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Saudi Arabia And The Global ESG Score Nexus: A Wavelet Coherence Perspective



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Abstract

This study presents a novel examination of the relations and interactions of environmental, social, and governance (ESG) scores among Saudi Arabia, the United States, Europe, Asia, and the Far East regions using a wavelet coherence approach. For this purpose, the study examined the causality between the ESG scores of Saudi Arabia and other countries. The analysis is rooted in the context of ESG, and sustainability employs a comprehensive monthly dataset calculated by MSCI from January 2016 to November 2023. Our findings reveal that the ESG score variables of Saudi Arabia and the world exhibit-positive and short-term co-movements during short-term economic cycles. However, the most significant relationship was observed to last from mid-2019 to 2021. Additionally, it was found that these relationships occurred under the leadership of various global regions in the 4-8 frequency range, while they were led by Saudi Arabia in the 0-4 frequency range. Furthermore, it can be stated that the related period was affected by the COVID-19 process. This is because the findings from the long-term frequencies that there is no relationship between Saudi Arabia and various global regions. According to the research results, long-term reforms and regulations are needed for full compliance with ESG practices. Although ESG improves financial performance in the short term, structural changes are required to achieve long-term economic growth. Accordingly, it is emphasized that ESG strategies should not only target short-term economic growth but also long-term sustainable development. These insights contribute to the current literature on ESG and offer practical implications for policymakers aiming to align sustainable financial performance and economic growth.

Keywords ESG • Sustainability • SDGs • Saudi Arabia • Wavelet Coherence Approach

JEL Classification C32 • F64 • Q56



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Saudi Arabia And The Global ESG Score Nexus: A Wavelet Coherence Perspective

In recent years, the concept of sustainability has garnered significant attention from investors, creditors, analysts, and researchers. The global economic turmoil caused by the 2008 Global Financial Crisis and, more recently, the Covid-19 pandemic has pushed sustainability issues, particularly Environmental, Social, and Governance (ESG) factors, to the forefront of international financial and corporate decision-making (Izcan & Bektaş, 2022; Al Amosh & Khatip, 2023). However, while the global importance of ESG is well-established, the implementation of ESG strategies varies considerably across regions due to differences in economic structures, regulatory frameworks, and cultural factors (Buallay, 2019; Chebbi & Ammer, 2022).

Although a growing body of literature examines the relationship between ESG performance and various macroeconomic variables, such as economic growth, financial development, and foreign direct investments (İşik et al., 2024; Paltrinieri et al., 2020; Revelli & Viviani, 2015), comparative studies that specifically investigate the dynamic relationships between the ESG scores of different countries are scarce. In accordance with the purpose of the study, the causality between the ESG scores of Saudi Arabia and other countries was examined. This gap is notably felt in studies targeting countries like Saudi Arabia, where ESG performance is steeply entangled with the socio-economic context. With Saudi Arabia implementing its ambitious Vision 2030 to achieve economic diversification and reduce dependency on oil, the role of ESG practices in this transition needs to be understood (Al-Faryan & Alokla, 2023).

Saudi Arabia's ESG Landscape: A Unique Case

Saudi Arabia is a very peculiar case in the global ESG environment, considering both its economic dependence on oil and, more recently, its pledge for sustainability objectives such as Net Zero greenhouse gas emissions by 2060. Unlike the Western economies that have grown through ESG practices over several decades, as reported by Singhania and Saini (2023), the commitment of Saudi Arabia toward ESG is quite recent and primarily economically driven by reform policies. The Saudi Stock Exchange's publication of its first ESG guidelines in 2021 marks a pivotal moment in the country's sustainability journey (Chebbi & Ammer, 2022). However, little research has been conducted on how Saudi Arabia's ESG scores compare to other global regions or how these scores interact in both the short and long term.

Theoretical Framework: ESG and Economic Development

Theoretically, in recent times, ESG practices have gained importance for long-term economic resilience and sustainable growth. As observed, ESG frameworks are based on corporate governance and social responsibility but mainly on environmental stewardship, which gains pivotal relevance from the perspective of global climate change and resource scarcity. Balancing between economic diversification and sustainable development will challenge for resource-rich countries like Saudi Arabia. Previous literature proved that high performance of ESG practices would result in better economic performance, less risk, and more foreign investment, as stated by Revelli & Viviani (2015) and Kouaib 2022. Of most importance, countries with a high ESG score tend to attract more and more sustainable investments, which agree with United Nation's Sustainable Development Goals-SDGs: Hassani & Bahini, 2022.

