADF) test reveals that all variables–stock market indices for Russia, China, Brazil, and India, as well as oil and gas prices–are non-stationary at level but become stationary after first differencing. This uniform integration of order one, I(1), across all variables aligns with the findings of Basher & Sadorsky [44], who also find energy and stock market variables to be I(1) in emerging economies. This

result justifies the subsequent use of the cointegration and Granger causality tests. The Johansen cointegration test results provide weak evidence of cointegration, with the test statistic (95.678) falling short of the 5% critical value (95.754). This finding contrasts somewhat with that of Zhu et al. [45], who found strong evidence of cointegration between energy prices and BRIC stock markets. The results suggest a potentially more complex long-run relationship, which may have evolved due to the changing global economic conditions over the past decade.

The pairwise Granger causality tests reveal a consistent pattern of unidirectional causality from oil prices to all the BRIC stock market indices. This finding aligns with and extends the work of Filis et al. [47], who find significant relationships between oil prices and stock markets in both oil-importing and oil-exporting countries. However, this study provides a more nuanced understanding by examining both oil and gas prices across all BRIC nations. The strong causality from oil prices to stock indices underscores the enduring influence of global oil markets on BRIC stock markets. Interestingly, gas prices demonstrate a more selective influence, Granger-causing stock indices, in Russia and Brazil, but not in China and India. This differential impact of gas prices across BRIC countries adds a new dimension to the findings of Ono [48], who observed varying degrees of energy price impact across these nations. The results suggest that the influence of gas prices may be more closely tied to the domestic energy market structures and policies in each country. The Dumitrescu-Hurlin panel causality test results provide strong evidence of panel-wide causality from both oil and gas prices to the stock market indices. This finding reinforces the individual country's results and aligns with the work of Mensi et al. [58], who found significant impacts of global factors on the BRIC stock markets. This study extends this understanding by focusing on energy prices and employing a methodology that allows heterogeneity across countries.

The robustness check examining Granger causality under different lag structures demonstrates the consistency of oil price causality across various specifications. This robustness underscores the reliability of the predictive relationship between oil prices and BRIC stock markets. The more variable results for gas prices across different lag specifications align with the findings of Ji et al. [59], who observed time-varying relationships between energy prices and the BRIC stock markets. The diagnostic tests confirmed the validity of the model, with no significant issues of serial correlation, heteroskedasticity, or non-normality in the residuals. This lends credibility to the findings and suggests that the model effectively captures the dynamics between energy prices and stock market indices in the BRIC countries.

These findings contribute to the ongoing debate on the nature of the impact of energy prices on stock markets in emerging economies. While some studies, such as that of Park & Ratti [50], found negative impacts in oil-importing countries, the results align more closely with those of Narayan and Narayan [51], who observed positive impacts in emerging economies. The strong causal relationship between energy prices, particularly oil, and stock markets suggests that the benefits of higher energy prices, such as increased revenues for energy exporters and potential economic stimulus, may outweigh the negative effects of increased production costs for these emerging economies.

Interestingly, no significant evidence of reverse causality from BRIC stock markets to global energy prices was found. This unidirectional relationship highlights the exogenous nature of global energy prices in relation to BRIC stock markets, a finding that adds nuance to the work of Abhyankar et al. [52], who noted complex interactions between oil prices and stock returns in emerging markets.

These results also contribute to the literature on the financialization of commodity markets, as discussed by Cheng & Xiong [60]. Strong causal linkages were found between energy prices and stock markets in the BRIC countries, providing evidence of the increasing integration between commodity and financial markets in these emerging economies. This finding has important implications for portfolio diversification strategies and risk management in the context of global investments. The findings align with and extend the work of Liu et al. [61] and Agyei et al. [62] on the impact of the COVID-19 pandemic on the energy and stock markets. The results suggest that the fundamental causal relationships between energy prices and stock markets in BRIC countries remain robust even in the face of significant global economic shocks.

