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**Article**

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# Energy Prices and Their Impact on US Stock Indices: A Wavelet-based Quantile-on-Quantile Regression Approach

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**ABSTRACT**

This study delves into the effects of crude oil and gas prices on the United States' (US) conventional, Islamic, and environmental, social, and governance (ESG) stock indices from January 2013 to December 2022. Decomposing original time series data to minimise inherent fluctuations and using the Quantile-on-Quantile (QQ) regression approach presents a nuanced view of how these energy prices impact different stock indices. The findings reveal that crude oil prices have a variable impact on the indices: high prices negatively influence the indices, low prices have a positive effect, and moderate prices yield a moderate positive impact. After data decomposition, this positive influence diminishes in higher quantiles, indicating an emerging neutral effect in stabilised conditions. In contrast, gas prices show a limited impact, with high prices slightly benefiting conventional and ESG indices but less so for the Islamic index. This suggests a more pronounced influence of oil prices on the indices, likely due to the dependence of many listed companies on oil. The study emphasises the importance of considering oil-related risks in investment strategies and highlights the asymmetric impact of crude oil prices on the US stock indices. These findings have significant implications for investors and policymakers. They underscore the need for careful consideration of oil price dynamics in investment decisions and the importance of staying vigilant against shifts in oil prices that could lead to market instability.

**Keywords:** Oil Prices, Gas Prices, Conventional Stock Index, ESG Stock Index, Islamic Stock Index, Quantile-on-Quantile Approach
**JEL Classifications:** C32, C58, G11, G14, G1

## 1. INTRODUCTION

The intricate relationship between energy costs, especially the fluctuations in oil prices, and the dynamics of the stock market has long been a subject of keen interest and extensive study in financial academia. The impact of oil prices on stock markets is substantial, mainly due to their immediate effects on company earnings and revenue streams (Arouri et al., 2012). This correlation varies by a country's economic profile; oil-exporting countries typically show a positive correlation (Kilian and Park, 2009), while oil-importing countries exhibit a more diverse link (Badeeb and Lean, 2018). In comparison, the influence of gas prices on stock markets is less explored, possibly because many countries rely more on crude oil for their energy needs. In 2018, crude oil accounted for approximately 99.6 million barrels per day in global energy consumption, overshadowing natural gas, which stood at about 66.29 million barrels per day (Haider, 2020). This disparity suggests a gap in research regarding the impact of gas prices on stock markets.

Our research aims to broaden the current understanding by examining the effects of oil and gas prices on three key US stock indices: the Standard and Poor's (S&P) 500, the Islamic index, and the Environmental, Social, and Governance (ESG) index. The S&P 500 reflects the overall US market, the Islamic index comprises Sharia law-compliant companies, and the ESG index focuses on firms with strong sustainability practices. This study is particularly crucial given the energy sector's significant role in the global economy and the need to understand how energy prices influence these varied indices. While the impact of oil and gas prices on conventional indices has always been addressed in the literature, their effect on Islamic and ESG indices is less understood, marking a critical research gap we intend to fill.

To effectively navigate the shift towards the ESG index, it is crucial to acknowledge the growing significance of sustainable investing in today's financial landscape. As the world gravitates towards environmentally friendly and socially responsible business practices, the ESG index becomes increasingly significant. In this context, understanding how fluctuations in oil and gas prices impact ESG indices becomes pivotal. These indices represent companies likely to be at the forefront of responding to changes in energy prices, given their focus on sustainability and governance. Thus, analysing the ESG index with oil and gas prices offers crucial insights into how energy market dynamics affect sustainable investment strategies. This aspect of our research addresses a notable gap: while many studies have focused on oil and gas price impacts on conventional financial metrics, their influence on sustainability-oriented and Islamic indices remains underexplored. This gap is particularly glaring in the face of a global shift towards sustainable energy sources, where oil and gas price shifts can have significant implications for ESG performance.

Meanwhile, the unique characteristics, innovation, and swift growth of Islamic stocks make them an attractive alternative for investment diversification. At their core, Islamic indices consist of stocks that have undergone a stringent screening process, excluding firms engaged in activities that are non-compliant with Sharia law, such as gambling, alcohol production, and tobacco production. Furthermore, the fundamentals of Islamic finance, anchored in assets and driven by them, differ significantly from those of conventional finance, typically interest-based and debt-associated.

Therefore, the remainder of our study endeavours to analyse the repercussions of oil and gas price changes on conventional, Islamic, and ESG stock indices, offering a novel perspective in ongoing academic discourse. By employing a wavelet-based Quantile-on-Quantile (QQ) regression, we delve into the relationship between fluctuations in oil and gas prices and the performance of these diverse stock indices. This approach, pioneered by Sim and Zhou (2015), allows us to explore how variations in oil and gas prices across different quantiles influence the indices, a perspective not fully captured in conventional regression models. In doing so, we seek to provide valuable insights into how fluctuations in oil and gas prices can influence various market segments, thus informing investment strategies and policy-making.

The findings of this study are expected to be a vital resource for comprehending the multifaceted interactions between energy prices and diverse stock indices in an increasingly volatile and uncertain global energy landscape. The study uncovers a heterogeneous relationship between crude oil and gas prices and the US indices. Notably, while gas is a significant daily energy source, its price shows minimal effect on the indices under investigation. Conversely, high oil prices (in the 0.80-0.90 quantiles) tend to negatively impact all the examined indices, while lower oil prices (0.10–0.30 quantiles) have a positive influence. This nuanced understanding becomes more apparent when decomposing oil prices, revealing that their positive influence intensifies in lower quantiles, and their negative impact grows in higher quantiles, as evidenced in crude oil prices' stabilising time series data.

The subsequent sections of this study are organised as follows: Section 2 provides a thorough review of pertinent literature; Section 3 details the adopted methodology and showcases the results obtained; Section 4 offers an in-depth discussion of these results, placing them in the context of established academic literature. Section 5 summarises the study by underscoring our findings' ramifications for investors and policymakers and proposes directions for upcoming research.

## 2. LITERATURE REVIEW

The Efficient Market Hypothesis (EMH) theory, positing that asset prices reflect all available information, thereby making price forecasting challenging (Fama, 1970), forms the bedrock of the current framework for stock market returns. However, empirical evidence often challenges this notion, with studies indicating that variables like oil prices significantly influence stock returns (Mensi et al., 2017; Dadzie et al., 2023). This discrepancy opens avenues for examining the dynamic relationship between energy prices and stock indices.

Research on the correlation between crude oil, gas prices, and stock indices presents a diverse picture. A considerable body of work (Driesprong et al., 2008; Filis, 2010) identifies a negative correlation between oil prices and stock returns. Contrarily, studies by Narayan and Narayan (2010) and Zhu et al. (2014) suggest a positive relationship. Others, like Apergis and Miller (2009) and Hatemi et al. (2017), find no significant connection. These varying findings can be attributed to methodological differences, sample selection, the time frame analysed, and the countries' specific economic characteristics, such as their status as oil exporters or importers (Smyth and Narayan, 2018). This discrepancy in findings underscores the complexity of the relationship and the importance of context in these analyses.

Mishra et al. (2019) investigated the impact of global crude oil prices on the Dow Jones (DJ)-Global Islamic Stock Index using a novel econometric approach that dissected the primary time series of crude oil prices. Their study, employing the QQ regression framework, showed a predominantly positive relationship between crude oil prices and DJ-Islamic stock market index quantiles. However, as the stability of the crude oil price data increased, they observed more varied impacts, including neutral or negative effects. This research underscored the nuanced influence of oil price fluctuations on different market sectors.

Chang et al. (2020) further explored the impact of global oil prices across varying stages of economic development, focusing on stock market returns and the DJ Islamic index across different sectors. They utilised advanced methodologies, including quantile unit root tests and quantile cointegration tests, concluding that oil price effects varied across different quantiles and industry sectors. Their findings highlighted the differential impact of oil price changes, suggesting potential investment opportunities in resilient sectors like Technology and Telecommunications during periods of oil price volatility.

Wang et al. (2022) examined the effects of oil prices, operating at different frequencies, on sales of various vehicle types. They found a general discouragement in the sale of fuel vehicles with fluctuating oil prices, especially at extreme quantiles. Conversely, oil prices drove sales in the electric vehicle sector, with some deviations due to government policies and market expectations.

The works of Bagchi and Paul (2023) and Liu et al. (2023) focused on the influence of crude oil prices on stock returns and foreign exchange rates in major economies. They observed significant long-term effects of Brent crude oil prices on these financial variables. Additionally, Abdullah et al. (2022) highlighted the importance of crude oil in portfolio diversification strategies for Australian investors, demonstrating its critical role in mitigating complex portfolio disturbances.

Despite the comprehensive nature of these studies, a notable gap remains in the literature. Most research has concentrated on conventional stock market indices, often neglecting the increasingly significant ESG and Islamic indices. Additionally, there is a predominant focus on oil prices, with less attention given to the impact of gas prices. Our research aims to fill these gaps by focusing on the effects of both oil and gas prices on conventional, ESG, and Islamic indices. This approach is particularly relevant in light of the growing importance of ESG and Islamic indices in the investment landscape and the escalating role of gas in global energy markets. By comprehensively analysing these relationships, our study contributes to a more nuanced understanding of the interplay between energy commodities and diverse stock indices.

## 3. METHODOLOGY

This article employs a comprehensive dataset encompassing a diverse range of oil and gas price data at multiple frequencies, alongside a detailed analysis of three key US stock indices: the conventional market index, the Islamic index, and the ESG index. This data, sourced from DataStream, consists of 2,583 daily observations from 2 January 2013 to 30 December 2022. The selection of the period for our dataset is strategic, capturing a decade marked by significant economic, technological, and policy shifts. This timeframe encompasses a complete economic cycle, including growth phases, a downturn, and crucial events such as the 2014-2016 oil price crash and the economic implications of the COVID-19 pandemic. Furthermore, this decade is pivotal due to the accelerated transition towards renewable energy and significant regulatory changes in energy and financial markets. Analysing this period allows for an in-depth understanding of how oil and gas prices interact with stock indices amidst these transformative changes.

The method that we use in this research is Maximal Overlap Discrete Wavelet Transform (MODWT) and Quantile-on-Quantile (QQ) regression. Combining MODWT with the QQ regression approach offers a comprehensive and robust framework for analysing complex economic and financial data. MODWT is instrumental in deciphering data at various frequencies or scales, unveiling unique behaviours and patterns often hidden in daily, monthly, or yearly averages. On the other hand, QQ regression elucidates nonlinear interrelationships between variables across different quantiles, a characteristic often observed in financial and economic datasets. By integrating these two methodologies, researchers can conduct an exhaustive examination of variable interrelationships across multiple scales and quantiles, yielding a more robust analysis. This fusion also enhances the handling of data uncertainty and volatility, with the MODWT isolating different frequency components and the QQ approach illuminating how relationships fluctuate across the distribution. Consequently, this combination provides profound insights into the intricacies of complex data relationships that might be overlooked with traditional regression methods or single-scale analysis. As such, it forms a powerful tool for unmasking complex, potentially nonlinear relationships across different scales, making it exceptionally well-suited for financial and economic research.