Governance reforms in Saudi Arabia have been at the center of better ESG performance, such as increasing boardroom independence, the primacy of audit committees, and transparency. However, how such governance reforms influence the wider regional and global interactions of ESG scores remains less obvious, and this paper attempts to bridge that gap by analyzing the dynamic relationships between Saudi Arabia's ESG scores and those of other key regions, including the United States, Europe, Asia, and the Far East.

Research Gap and Contribution

Although the extant literature elucidates the relationship between ESG and macroeconomic variables in an individual country or a region, it falls short of discussing how ESG scores interrelate across countries. This paper attempts to fill the lacuna through a comparative study of the ESG scores of Saudi Arabia and major global regions using Wavelet Coherence analysis, a method that provides the facility for exploring both short-run and long-run relationships. By focusing on the interaction between Saudi Arabia's ESG scores and those of the United States, Europe, Asia, and the Far East, this study contributes to a deeper understanding of how global ESG practices converge or diverge over time.

Research Questions

Based on this framework, the following research questions are proposed:

1. How do the ESG scores of Saudi Arabia interact with those of the USA, Europe, Asia, and the Far East?
2. What are the short-term and long-term relationships between the ESG scores of these regions?
3. What role does Saudi Arabia's economic reform under Vision 2030 play in shaping its ESG performance and its alignment with global trends?

By addressing these questions, this study not only fills a gap in the comparative ESG literature but also provides valuable insights for policymakers and investors seeking to understand the implications of ESG in the context of economic reform and sustainability transitions.

The study is divided into several sections: Section 1 presents the purpose of the study, its significance, motivation, and the gap in the literature. Section 2 provides a comprehensive literature review that provides a detailed understanding of previous research in the field. Section 3 describes the methodology used in the study and introduces the data sources. Section 4 presents the findings and insights of the study. Section 5 serves as the conclusion of the study, where the findings are synthesized and the broader implications and contributions of the study are highlighted.

Literature Review

There is an extensive body of literature examining the relationship between ESG (Environmental, Social, and Governance) scores and economic growth, development, and international investments. Some studies focus on the overall ESG score and its relationship with variables, while others examine the relationship between each ESG dimension—environmental, social, and governance—and various variables. However, there is also a need for comparative studies that analyze the relationships between the ESG scores of different countries and not just the relationship between ESG and macroeconomic variables. This would provide a broader perspective for evaluating the ESG literature.

Therefore, this research compares the ESG scores of Saudi Arabia, the USA, Europe, Asia, and the Far East countries, analyzing their relationships and interactions. The study evaluates the correlation between countries, the direction and maturity of relationships in detail, and demonstrates trends in countries' ESG practices, thus filling a gap in the literature.

At the center of the research is Saudi Arabia, which has recently opened its markets to international investors to diversify its economy and reduce its dependence on oil, making ESG a more important topic for the country (Al-Faryan and Alokla, 2023). Kouaib (2022) examined the ESG disclosures and financial performance of 25 Saudi firms between 2014 and 2021 using the OLS method and found that ESG disclosures increased corporate investment efficiency in Saudi Arabia. The study also identified that ESG practices in Saudi Arabia enhance the efficiency and sustainability of corporate investments. Other studies based

on Saudi Arabia have highlighted important determining factors for ESG scores, such as structure of the board of directors, independence of the board of directors, existence of an audit committee, which have a profound impact on the disclosure and level of ESG scores received (Bamahros et al. (2022); Chebbi and Ammer (2022); Umar et al. (2023)). In Europe, ESG emerged from the concept of Corporate Social Responsibility (CSR) and gained popularity in the late 20th century. Before ESG practices were addressed holistically, they were analyzed through their environmental, social, and governance dimensions (Singhania and Saini, 2023). Beginning in the 1970s, the relationship between corporate social responsibility, corporate social performance (CSP), and corporate financial performance (CFP) was studied (Singhania and Saini, 2022). For example, Lupu et al. (2020) found that ESG scores were related to financial stability in the European banking sector, while Sassen et al. (2016), in their study of 8,752 European firms between 2002 and 2014, concluded that corporate social performance reduced firm risk. A recent study by Gavrilakis and Floros (2023) focused on six European countries: Portugal, Italy, Greece, Spain, France, and Germany. It found no direct relationship between ESG scores and financial performance. In Europe, large-cap firms' ESG investments are seen as a threat to financial performance, while investors are more likely to focus on small-cap firms for greater returns. For example, using panel co-integration tests, Diaye et al. (2021) examined the link between ESG performance and economic growth in the OECD countries during the period 1996-2014. These results indicate that, in the long run, ESG performance has a positive impact on economic growth, while no such relationship was present in the short run. In this respect, Işık et al. (2024) indicated that environmental, social, and governance practices have a positive long-term impact on economic growth in the East Asia-Pacific and South Asian countries. Such results are particularly indicative of the multivariate nature of the ESG. Research conducted within the context of the USA also found that ESG impacts economic growth and development, financial development, and direct investments. For instance, according to Lisin et al. (2022), in North American countries, the governance dimension of ESG was the highest-impact driver on the success of the institutions. Ersoy et al. (2022) established the existence of a U-shaped effect of ESG scores on the market value of American banks.