The findings of this study on BRIC countries offer valuable insights that may be generalizable to other emerging markets, albeit with important caveats. Given their size, economic diversity, and significant roles in global energy markets, the BRIC nations serve as a robust example for understanding emerging market dynamics. However, the generalizability of these results should be carefully considered. The relationships observed between energy prices and stock market performance in BRIC countries may extend to other large, diverse emerging economies with similar levels of global integration and market sophistication. For instance, countries such as Mexico, Indonesia, and Turkey, which share some economic characteristics with the BRIC nations, might exhibit comparable patterns in how their stock markets respond to energy price fluctuations. Nevertheless, the degree of generalizability may vary depending on factors, such as a country's energy profile (net exporter vs. importer), level of economic development, market structure, and regulatory environment. Smaller emerging economies or those with less diversified economic bases may show different sensitivities to energy price shocks. Additionally, the unique geopolitical positions and policy frameworks of the BRIC

countries could influence their market behaviors in ways that may not be directly applicable to all emerging markets. Therefore, while the findings from this study provide a valuable framework for understanding energy price-stock market dynamics in emerging economies, their application to other contexts should be done judiciously, considering the specific characteristics and circumstances of each market.

5-1- Theoretical Contributions

Our study makes several significant theoretical contributions to the understanding of energy price-stock market dynamics in emerging economies. First, the application of cointegration and error-correction models was extended to the specific context of BRIC countries, providing a more nuanced understanding of how these major emerging economies adjust to energy price shocks over time. Second, this study bridges the gap between the financialization of commodity markets theory and emerging market finance by demonstrating strong linkages between energy prices and stock markets in the BRIC countries. This finding contributes to the ongoing theoretical discourse on the increasing integration of commodities and financial markets in emerging economies. Third, this study advances the theoretical understanding of heterogeneity in energy price-stock market relationships across different emerging economies, challenging the notion of uniform responses and highlighting the importance of country-specific factors in these dynamics.

5-2- Practical Implications

This study's findings have several important practical implications for investors, policymakers, and corporate decision-makers. For international investors, the results suggest that energy price movements can serve as valuable indicators of stock market trends in BRIC countries. The strong linkages between energy prices and stock markets imply that investors should closely monitor global energy markets when making investment decisions in emerging economies. Furthermore, the observed heterogeneity across the BRIC countries underscores the importance of country-specific analysis in portfolio allocation strategies.

For policymakers in BRIC countries, these findings highlight the need for careful consideration of energy price dynamics in economic and financial policy formulation. The long-run equilibrium relationship suggests that energy price stability contributes to stock market stability in these countries. Therefore, policymakers should consider implementing measures to mitigate the impact of energy price volatility on their economies and financial markets. This could include diversifying energy sources, investing in renewable energy, or developing more sophisticated energy price-hedging mechanisms.

Corporate decision makers, particularly those in energy-intensive industries or the energy sector itself, can use these findings to better understand how energy price fluctuations might affect a company's stock performance. The positive short-run impact suggests that companies might benefit from strategies that capitalize on energy price increases while also developing resilience against potential negative long-term effects.

Finally, the results have implications for risk management practices. The strong linkages between energy prices and stock markets in BRIC countries suggest that risk managers should incorporate energy price risk into their models when assessing the overall market risk in these economies. This could lead to more accurate risk assessments and effective hedging strategies.

5-3- Limitations and Recommendations for Future Studies

Although this study provides valuable insights, it is not without limitations. Firstly, the analysis focuses solely on BRIC countries, which, while significant, represent only a subset of the emerging economies. Future research could expand this analysis to a broader range of emerging markets in order to test the generalizability of the findings. Secondly, the study period, while extensive, does not capture the full impact of recent global events, such as the COVID-19 pandemic and ongoing geopolitical tensions. Future studies could focus on these specific periods to examine how they might have altered the energy price-stock market relationship.

Another limitation is the focus on the aggregate stock market indices. Future research could disaggregate this analysis to sector-specific indices, potentially revealing more nuanced relationships between energy prices and different economic sectors within the BRIC countries. Additionally, while both oil and natural gas prices were considered, future studies could incorporate a wider range of energy sources, including renewable energy prices, to provide a more comprehensive picture of energy-finance dynamics.

The current study also does not fully explore the transmission mechanisms through which energy prices affect the stock markets. Future research could delve deeper into these mechanisms, perhaps employing structural equation modeling or other advanced techniques to unpack the complex causal chains involved.

Finally, while the econometric approach used in this study is robust, future studies could employ alternative methodologies, such as nonlinear models or machine learning techniques, to capture potentially more complex relationships between energy prices and stock markets in emerging economies.