### 3.1. Maximal Overlap Discrete Wavelet Transform (MODWT)

Wavelet analysis is a method that combines both the time and frequency aspects of a time series. Wavelet analysis differs from other statistical techniques because it can break down the time series into multiple wavelet levels. According to Ramsey (1999), wavelets produce an orthogonal decomposition of data across time scales, offering a nonparametric depiction of each time series. Moreover, wavelets possess the unique characteristic of preserving temporal data when breaking down the series' frequency. This ensures they encompass all details in the time series pertinent to particular time durations and points (Gençay et al., 2001). Such a characteristic allows wavelets to manage the time series' non-stationary attributes effectively. Two primary wavelet functions can be delineated: the father (ϕ) and mother (ψ) wavelets, both capable of depicting any time-based function (Ramsey, 2002). Father wavelets, which sum up to one, illustrate extensive-scale smooth signal elements. In contrast, mother wavelets, summing up to zero, display variations from these smooth parts. While father wavelets yield scaling coefficients, mother wavelets give rise to different coefficients. The representation of the father wavelet is as follows:

$$\phi_{j,k} = -2^{-j/2}\phi\left(\frac{t-2^j k}{2^j}\right) with \int \phi(t)dt = 1 \tag{1}$$

The mother wavelet is represented as follows:

$$\psi_{j,k} = -2^{-j/2}\psi\left(\frac{t-2^j k}{2^j}\right) with \int \psi(t)dt = 0 \tag{2}$$

The father and mother wavelets act as base functions guiding the series of coefficients. The coefficients associated with smoothness, derived from the father wavelets, can be illustrated as follows:

$$S_{j,k} = \int f(t)\phi_{J,k} \tag{3}$$

The specific coefficients, which are obtained from the mother wavelet, can be characterised as follows:

$$d_{j,k} = \int f(t)\psi_{J,k} \, With \; \mathrm{j} = 1 \ldots\ldots\ldots \mathrm{J} \quad (4)$$

The highest scale of the former reaches up to $2^j$, while the detailed coefficients are extracted from the mother wavelets across all scales ranging from 1 to J. The function, denoted as *f(.)*, can be articulated based on the aforementioned coefficients in the following manner:

$$f(t) = \sum_k S_{J,k}\phi_{J,k}(t) + \sum_k d_{J,k}\psi_{J,k}(t) \ldots + \sum_k d_{J,k}\psi_{j,k}(t) \ldots + \sum_k d_{1,k}\psi_{1,k}(t) \quad (5)$$

After simplifying Equation (5), we obtain the following result:

$$f(t) = S_J + D_J + D_{J-1} + \ldots + D_j + \ldots + D_1 \quad (6)$$

The orthogonal components can be expressed in the following way:

$$S_J = \sum_k S_{J,k}\phi_{J,k}(t), \quad (7)$$

$$D_J = \sum_k d_{J,k}\psi_{J,k}(t) \cdot \mathrm{j} = 1, \& \ldots \mathrm{J} \quad (8)$$

Wavelet analysis provides a layered breakdown of *f(t)* as { SJ, DJ-1,…, D1}. Here, *Dj* represents the wavelet detail at the jth level, associated with changes in the series at scale *λj*. *Sj* is seen as the accumulated shift across each level. As *j* rises, *Sj* displays enhanced smoothness (Gençay et al., 2001). We use the Maximal Overlap Discrete Wavelet Transform (MODWT) to evaluate the scaling and wavelet coefficients. A distinct advantage of MODWT is its absence of specific constraints, such as requiring the data size to match an integer multiple of $2^{J0}$, a limitation present in the Discrete Wavelet Transform (DWT) (Percival and Walden, 2000). This adaptability emphasises our choice of MODWT. The precise and smooth coefficients derived from MODWT are connected with zero-phase filters. These filters ensure the alignment of the original time series attributes with the Multi-Resolution Analysis (MRA) features. It is argued that estimators based on DWT are theoretically less efficient than those derived from MODWT (Gençay et al., 2001). Moreover, while DWT uses weighted differences and averages from adjacent data points, MODWT adopts a shifting difference and average approach, retaining the same number of observations at each wavelet decomposition level.

This research employs the Daubechies Least Asymmetric (LA) filter with an 8 (LA8) length. According to Gençay et al. (2001), the LA(8) wavelet is smoother than the HAAR wavelet filters, which have been widely used in previous studies. Additionally, Cornish et al. (2006) argue that the LA(8) filter presents a higher degree of uncorrelatedness across scales compared to its counterpart, the HAAR filter. We break down the series into wavelet coefficients from D1 to D9. The detail coefficient, Dj, yields data resolution at scales spanning from $2^j$ to $2^{j+1}$. Oscillations that correlate to periods of 2-4, 4-8, 8-16, 16-32, 32-64, 64-128, 128-256, 256-512, and 512-1024 days are represented by $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9$ in that order. The wavelet smooth, $S_9$, encapsulates long-term variations.

### 3.2. Quantile-on-Quantile Approach

Many academic studies seeking to understand and measure the relationship between 2 time series datasets typically start with linear regression. Subsequently, they often transition to the Quantile Regression model pioneered by Koenker and Bassett (1978). Since its inception, Quantile Regression Analysis (QRA) has become a popular econometric tool for capturing and examining the dynamic relationship and interdependency structure across time series datasets. However, a significant limitation of the QRA approach is its restricted scope in capturing the full extent of interdependency. Although QRA excels in evaluating the variable relationships at different points of the conditional distribution, it fails to consider how specific uncertainties might influence the relationship between dependent and independent variables.

Sim and Zhou (2015) pioneered the QQ approach in response to the constraints of QRA. In this research, considering their frequencies, we adopt the QQ approach to depict the quantile of US index returns in conjunction with crude oil and gas price returns. A standout advantage of the QQ approach is its capability to detect variations in correlations between variables throughout their conditional distribution, granting a comprehensive perspective on their interlinked relationship. Utilising the QQ model in our research involves selecting different uncertainty quantiles and exploring the specific effects of uncertainties in oil and gas prices, factoring in their diverse frequencies on the separate quantiles of US stock index returns.

Recently, significant progress has been observed in applying the QQ technique, as evidenced by studies like Sharif et al. (2019) and Shahbaz et al. (2018). When estimating the QQ regression model, there are two primary approaches: (1) the system of triangular equations proposed by Ma and Koenker (2006) and (2) the individual equation regression approach put forth by Sim and Zhou (2015), which builds upon the foundation laid by Ma and Koenker (2006). In this research, we opt for the individual equation regression technique for our analysis and estimation. To elaborate, we represent the US conventional stock index returns (USC) quantile as θ. Our initial step involves modelling the θ-quantile of USC returns based on its prior lag, denoted $USC_{t-1}$, and considering the crude oil prices, symbolised as $Oil_t$. The relation can be illustrated as:

$$USC_t = \beta^\theta \mathrm{Oil}_t + \varepsilon_t^\theta \quad (9)$$

is the error term, which has a zero θ-quantile. Considering our limited prior knowledge about the connection between US stock index returns and global crude and gas price fluctuations, we approach the relationship function (.) as unspecified. This research investigates the association between the θ-quantile of US stock index returns and the θ-quantile of crude oil prices, denoted by Oil*τ*. We streamline the function (.) using a first-order Taylor expansion based on Oil*τ*. This relationship can be expressed as:

$$\beta^\theta\left(Oil_t\right) \approx \beta^\theta\left(\mathrm{Oil}^\tau\right) + \beta^{\theta'}\left(\mathrm{Oil}^\tau\right)\left(\mathrm{Oil}_t - Oil^\tau\right). \quad (10)$$

Drawing from the research conducted by Sim and Zhou (2015), $\beta^\theta\left(\mathrm{Oil}^\tau\right)$ and $\beta^{\theta'}$ can be recharacterised as $\beta_0(\theta,\tau)$ and $\beta_1(\theta,\tau)$ respectively. Accordingly, Equation (10) can be reformulated as follows:

$$\beta^{\theta}\left(\mathrm{Oil}_t\right) \approx \beta_0(\theta,\tau)+\beta_1(\theta,\tau)\left(\mathrm{Oil}_t-\mathrm{Oil}^{\tau}\right) \quad (11)$$

On substituting Equation (11) into Equation (9), we get,

$$USC_t = \beta_0(\theta,\tau)+\beta_1(\theta,\tau)\left(Oil_t-Oil^{\tau}\right)+\varepsilon_t^{\theta} \quad (12)$$

Additionally, this research probes the impact of diverse frequencies of oil price returns, denoted as oil.d1, Oil.d2, oil.d3, oil.d4, oil.d5, oil.d6, oil.d7, oil.d8, oil.d9, and oil.s9, on US stock index returns. In this study, we employ the Gaussian kernel to assign weights to observations close to the empirical quantile of uncertainty, using a designated bandwidth to gauge the local influence of the $\tau$ quantile of uncertainty.

## 4. EMPIRICAL ANALYSIS

Tables 1 and 2 display the summary statistics and the correlations among the variables, respectively. The pronounced Jarque-Bera test statistics, evident in Table 1, verify the non-normal distribution of every variable at the 1% significance level. This data's non-normality implies an absence of a straightforward linear connection between the variables in question. Hence, we opted to probe the nonlinear relationships between the oil and gas prices and the US indices using quantile techniques, as recommended by Troster et al. (2018) and Sharif et al. (2019).

This study uses a contemporary methodology to examine how different crude oil and gas price frequencies impact US indices. This relationship is analysed within a time series framework through wavelet analysis. The original return data for the scrutinised variables is fragmented into nine separate frequency elements via wavelet methods. Figures 1 through 5 showcase the original returns data for crude oil, gas prices, and the indices' components after decomposition. These illustrations emphasise higher frequency elements over brief spans, with the fluctuations becoming more consistent over extended durations. The summary statistics depict a non-normal distribution for the variables, which supports using a quantile-centric method to tackle the pronounced tails in the data.

Table 1 provides descriptive statistics for five distinct variables: "USA_ESG", "USA_S&P500", "USA_Islamic", "Oil_Prices", and "Gas_Prices". The mean and median for all these variables are zero on three decimal points, indicating no net gain or loss on average and an equal probability of positive or negative log returns. The standard deviation indicates the volatility of these returns, with `Gas_Prices` being the most volatile (0.061) and "USA_ESG", "USA_S&P500", and "USA_Islamic" exhibiting the least volatility (0.011). The negative skewness of all indices suggests a higher likelihood of more significant negative returns, with "Oil_Prices" showing the most pronounced left skew (−0.985). Kurtosis, a measure of the potential for extreme outcomes, is highest for "Gas_Prices" (58.253), implying a high probability of outliers. The minimum and maximum log returns represent the highest single-day loss and gain for each variable, respectively, which are most pronounced for "Gas_Prices" (−1.025 and 0.746). Notably, despite "USA_ESG", "USA_S&P500", and "USA_Islamic" exhibiting less volatility and skewness, "Oil_Prices" and particularly "Gas_Prices" demonstrate higher risk due to their increased volatility, skewness, and kurtosis. Furthermore, the Jarque-Bera test results suggest that none of the variables follows a normal distribution, with "Gas_Prices" deviating the most from normality, possibly due to its high kurtosis and skewness. Even "USA_Islamic", with the lowest Jarque-Bera statistic, deviates significantly from a normal distribution. However, this test should be interpreted cautiously as it is sensitive to sample size and may reject the null hypothesis of normality even with minor deviations in larger samples.

Table 2 displays a correlation matrix as a heatmap, where each cell's colour intensity denotes the strength of the correlation coefficient between the paired variables. Vibrant red hues represent high positive correlations, while lighter blue shades indicate lower positive correlations. The correlation coefficient, which can range between −1 and 1, signifies the intensity and direction of the relationship between the variables. In this dataset, the USA ESG index exhibits a significant positive correlation with the USA S&P500 (conventional index) and USA Islamic indices, boasting coefficients of 0.997 and 0.964, respectively. Likewise, a strong positive correlation of 0.97 is observed between the USA S&P500 and USA Islamic indices. The correlation between gas and oil prices is relatively low, reflected by a coefficient of 0.022, and other correlations involving these two variables and the indices are considerably weaker. Nevertheless, it is essential to note that these correlation coefficients represent relationships between variables and should not be misconstrued as causal relationships.

The original returns data for the investigated variables are decomposed into nine distinct frequency components using wavelet analysis. Figures 1 through 5 depict the graphs of raw return data for crude oil and gas prices, complemented by the detailed breakdown of the decomposed components for the US conventional index, Islamic index, and the ESG index. Figure 1 exhibits the presence of high-frequency elements over a short span for oil prices, with the fluctuations stabilising over extended periods. The year 2020 shows pronounced volatility, as seen in plots d1 through d7, a trend likely attributable to the impact of the COVID-19 pandemic.