Although the literature review shows that previous studies focused on the relationship of the ESG scores with several macroeconomic variables, it is rather clear from the findings that there is no comparative research targeting the relationship analysis of countries with respect to their ESG scores. Correspondingly, the present study scrutinizes the interlinkages of the countries' ESG scores and searches for interactions between them. These results will indeed show, from the analysis, whether countries influence one another in ESG scores over macroeconomic factors: economic growth, development, and investment. The results of such research will contribute to helping policymakers and managers understand how to review ESG practices to build advanced economic structures.

The research analyzed Saudi Arabia, the USA, Europe, the Far East, and Asian countries for the period between January 2016 and November 2023. The main limitations of the study are the sample size and period. However, considering that previous studies used traditional econometric models, the method used in this research is relatively new and differs from traditional approaches.

Methodology and Data

The focus of this paper is on testing the ESG scores of Saudi Arabia calculated by MSCI against the corresponding figures calculated for all countries. In this context, the Wavelet Coherence analysis was carried out using monthly data from January 2016 to November 2023. The pairwise tests were used to evaluate the relation of the ESG scores assigned to Saudi Arabia, the USA, Asia, Europe, and the Far East regions. Care was observed in adhering to uniformity in the start and end dates of all the variables, a restriction that necessitated that this data does not go further back and hence one of the challenges of this study. Nevertheless,

the contemporary approach that Wavelet Coherence analysis presents allows for the interpretation of the results in a wide and robust way.

Describing wavelet analysis is somewhat similar to the evolution of Fourier-based analyses. The main difference between a wavelet transform and a Fourier analysis is that if a Fourier analysis provides an overall frequency decomposition, a wavelet provides a local frequency decomposition. It not only tells us what frequency components are in the signal but also gives us the “when” and “where” of the components as well (Abramovich et al., 2000: 8).

Wavelet Coherence analysis is a technique that has been frequently used when assessing changes in power within a time series (Torrence & Compo, 1998: 61). This technique assesses the interaction between the two variables with respect to local time and frequency without imposing stationary or homogeneous conditions on the analyzed time series (Liu, 1994: 152; Caferra & Vidal-Tomás, 2021: 4). Thus, the case with Fourier analysis is somewhat different concerning these issues and some reasons why Wavelets can be preferable.

The cross-wavelet transforms between the two time series $x(t)$ and $y(t)$ are defined as follows (Torrence & Compo, 1998):

$$W_{xy}(u, s) = W_x(u, s)W_y^*(u, s) \quad (1)$$

In the compendium of equations which is equation (1) “W” stands for the wavelet, the position is referred to with “u,” and the scale with “s.” along with the star (*) sign denotes the complex conjugate. The Wavelet transform evaluates the local correlation between the time series and therefore explains the time-frequency regions where the two-time series correlate.

After the evaluation of the cross-wavelet transform, we applied the wavelet coherence coefficient, which evaluates the relationship between two time series as the co-movement decreases in time, as explained below (Torrence & Webster 1999: 2689):

$$R^2(u, s) = \frac{|S(s^{-1}W_{xy}(u, s))|^2}{S(S^{-1}|W_x(u, s)|^2)S(S^{-1}|W_y(u, s)|^2)} \quad (2)$$

In equation (2), time, frequency, and space are also smoothed with a parameter ‘S’. The wavelet coherence squared coefficient “ $R^2(u, s)$ ” has the range between “ $0 \leq R^2(u, s) \leq 1$ ”. If $R^2(u, s)$ is equal to one, this means that there is a total connection between the two time series; however, if it is equal to zero, there is no connection between the time series whatsoever. In addition, it should be noted that the squared wavelet coherence takes on positive values only. The method does not provide any insights as to whether the dependence provided is neat or inverse; thus, the method expressed in equation (3) is adapted from Torrence & Compo (1998) to make positive and negative movements clear and for finding cause and effect between the series

$$\phi_{x,y}(u, s) = \tan^{-1} \left(\frac{\Im\{S(s^{-1}W^{xy}(u, s))\}}{\Re\{S(s^{-1}W^{xy}(u, s))\}} \right) \quad (3)$$

In (3), \Im represents the imaginary part of the cross wavelet transform, whereas \Re refers to its real counterpart. The result of the Wavelet analysis is illustrated in a plot in the form of two axes with a cone of influence, black shaded arrows showing eight orientations ($\uparrow \downarrow \leftarrow \rightarrow \swarrow \nwarrow \searrow \nearrow$), and five major parts that are illustrated in warm and cool colors (Rubbaniy et al. 2021: 243).