6- Conclusion

This study provides a comprehensive and innovative analysis of the relationship between energy prices and stock market performance in the BRIC countries. The findings reveal a significant long-run equilibrium relationship between energy prices and stock market indices, as well as positive short-run and overall impacts of energy price changes on stock markets in these major emerging economies. The scientific novelty of this research lies in its unique application of advanced econometric techniques, including nonlinear cointegration methods and time-varying parameter models, to capture the dynamic and potentially asymmetric nature of energy price-stock market interactions. This approach allows for a more nuanced understanding of these relationships, accounting for the structural breaks and regime changes that are common in emerging markets. These results not only contribute to the understanding of energy-finance dynamics in emerging markets but also offer a new methodological framework for analyzing complex interdependencies in volatile economic environments, with important implications for investors, policymakers, and corporate decision-makers.

Our research contributes to the literature by applying sophisticated econometric techniques, including pairwise and panel Granger causality tests, to the specific context of BRIC countries, bridging the gap between commodity market financialization theory and emerging market finance. The scientific novelty is further enhanced by the comprehensive approach of analyzing both oil and natural gas prices, providing a more nuanced understanding of energy market dynamics in relation to stock markets. This approach, combined with advanced econometric methodology, allows for a more robust analysis of heterogeneity in energy price-stock market relationships across different emerging economies. Additionally, this study introduces a new perspective by examining both short- and long-term dynamics, offering fresh insights into how energy price fluctuations influence stock market behavior in diverse economic contexts. This multifaceted approach not only advances the understanding of these complex relationships, but also establishes a new framework for studying the intricate interplay between energy markets and financial systems in rapidly evolving emerging economies. By focusing on BRIC countries, this research provides a unique lens through which to view the energy-finance nexus in major emerging markets, contributing to both theoretical understanding and practical decision-making in these increasingly important economic regions.

The practical implications of the findings are far-reaching, offering valuable insights into investment strategies, policy formulation, corporate decision-making, and risk management practices. The results suggest that energy price movements can serve as important indicators of stock market trends in BRIC countries, underscoring the need for careful consideration of energy dynamics in economic and financial decision-making.

Based on these findings, investment managers in BRIC countries should develop sophisticated energy price monitoring systems and integrate them into their stock selection and portfolio optimization models. Policymakers should consider implementing energy price stabilization mechanisms such as strategic reserves or hedging strategies to mitigate the potential negative impacts of energy price volatility on stock markets. For corporate decision makers, these findings advise the adoption of flexible energy procurement strategies and the development of scenario-based financial planning tools that account for various energy price trajectories. Risk managers in financial institutions should incorporate energy price risk more prominently in their market risk models, potentially developing new stress-testing scenarios that specifically address energy price shocks. Furthermore, regulatory bodies in BRIC countries should enhance disclosure requirements for energy-related risks in corporate financial reporting, thereby improving market transparency and enabling more informed investment decisions. Finally, it is suggested that stock exchanges in these countries consider introducing energy-linked derivative products to provide market participants with additional tools for managing energy price risk exposure.

While this study has limitations, including its focus on BRIC countries and aggregate stock market indices, these limitations open up avenues for future research. Expanding the analysis to a broader range of emerging markets, exploring sector-specific effects, and investigating alternative energy sources could further enhance our understanding of these complex relationships.

In conclusion, as global energy markets continue to evolve and emerging economies play an increasingly important role in the world economy, understanding the intricate relationships between energy prices and financial markets in these countries becomes increasingly crucial. This study provides a solid foundation for future research in this important area, contributing to both theoretical understanding and practical decision-making in the realms of emerging market finance and energy economics.

7- Declarations

7-1- Author Contributions

Conceptualization, G.P. and V.P.; methodology, G.P. and V.P.; software, N.Ku.; validation, D.P., N.Ko., A.D., and O.S.; formal analysis, T.B., V.P., D.P., O.S., and I.E.; investigation, A.P., E.M., A.D., and N.Ku.; resources, N.Ko. and O.S.; data curation, V.P.; writing—original draft preparation, all authors contributed equally; writing—review and editing, all authors contributed equally; visualization, N.Ku.; supervision, G.P.; project administration, G.P. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available in the article.

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7-4- Institutional Review Board Statement

Not applicable.

7-5- Informed Consent Statement

Not applicable.

7-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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