**Table 1: Descriptive statistic**

| Index | Mean | Median | Standard deviation | Skewness | Kurtosis | Minimum | Maximum | Jarque-Bera |
|---|---|---|---|---|---|---|---|---|
| USA_ESG | 0.000 | 0.000 | 0.011 | −0.854 | 16.331 | −0.130 | 0.090 | 29017 |
| USA_S&P500 | 0.000 | 0.000 | 0.011 | −0.847 | 17.122 | −0.128 | 0.090 | 31862 |
| USA_Islamic | 0.000 | 0.000 | 0.011 | −0.751 | 15.706 | −0.118 | 0.087 | 26792 |
| Oil_Prices | 0.000 | 0.001 | 0.025 | −0.985 | 17.445 | −0.280 | 0.191 | 33172 |
| Gas_Prices | 0.000 | 0.000 | 0.061 | −0.455 | 58.253 | −1.025 | 0.746 | 365303 |

USA_ESG represents US ESG index, USA_S&P500 represents US conventional index and USA_Islamic represents US Islamic index

**Figure 1:** Trend plot of oil prices

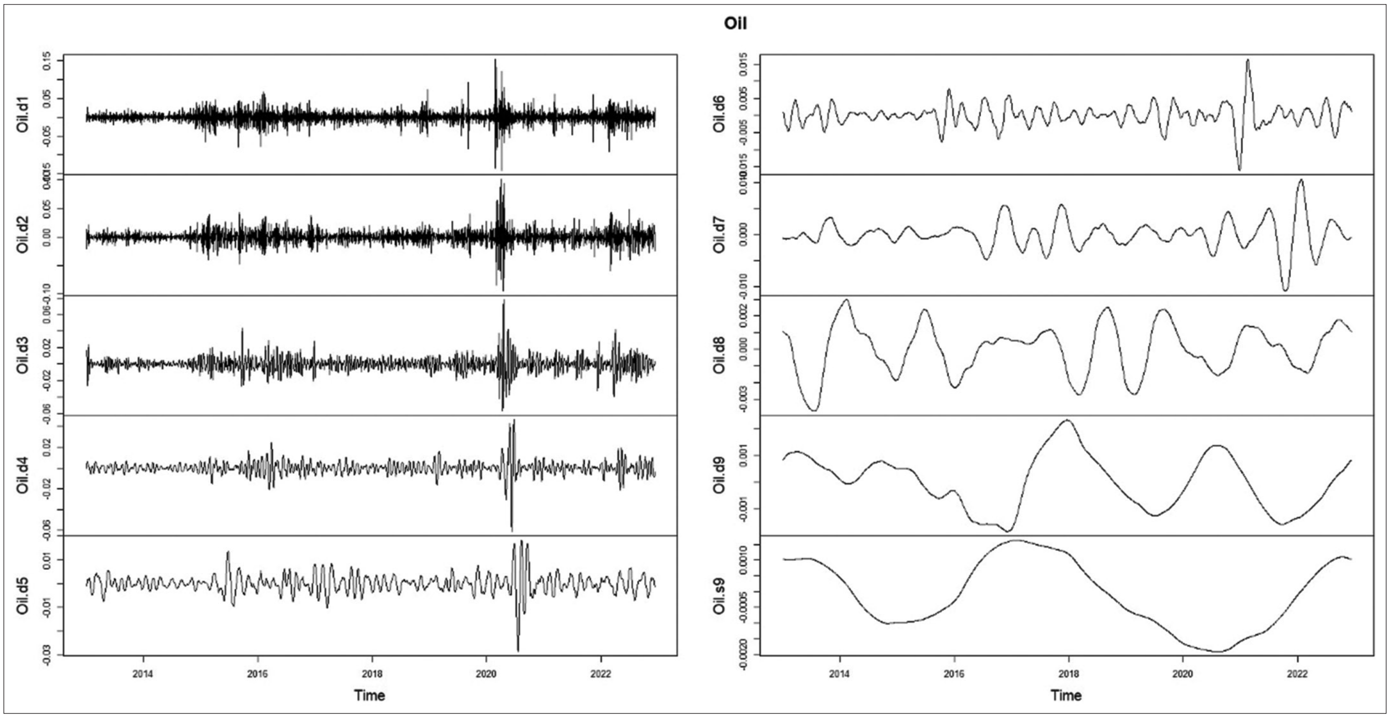



**Table 2: Correlation Heatmap**

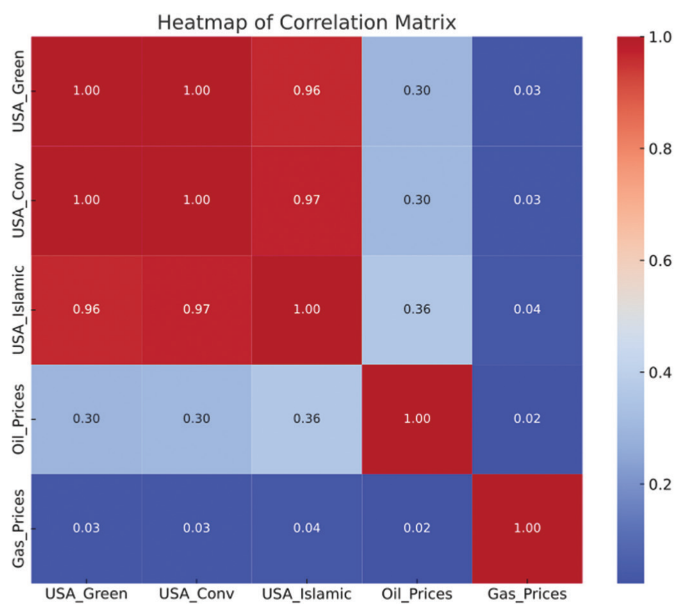



Figure 2, which depicts the trend of gas prices, closely resembles Figure 1 in terms of exhibiting high-frequency components over shorter intervals, with the variations becoming more stable over longer durations. While there is significant volatility in 2020, the period of this volatility is shorter than that of oil prices. According to Nyga-Łukaszewska and Aruga (2020), the COVID-19 pandemic impacted the US crude oil and natural gas markets, influencing short-term and long-term relationships. The increasing number of COVID-19 cases in the US negatively affected the price of crude oil but positively impacted the price of natural gas. The differing responses of the oil and gas markets to the pandemic could be attributed to the greater stability of gas prices, possibly due to preceding mild winters. Consequently, market participants, particularly exporters, adopted a more conservative stance towards future investments, anticipating reduced gas sales.

Figures 3-5 display the trend plots for the US conventional, Islamic, and ESG indices from 2013 to 2022. Like Figures 1 and 2, these figures also show the presence of high-frequency components over shorter durations, with the variations becoming more stable over longer periods. The trend plots for these indices are nearly identical, as most of the components of these indices are composed of the same companies.

### 4.1. Maximal Overlap Discrete Wavelet Transform (MODWT)

This study investigates the relationship between crude oil and gas prices and three types of US stock indices: conventional, Islamic, and ESG. The research employs a MODWT-based covariance analysis to discern patterns and trends over varying timeframes. Figures 6 and 7 reveal similar wavelet covariance results for the US conventional stock index and the US ESG stock index when correlated with gas prices. A positive covariance is observed over very short and short durations, indicating that these variables tend to move in tandem. However, this relationship weakens over medium, long, or very long terms. Moreover, both figures show a positive correlation across short, long, and very long durations, with a negative correlation during the medium term. Figure 8, correlating the US Islamic stock index with gas prices, mirrors these trends. This consistency across all three indices could stem from similar market dynamics and components affecting them. As these indices often include overlapping companies, their responses to gas price fluctuations are likely to be analogous.

**Figure 2:** Trend plot of gas prices

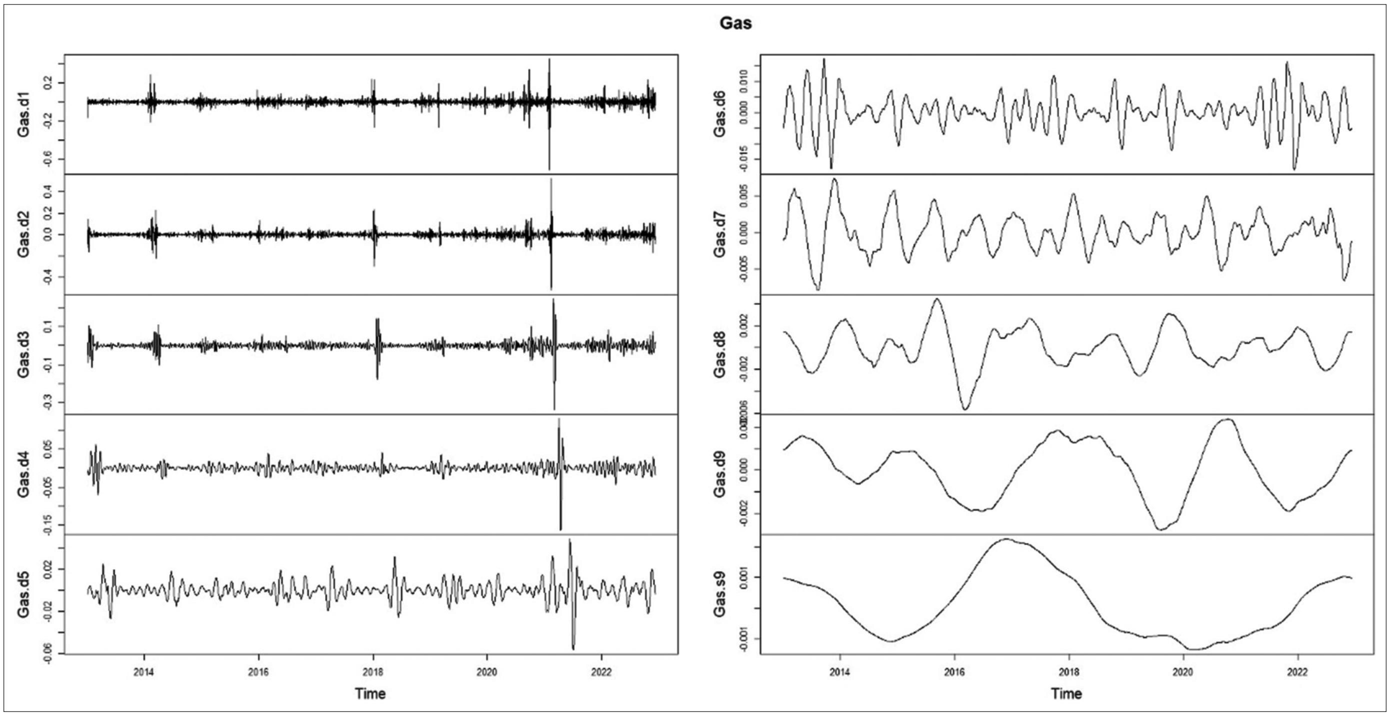
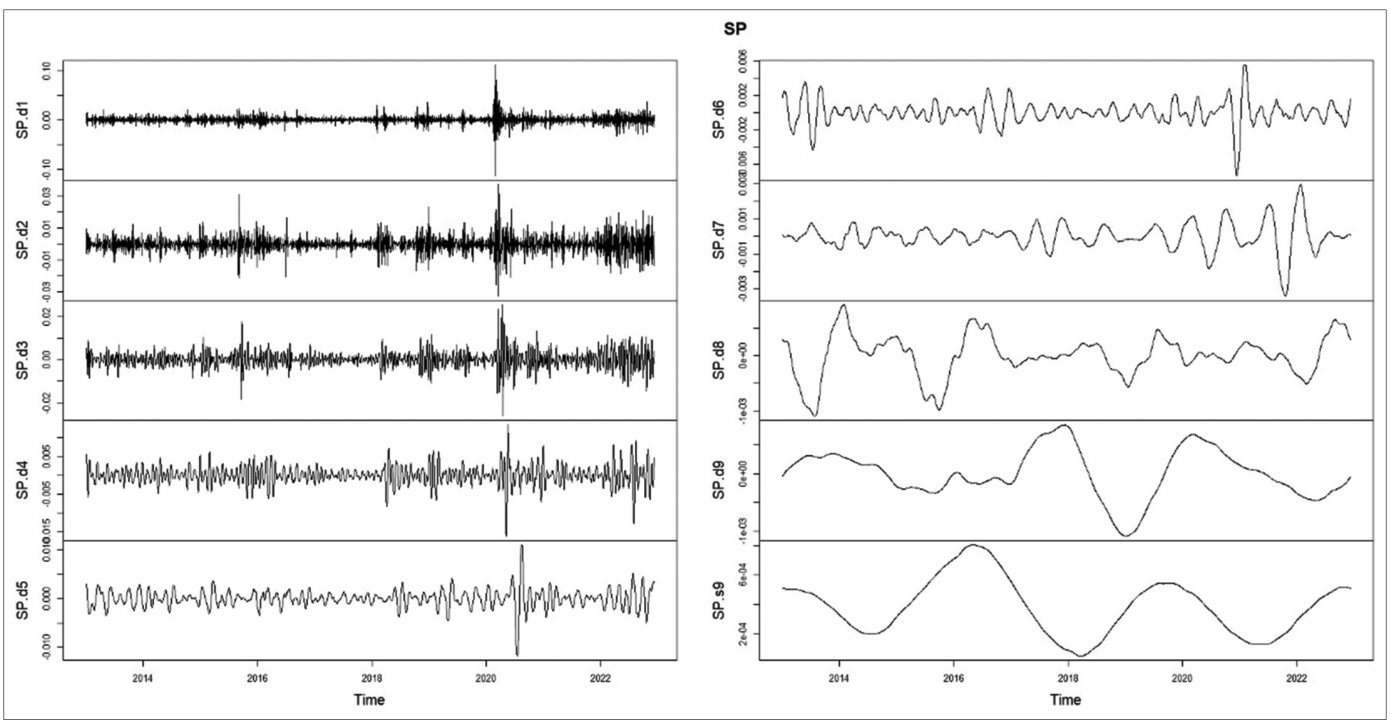



**Figure 3:** Trend plot of the S&P 500 index




In Figures 9 and 10, the covariance and correlation between oil prices and the US conventional and ESG indices, respectively, are explored. Both figures display a positive covariance over very short and short terms, indicating synchronised movement of these variables. However, this covariance diminishes over longer durations, suggesting that other factors might influence these indices, weakening the relationship between the two variables during these longer periods. Despite this, a consistent positive correlation is observed across all durations. Figure 11, examining the relationship between oil prices and the US Islamic index, echoes these findings. This similarity across the three indices indicates shared influences and market dynamics. Again, the overlapping nature of the companies included in these indices might be a contributing factor which warrants further investigation.

## 4.2. Quantile-on-Quantile Estimates

Figures 12-17 showcase the outcomes of the QQ analysis concerning the US stock indices vis-à-vis crude oil and gas prices

**Figure 4:** Trend plot of the STOXX USA 500 ESG

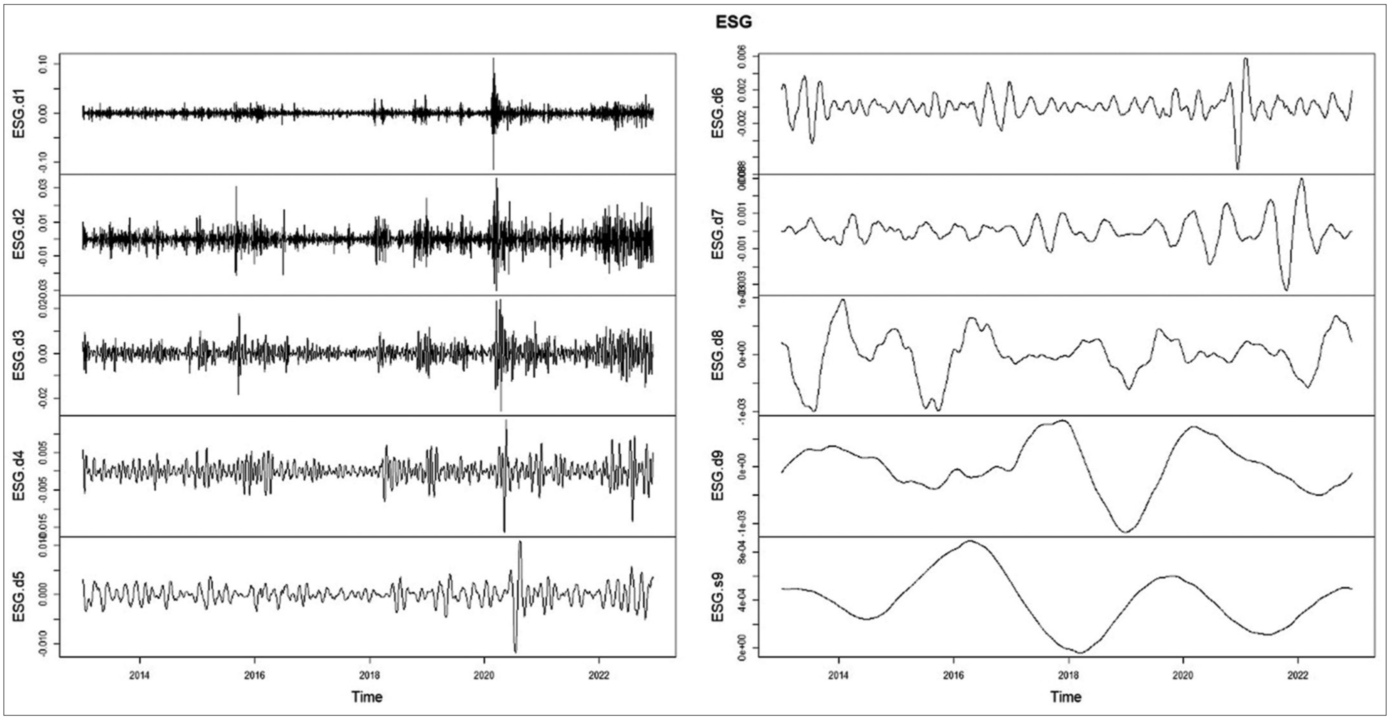
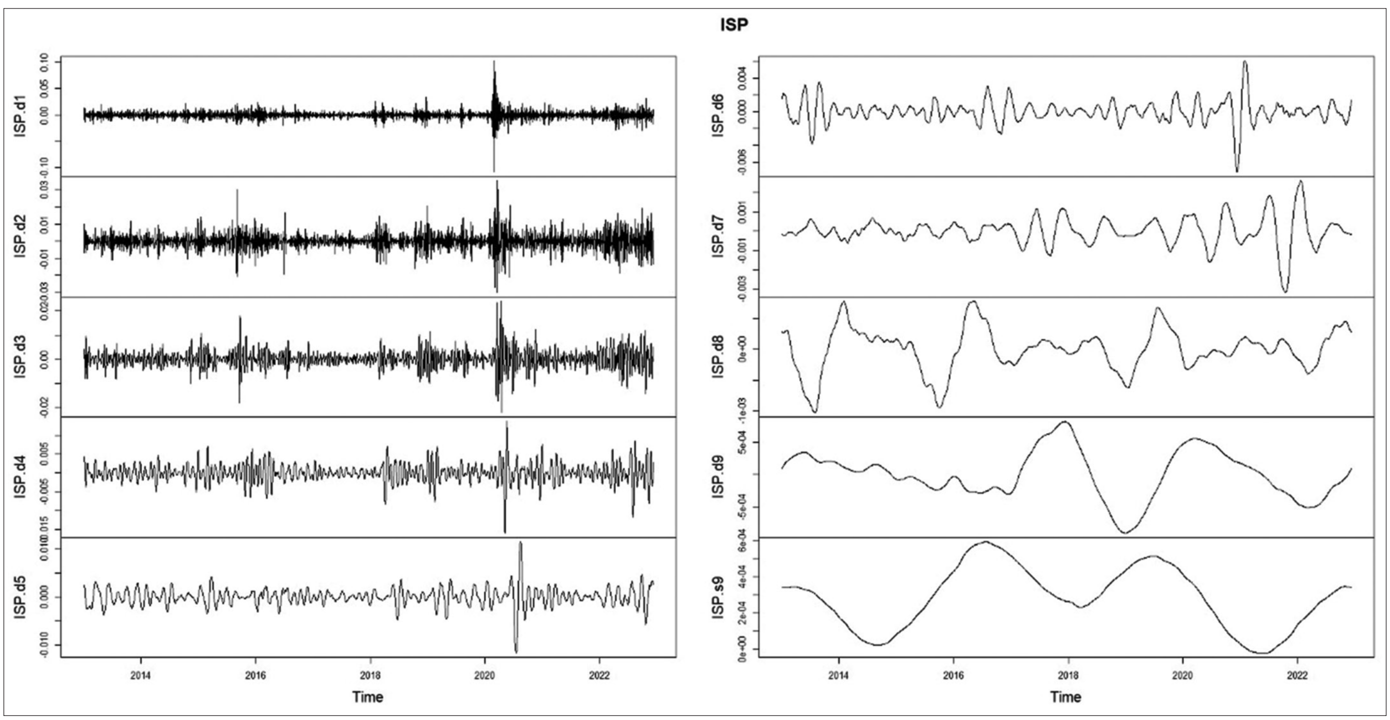


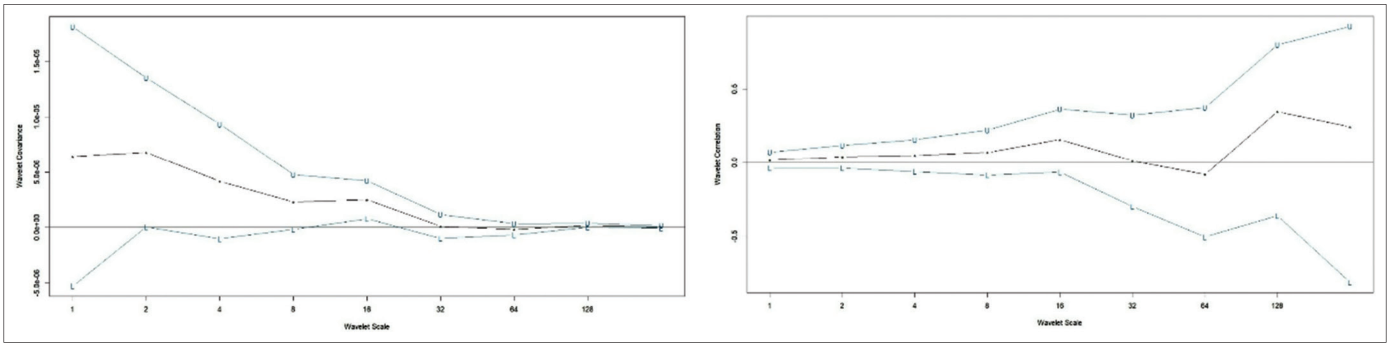

**Figure 5:** Trend plot of the islamic stock price




and their various segmented series. These diagrams depict the slope coefficient estimations, denoted as $\hat{\beta}_1(\theta,\tau)$ , which measures the impact of the $\tau^{th}$ quantile of oil and gas prices on the US stock indices across varied θ and $\tau$ values. A colour gradient is employed within these figures to signify the correlation coefficients between the oil and gas prices and the US indices. The deepest blue hues correspond to the lowest coefficient values, suggesting a tenuous relationship. Conversely, the most intense red shades are synonymous with the highest coefficient values, implying a potent relationship.

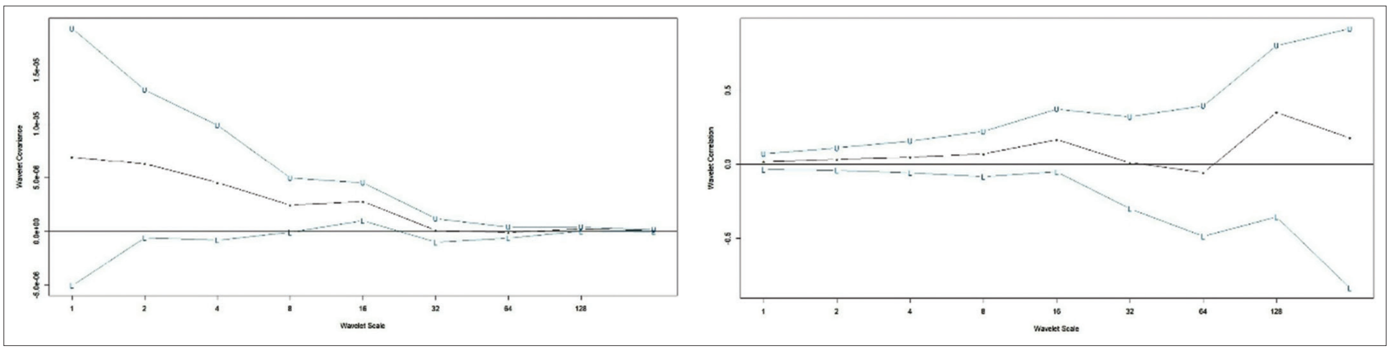
The QQ analysis reveals varying influences of oil and gas prices on US stock indices, contingent upon the quantiles of both dependent and independent variables. This variation is distinctly observed in Figure 12, which demonstrates a pronounced positive correlation between gas prices and the US conventional stock index (S&P 500) across various quantiles. The most potent positive relationship between gas prices and the US stock index emerges at the higher quantiles of both metrics (0.80-0.90), indicating a direct association between the index and gas prices. Conversely,

**Figure 6:** Wavelet covariance and correlation analysis between the US conventional stock index and gas price



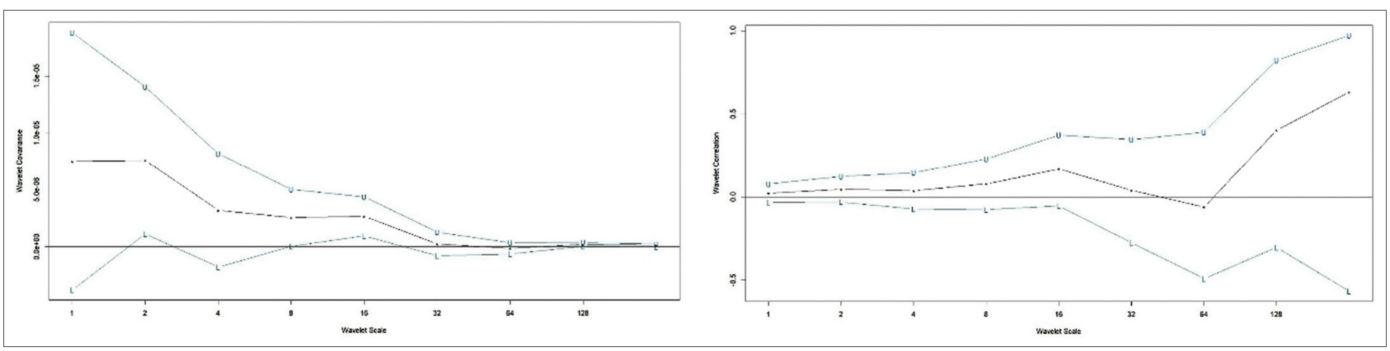

Note: The symbols "U" and "L" respectively denote the upper and lower bounds of the 95% confidence interval. The black dotted line illustrates the covariance and correlation between the commodity price and the stock price index

**Figure 7:** Wavelet covariance and correlation analysis between the US ESG stock index and gas price



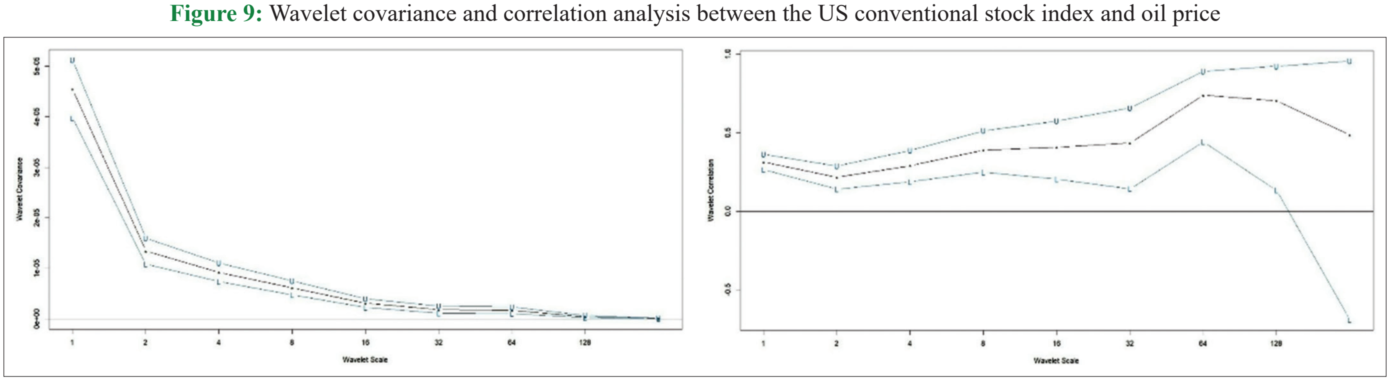

Note: The symbols "U" and "L" respectively denote the upper and lower bounds of the 95% confidence interval. The black dotted line illustrates the covariance and correlation between the commodity price and the stock price index

**Figure 8:** Wavelet covariance and correlation analysis between the US islamic stock index and gas price



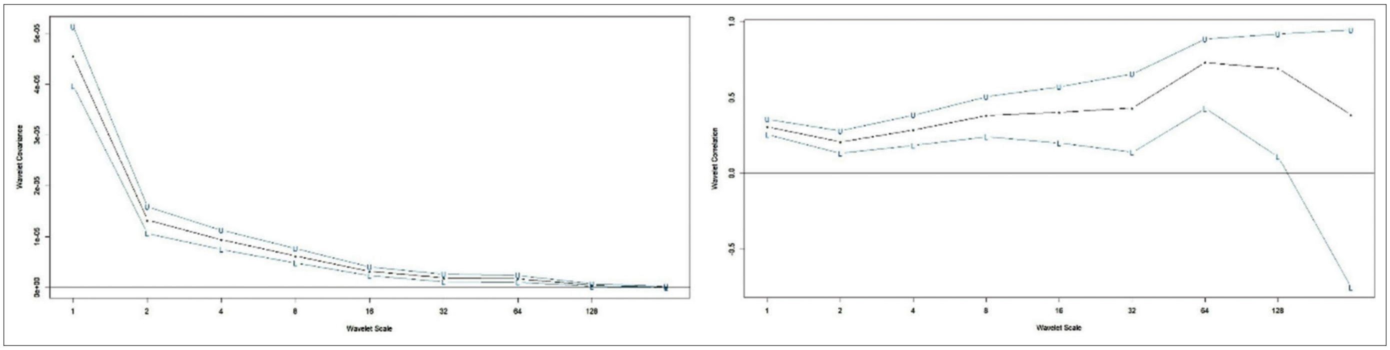

Note: The symbols "U" and "L" respectively denote the upper and lower bounds of the 95% confidence interval. The black dotted line illustrates the covariance and correlation between the commodity price and the stock price index

**Figure 9:** Wavelet covariance and correlation analysis between the US conventional stock index and oil price



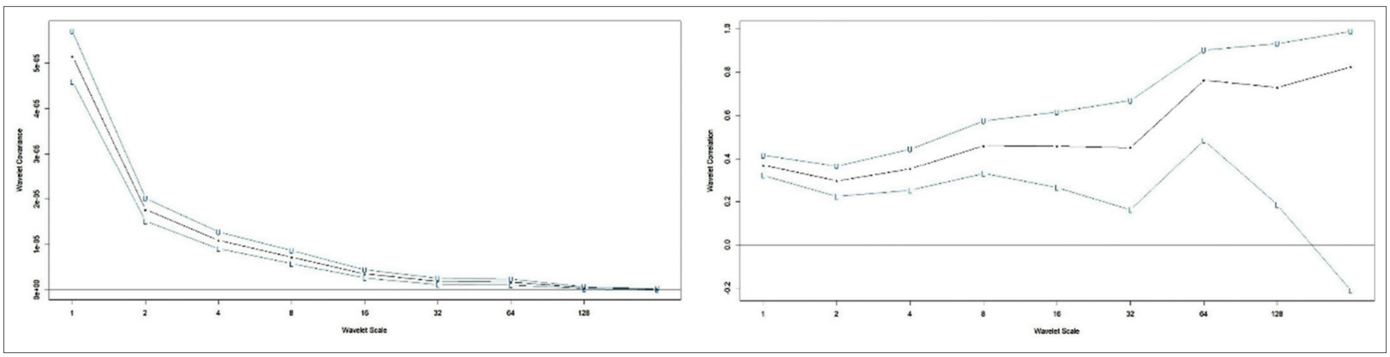

Note: The symbols "U" and "L" respectively denote the upper and lower bounds of the 95% confidence interval. The black dotted line illustrates the covariance and correlation between the commodity price and the stock price index

**Figure 10:** Wavelet covariance and correlation analysis between the US ESG stock index and oil price



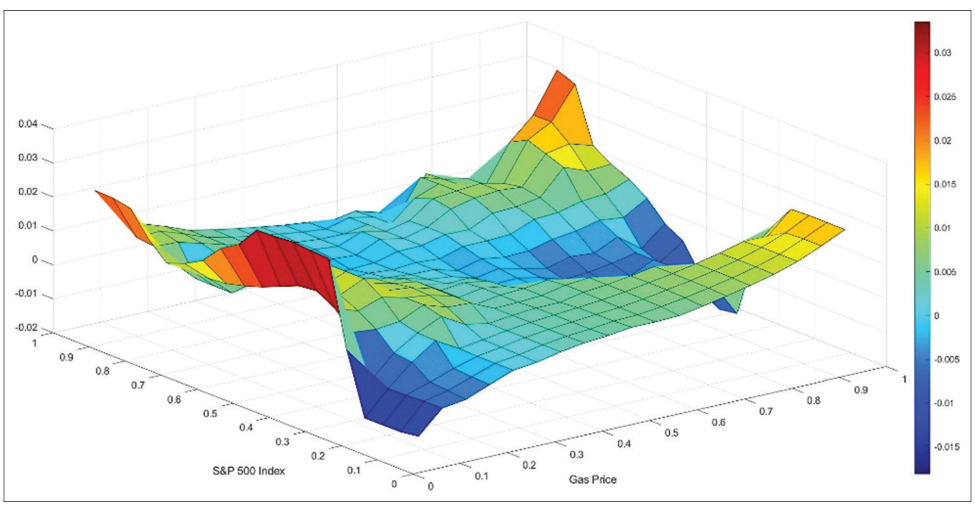

Note: The symbols "U" and "L" respectively denote the upper and lower bounds of the 95% confidence interval. The black dotted line illustrates the covariance and correlation between the commodity price and the stock price index

**Figure 11:** Wavelet covariance and correlation analysis between the US islamic stock index and oil price




Note: The symbols "U" and "L" respectively denote the upper and lower bounds of the 95% confidence interval. The black dotted line illustrates the covariance and correlation between the commodity price and the stock price index

**Figure 12:** The coefficient between the S&P500 stock index and Gas Price




at the lower quantiles (0.10-0.20), a dip in gas prices also mirrors a downturn in the conventional index. Despite market oscillations, the index predominantly positively reacts to gas price alterations throughout most quantiles. Summarising, gas prices predominantly positively influence the US conventional stock index.

Figure 13's analysis reveals a substantial and positive linkage between oil prices and the conventional stock index over various quantile segments, pointing to a direct tie between the two entities. The strongest affinity is evident in the lower quantiles for both oil prices and the index (0.10-0.30). However, post the 0.40 quantile, the influence of oil prices on the index starts to wane, albeit staying positive. This underscores that even though oil prices generally boost the US conventional stock index, the magnitude of this impact differs depending on the quantile spectrum. Interestingly, the index's lower quantiles (0.05-0.25) are adversely affected by the upper quantiles of oil prices (0.85-0.95), implying that surges in oil prices might dampen the US conventional index during downturns in the market.

**Figure 13:** The coefficient between the S&P500 stock index and oil price

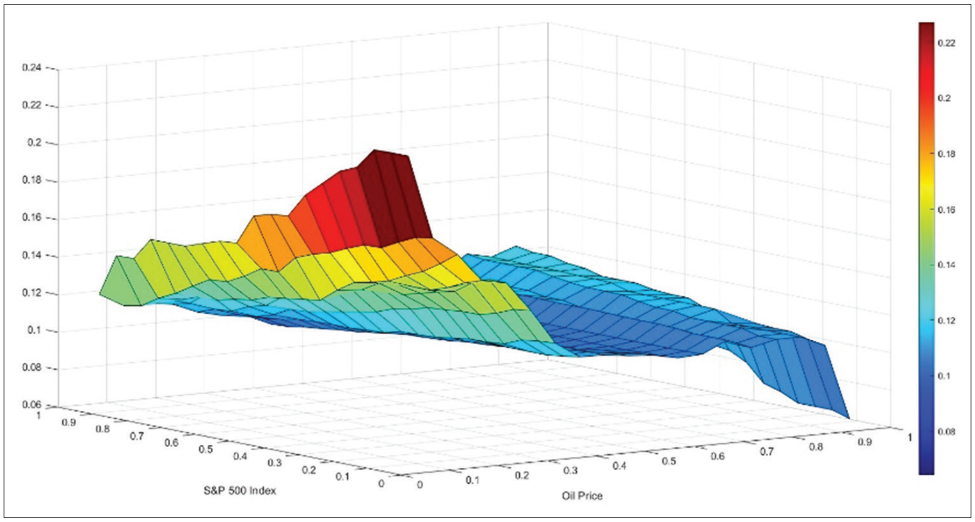



**Figure 14:** The Coefficient between the US ESG stock index and Gas Price

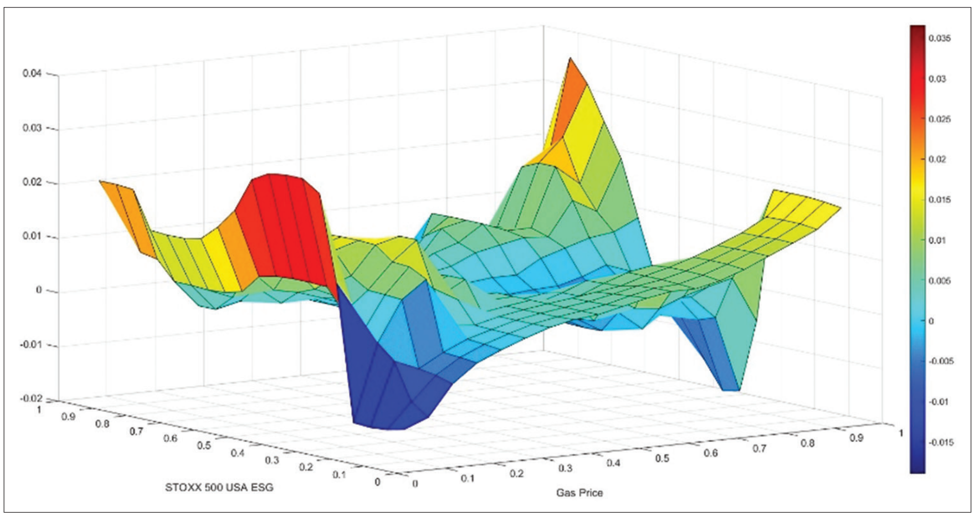
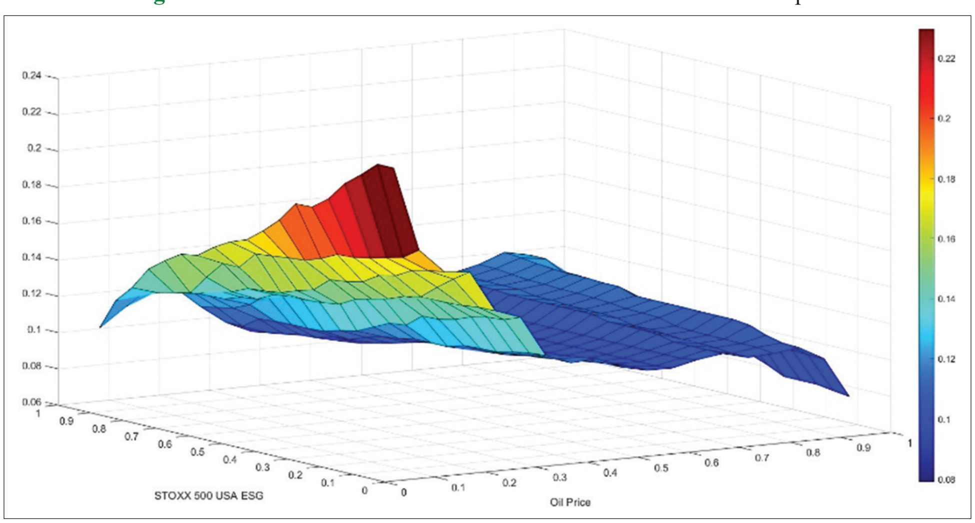



**Figure 15:** The Coefficient between the US ESG stock index and oil price




Several insights can be drawn from examining the decomposed oil price series at d1, d2, and d3 in Figures 18-20 and their interplay with the conventional index. Oil prices have a marked positive effect in the lower quantiles (0.10-0.20), mirroring findings from Figure 13. Nevertheless, starting from the 0.30 quantile, this robust positive association starts to fade, and this trend persists up to the 0.90 quantile across the decomposed series. As we dissect the data, the favourable impact of oil

**Figure 16:** The coefficient between the US islamic index and gas price

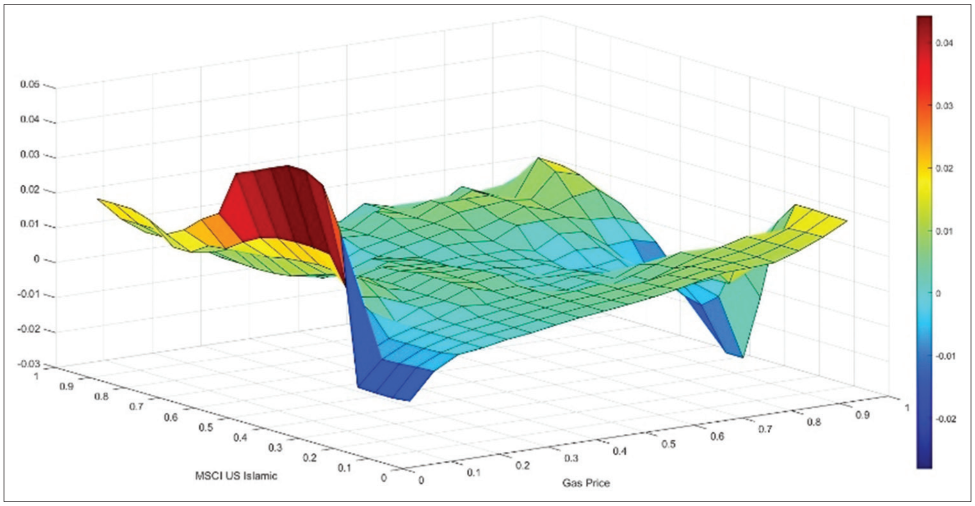



**Figure 17:** The coefficient between the US islamic index and oil price

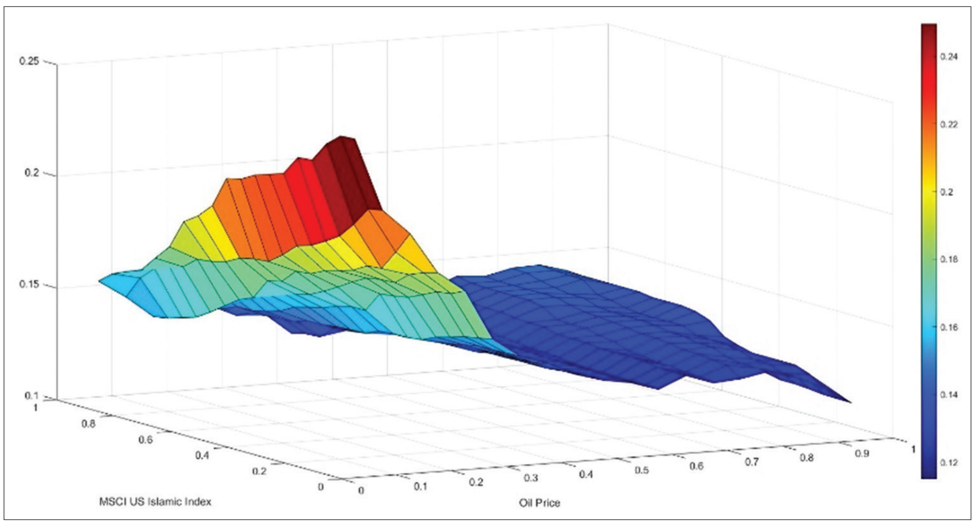
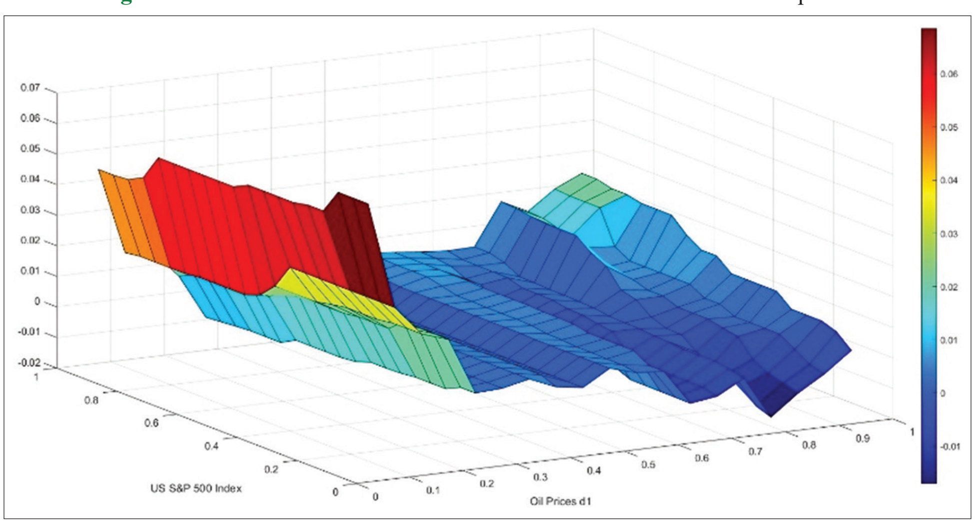



**Figure 18:** The coefficient between the US S&P 500 stock index and oil price d1




prices on the conventional index becomes less pronounced, with adverse outcomes taking the forefront. The primary data series indicates that the conventional index benefits substantially from oil price shifts in its lower quantiles. When decomposing the series, extraneous fluctuations or noise gets minimised, leading to a more stable series. As the original data is partitioned, the

**Figure 19:** The coefficient between the US S&P 500 stock index and oil price d2

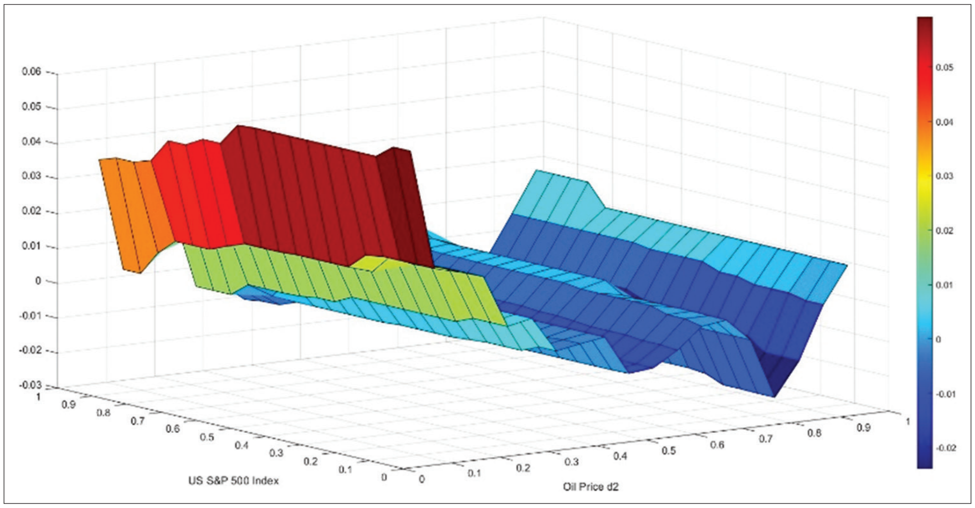
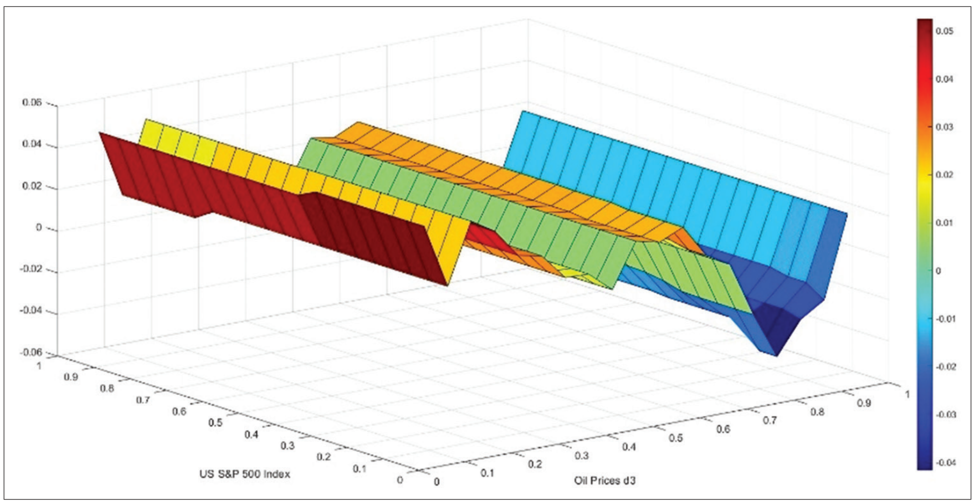



**Figure 20:** The coefficient between the US S&P 500 stock index and oil price d3




positive sway of oil prices diminishes, revealing a more neutral or negative influence.

An analysis of Figure 14, which delves into the relationship between gas prices and the US ESG stock index, reveals that the impact of gas prices on the index is relatively minimal within the central quantiles of both parameters. Nonetheless, a marked positive correlation is observed between the lower quantiles (0.05-0.30) and the higher quantiles (0.8-0.9) for gas prices and the ESG index. As such, Figure 14 underscores that the influence of gas prices on the ESG index is most significant at the extreme ends of the quantile range. This indicates that the ESG index responds positively to shifts in gas prices.

Figure 15 demonstrates a consistently favourable correlation between oil prices and the US ESG stock index over most quantile ranges. This positive relationship is notably potent within the 0.10-0.30 quantile band, suggesting that the index generally rises alongside oil prices in this spectrum. This pattern is evident across many quantiles, inferring a generally positive response of the US ESG stock index to oil price variations, especially within the lower quantiles. Nevertheless, when oil prices climb (particularly in the 0.85-0.95 quantile bracket), they adversely affect the US ESG index's lower quantiles (0.05-0.25), though this influence is not as strong as it is on the conventional index. This implies that during downturns in the market, escalating oil prices might hinder the US ESG index, mirroring the effects on the conventional index. On the flip side, when the US ESG index's upper quantiles (0.85-0.95) are considered, a downturn in the lower quantiles (0.05-0.25) of oil prices exhibits a negative impact. This suggests that a decline in oil prices might harm the ESG index during market upswings, possibly because many of its constituent companies depend on high oil prices to augment their earnings.

Several patterns emerge when examining the decomposed series of oil prices at d1, d2, and d3 alongside the US ESG index in Figures 21-23. The oil price exhibits a marked positive impact in the lower quantiles (0.10-0.20), mirroring the original data shown in Figure 15. However, a discernible negative effect is evident from the 0.30 quantile up to the 0.90 quantile for d1 and d2, as illustrated in Figures 21 and 22. For d3, as shown in Figure 23, a significant negative impact is only seen in the higher quantiles (0.80-0.90), while the medium quantile presents a negligible oil

**Figure 21:** The coefficient between the US ESG stock index and oil price d1

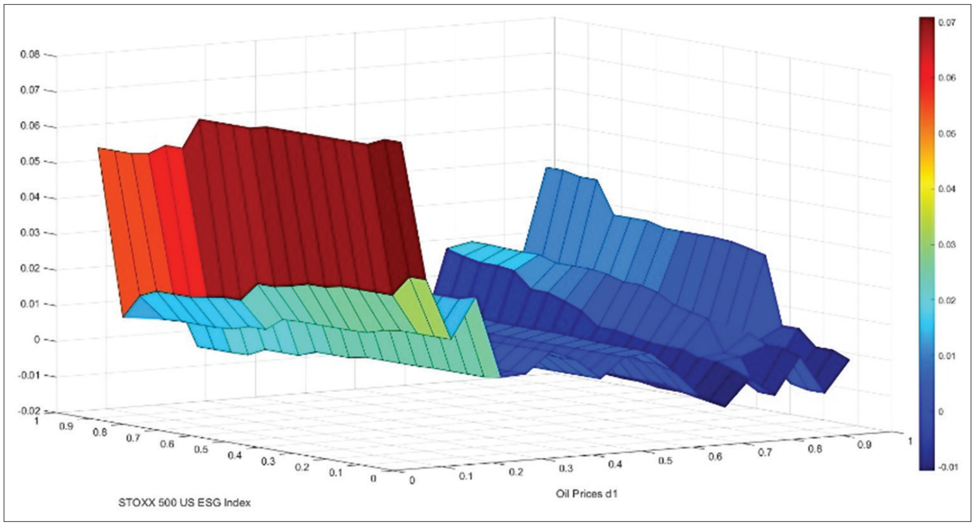



**Figure 22:** The coefficient between the US ESG stock index and oil price d2

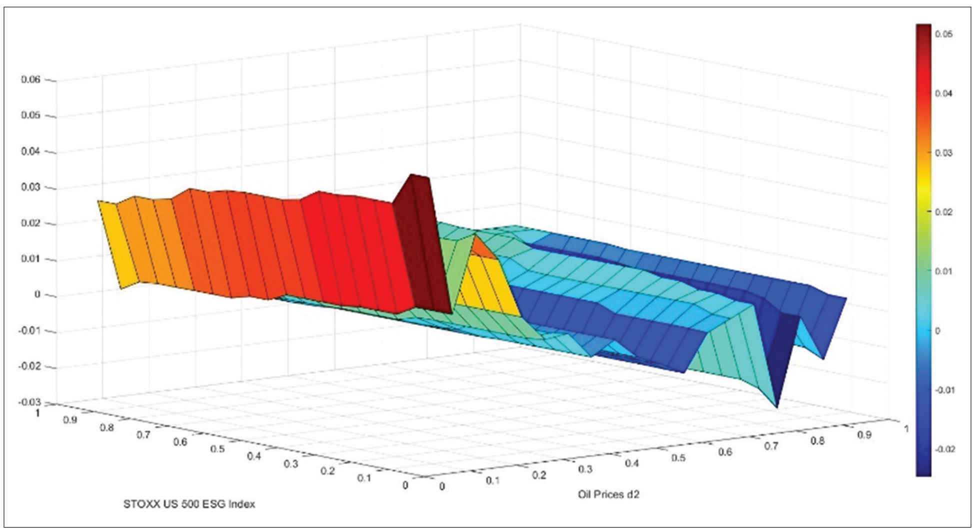
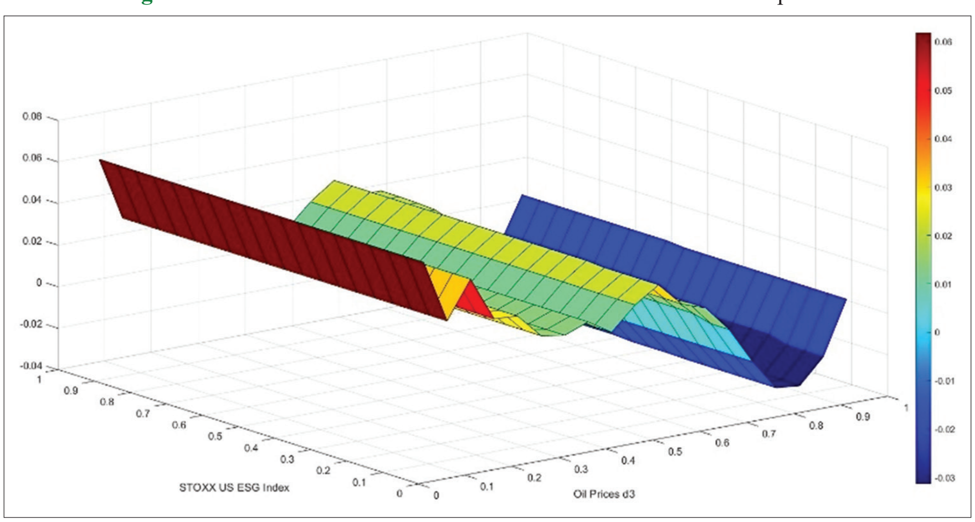



**Figure 23:** The coefficient between the US ESG stock index and oil price d3




price effect. In the decomposed data, the positive influence of oil prices on the ESG index wanes, with d1 and d2 predominantly showing a negative trend. Our analysis suggests that in the original dataset, oil price fluctuations notably bolster the ESG index in the lower quantiles. Decomposing the series filters out its inherent fluctuations, resulting in a more stable dataset. As this decomposed of the original oil price series progresses, the initially positive influence diminishes, making way for a neutral or zero effect. As the data's stability increases, the positive influence of oil prices fades, and the negative influence takes the forefront. These findings align closely with the patterns observed in the decomposed oil price data related to the conventional index.

Figure 16 illustrates a positive influence between gas prices and the US Islamic index across many quantile groups, indicating a direct relationship. A noteworthy observation is that in the lower quantiles of gas prices (0.10-0.20), a reduction in gas prices corresponds with a decrease in the value of the US Islamic stock index. Although the influence of gas prices on the Islamic index is generally muted in the middle and high quantiles, it becomes substantial when both variables are in their lowest quantiles. This suggests a complex relationship between gas prices and the US Islamic stock index, where a largely positive influence becomes notably significant at the lower quantiles of both variables.

Figure 17 emphasises the notable positive impact of oil prices on the US Islamic stock index, especially within the lower quantiles (0.10-0.30). However, as we move to the mid to high quantiles (0.40-0.90), the effect of oil prices on the US Islamic index seems to wane. Even with this tapering, the correlation persists as positive, indicating that a rise in oil prices typically corresponds with a boost in the index's value. The data underscores that oil prices generally favourably impact the US Islamic stock index, with the most profound effect evident in the lower quantiles of both metrics. Additionally, the upper quantiles of oil prices (i.e., 0.85-0.95) negatively influence the US Islamic index's lower quantiles (0.05-0.25). This suggests that during downtrends in the market, escalating oil prices could dampen the performance of the US Islamic index. Interestingly, this trend mirrors that observed in all three indices analysed, hinting at the possibility that these indices might comprise a similar roster of companies.

In our subsequent analysis focusing on the decomposed series of oil prices at d1, d2, and d3 in relation to the US Islamic index, as presented in Figures 24-26, we discern several patterns. Oil prices have a pronounced positive impact in the lower quantiles (0.10-0.20), echoing the original data depicted in Figure 17. Nevertheless, a distinct negative influence emerges from the 0.30 quantile to the 0.90 quantile across all three decomposed datasets, d1, d2, and d3, as shown in Figures 24-26. The decomposed data reveals a diminishing positive impact of oil prices on the US Islamic index, with a prevailing negative trend across d1, d2, and d3. Drawing from this analysis, it's evident that in the original dataset, oil price shifts notably boost the Islamic index in the lower quantiles. However, as we break down the original oil price series, the initially positive influence starts to recede, making way for an increasingly dominant negative effect. As the data becomes more stable, the positive influence of oil prices peters out, allowing the negative influence to become more pronounced. These observations are consistent with the trends identified in the decomposed oil price data pertaining to the US conventional and ESG indices.

When examining the impact of oil prices on the US conventional index, the positive effect weakens and a slope of 0.10 becomes prominent across all quantiles. A similar downward trend in slope is observed in the relationship between oil prices and the US ESG index, where the slope decreases from the lower quantile and maintains at 0.10 up until the 0.95 quantile. The relationship between oil prices and the US Islamic index mirrors the trends observed with the conventional and ESG indices, with the slope exhibiting a downward trend from the lower to the higher quantiles. The close approximation of the results obtained for the US conventional index with the US ESG and Islamic indices could be attributed to the underlying common factors that affect these indices. These could include overall economic conditions, monetary policies, and investor sentiments, which would have similar effects on all these indices. Furthermore, since all these indices consist of mostly overlapping companies operating in similar market conditions, they would be affected almost identically by changes in oil and gas prices.

One key observation is that the influence of oil prices on the US indices is higher across all quantiles than gas prices within the US indices. The higher coefficient value observed between oil

**Figure 24:** The coefficient between the US islamic Index and oil price d1

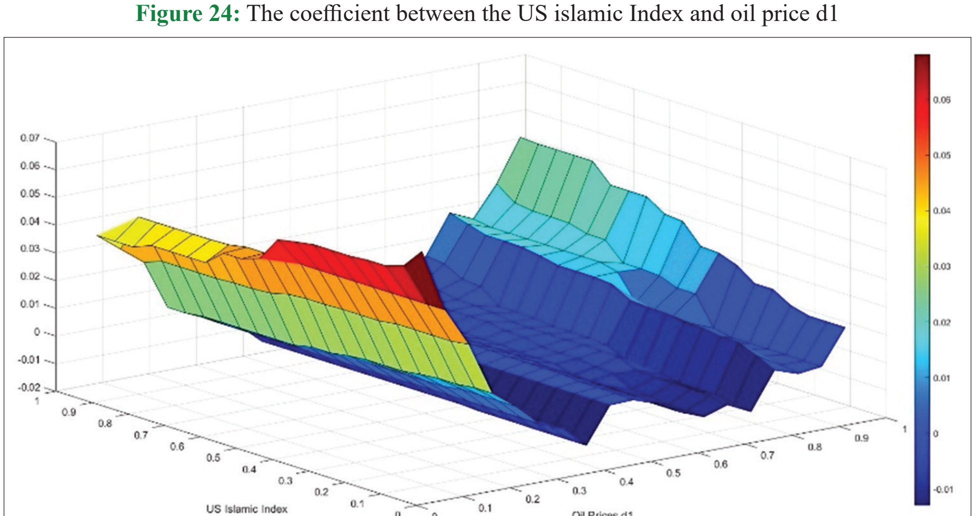


**Figure 25:** The coefficient between the US islamic index and oil price d2

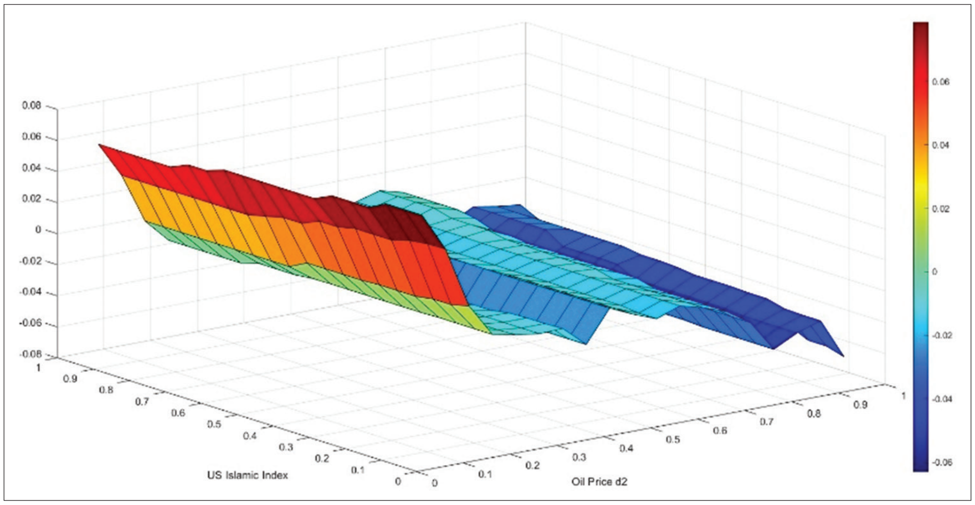
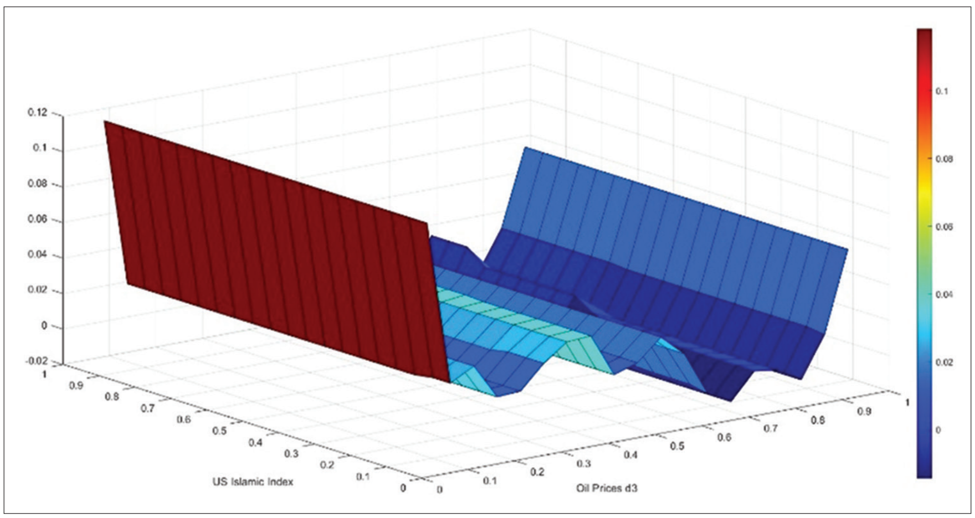



**Figure 26:** The coefficient between the US islamic index and oil price d3




prices and US indices, as compared to that between gas prices and US indices, can be attributed to several factors. Firstly, oil is a more pervasive commodity in the global economy, serving as both an energy source and a raw material for various industries. This broad utilisation implies that oil price fluctuations may impact a wider range of sectors within the US indices. Secondly, changes in oil prices directly influence gasoline prices, which, in turn, can significantly affect consumer spending. This may impact the profitability of companies within US indices, leading to observable shifts in the market. In contrast, natural gas, primarily used for heating and electricity, may not affect consumer spending as pronounced. Thirdly, oil prices tend to be more sensitive to geopolitical events, and disruptions in oil supply can cause prices to spike, affecting US indices. Fourthly, oil markets exhibit greater liquidity than natural gas markets, making oil prices more responsive to global economic trends reflected in US indices. Lastly, oil can be transported globally easily, creating a more unified global price. In contrast, natural gas requires specific infrastructure for transportation, leading to regional price discrepancies and potentially a lower correlation with US indices. It is essential to note that these are potential explanations, and the actual reasons may be multifaceted and interlinked, subject to changes over time due to evolving market dynamics and economic structures.

The analysis proposes that oil price volatility may have an immediate, positive effect on US indices. Yet, once oil prices stabilise, their continued increase could negatively impact US indices over a prolonged period. This outcome may be attributed to the significant presence of oil-exporting companies in US stock indices. These companies often see an enhancement in stock returns due to higher revenues when oil prices increase. However, the same cannot be said for the influence of gas prices on US indices. The almost zero coefficient value of gas prices on the three indices indicates a minimal impact, suggesting that these indices are largely impervious to changes in gas prices within those quantiles. This outcome is at odds with Arora and Lieskovsky's 2014 findings, which posit that the natural gas supply primarily drives domestic economic activity. Given that the gas price has minimal influence on the indices in the original data, we don't delve deeper into analysing the decomposed data of gas prices on the indices.

The findings of this study largely echo previous research. For example, our results align with Chang et al.'s 2020 research, which identified a positive link between oil prices and the US Islamic index, particularly at the extreme quantiles of both markets. Similarly, our observations are congruent with the insights of Bouri et al. (2017), Narayan et al. (2019), and Mishra et al. (2019). These researchers pinpointed a multifaceted and fluctuating connection between oil prices and stock indices, often described as "heterogeneous", "asymmetric", or "nonlinear". In line with Arshad (2017), our study also uncovers a varied interplay between global crude oil prices and the Islamic stock market-a trend that is also applicable to the US conventional and ESG indices. Moreover, our findings parallel those of Reboredo and Ugolini (2016). Their study on BRICS nations' stock markets revealed similar asymmetries in how oil prices affect conventional stock returns in those economies.

The QQ analysis demonstrates nuanced interactions between US stock indices and crude oil and gas prices across varied quantiles. It underscores a generally positive correlation between these commodities and the stock indices, but the magnitude and direction of the influence vary depending on the quantiles considered. Specifically, gas prices consistently positively impact the US conventional stock index, while oil prices exhibit a more complex relationship, bolstering the index in lower quantiles but potentially negatively affecting it during market downturns. This pattern is echoed in the ESG and Islamic indices, suggesting overlapping companies or underlying common factors among these indices. One pivotal insight is the more pronounced influence of oil prices on US indices compared to gas prices. Oil's omnipresence in the global economy, its direct linkage to consumer spending due to its influence on gasoline prices, its heightened sensitivity to geopolitical events, and its liquid global market might account for this differential impact. On the other hand, natural gas's localised pricing and infrastructure-intensive transportation may reduce its correlation with US indices. While oil price volatility might immediately benefit US indices due to the dominance of oil-exporting companies, a stabilised increment in oil prices could be detrimental in the long run. The results shed light on the intricate dynamics between energy commodities and financial markets, emphasising the importance of understanding these relationships in the context of broader economic and geopolitical factors.

Our analysis elucidates a complex, quantile-specific interplay between US stock indices and oil and gas prices. For investors, this suggests the potential for quantile-driven investment strategies, particularly in periods of high oil prices, where a cautious approach towards conventional and Islamic indices may be beneficial due to observed negative impacts in upper quantiles. Conversely, lower quantiles present investment opportunities during lower oil prices. Diversification based on commodity sensitivity is another critical implication, with varied impacts of oil and gas prices on different indices, such as conventional, ESG, and Islamic. Moreover, the significant influence of oil prices, especially in their sensitivity to global events, underscores investors' importance in being vigilant about economic and geopolitical developments. This insight is pivotal for both short-term gains, leveraging immediate positive effects of oil price volatility, and long-term investment strategies, considering potential sustained negative impacts. Lastly, our analysis using decomposed oil price series provides a more nuanced understanding of market dynamics, suggesting that investors should incorporate these finer details into their decision-making process. Thus, our study expands academic understanding and offers concrete implications for investors, emphasising the need for dynamic and informed investment strategies in complex market relationships.

## 5. CONCLUSION

This research evaluates the influence of crude oil and gas prices on the US conventional, ESG, and Islamic indices, utilising daily data from 2 January 2013 to 30 December 2022. We adopt a distinct econometric methodology: First, breaking down the original time series data for crude oil and gas prices to filter out inherent volatility and subsequently probing their impact on the indices. Furthermore, we incorporate the QQ regression technique, a methodology refined and broadened by Sim and Zhou in 2015. The QQ approach offers advantages over conventional methods like Ordinary Least Square (OLS) and Quantile Regression, as it assesses how distinct quantiles of crude oil and gas prices and their subsequent effects align with varying quantiles of the indices, providing a detailed understanding of the interplay between the dependent and independent variables.

The findings of this research indicate a nuanced effect of global crude oil prices on the indices, whereas gas prices exert a limited impact. The three indices largely show consistent reactions to the independent variable in its raw data format: high oil prices lead to a dip in the indices, low oil prices boost them, and moderate oil prices yield a slight positive influence. This suggests that stock indices respond to oil prices at higher and lower quantiles. However, when we process the original global crude oil price data to remove inherent volatilities, the upbeat influence begins to wane in the mid to high quantiles, giving way to a neutral or non-effect. Alongside this neutral effect, a negative effect becomes more pronounced. As the crude oil price data is stabilised through this decomposition, its detrimental effect on the US indices amplifies, and its beneficial influence recedes.

As for gas prices, when they are high, they positively impact the high quantiles of the US conventional and ESG indices and have a less positive effect on the Islamic index. This suggests high gas prices will positively influence the conventional and ESG indices. However, as shown in the figures above related to gas prices, the coefficient value of the gas prices with the indices is nearly zero, indicating a minimal influence. This underscores that the movement of oil prices is more significant than gas prices for the US indices being studied. This may be because many companies listed in these indices heavily rely on oil as an energy source or a revenue stream. Hence, we choose not to decompose the gas prices further and stick with the original dataset.

From an investment standpoint, investors must consider oil-related risks and returns when setting performance expectations, allocating assets, and crafting their investment portfolios. However, they can generally overlook the risks associated with gas as gas prices have minimal impact on US stock indices. Investors would benefit from selecting stocks with a strong positive correlation with oil price fluctuations as they can predict them better. Furthermore, this research underscores the asymmetric impact of crude oil prices on US stock indices. The insights from this study can enhance predictions about US stock index trends and highlight potential investment vulnerabilities. These insights can guide portfolio diversification strategies across varying investment timelines for investors.

The analysis also highlighting the need for quantile-specific investment strategies. In periods of high oil prices, a cautious approach is advised for conventional and Islamic indices due to negative impacts in upper quantiles, while lower quantiles offer opportunities during lower oil prices. Diversification, considering the varied impacts of oil and gas on different indices such as conventional, ESG, and Islamic, is crucial. The significant role of oil prices, particularly their sensitivity to global events, underscores the importance of investor vigilance for short-term gains, capitalising on immediate oil price volatility, and long-term strategies considering sustained impacts. This nuanced understanding of market dynamics, enriched by decomposed oil price series analysis, advises investors to integrate these insights into their decision-making, thus enhancing both academic and practical approaches to complex market relationships.

Given that the results mainly pertain to positive or negative oil price shocks, the influence of oil prices on stock returns becomes clear during notably high or low stock market performance phases. Such trends often stem from either optimistic or pessimistic investor outlooks, leading to irrational investment behaviours typical of stock markets. Policymakers should be wary of unpredictable oil price information that might induce market instability.

While this study provides valuable insights into the relationship between crude oil and gas prices and US stock indices, it is not without limitations. Firstly, the study's time frame, from 2 January 2013 to 30 December 2022, may not capture long-term trends or account for historical shifts in energy markets and their potential impact on stock indices. Additionally, while the QQ regression framework offers a nuanced perspective, it, like all models, has inherent biases and may not capture all complexities of the real-world relationship. Deciding not to decompose gas prices based on preliminary findings could also mean potential nuances in gas price influences are overlooked. Furthermore, the study's focus on US indices might limit the generalizability of the findings to other global markets with different economic structures and energy dependencies. Lastly, this analysis does not explicitly consider external factors such as geopolitical events, global economic downturns, or significant policy shifts, which might affect both energy prices and stock indices. Future research could address these limitations by expanding the timeframe, incorporating more diverse econometric models, and analysing other influential external factors.

The findings of this study have several policy implications that can guide decision-making at both the national and international levels. Given the significant influence of crude oil prices on US stock indices, policymakers need to recognise the vulnerability of financial markets to energy price fluctuations and devise strategies to mitigate potential adverse effects. This could involve implementing fiscal and monetary policies that stabilise the economy during periods of volatile oil prices. Moreover, the minimal impact of gas prices on the indices suggests that diversifying energy portfolios by promoting natural gas and other alternative energy sources could be a strategic move to reduce the economy's sensitivity to oil price shocks. Diversification can provide economic stability and align with global sustainability goals. Policymakers should also consider enhancing transparency in the oil market and fostering international cooperation to manage and stabilise global crude oil prices. Additionally, given the growing importance of ESG and Islamic indices in the global financial landscape, tailored policies and regulatory frameworks should be developed to support and promote these market segments. Encouraging investments in sectors less sensitive to oil price shocks, as identified in the study, can also be a proactive strategy to shield the economy from the volatile energy market. Overall, a multi-pronged policy approach, rooted in the findings of this study, can help create a resilient financial market that thrives even amidst the unpredictabilities of global energy prices.

## 6. ACKNOWLEDGEMENTS

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