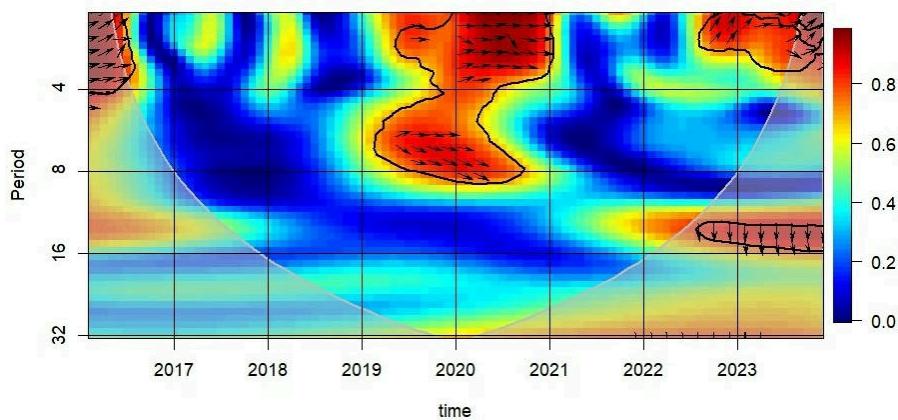
Findings

In this section, the relationships are constructed between Saudi Arabia's ESG scores and the ESG scores of different regions of the world facilitated by the wavelet coherence analysis. In the diagrams, the base axis refers to time while the vertical axis refers to frequency. Also, the frequency of 0-8 on the left vertical axis denotes a short term while the period of 8-32 frequency values stands for a long term. In addition, the red shades in the figure show that the variables move together and the blue shades show that the variables do not link with each other. The areas that are black-edged are the areas that are significant at a level of 5%. Below are presented the wavelet coherence analyses to illustrate the relationship between the ESG scores of Saudi Arabia and the scores of the USA, Europe, Asia, and the Far East.

Figure 1

Wavelet Coherence: Saudi Arabia vs. USA

SUUD vs USA

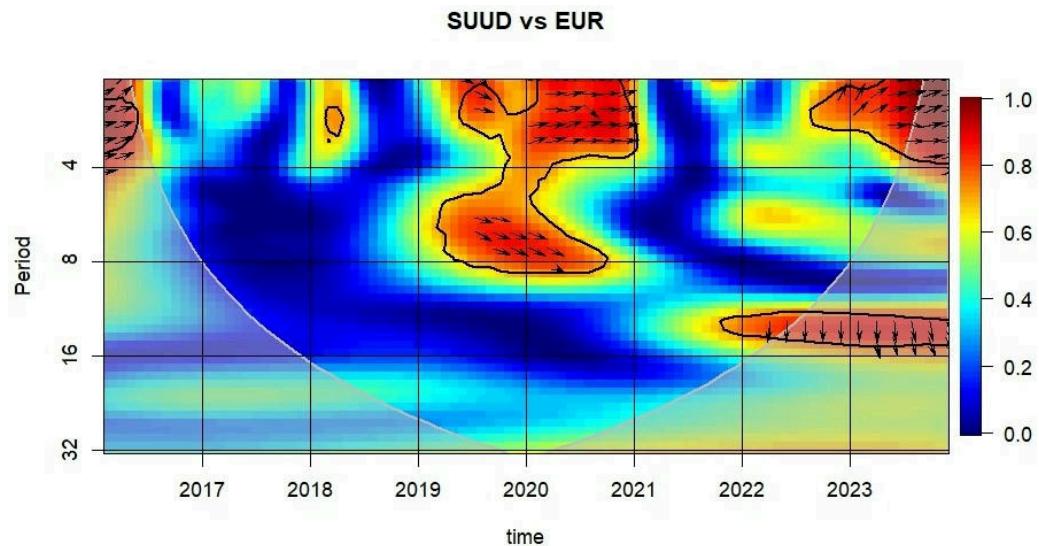


In Figure 1, if we observe the Wavelet Coherence graph of Saudi Arabia vs. USA, it can be seen that in short-term economic cycles, a brief positive co-movement occurs with regards to the arrows direction (\uparrow) around mid-2016, whereas from the mid-year of 2019 to 2021, a closely correlated relationship based on the directions of the arrows (\nearrow) is observed. Furthermore, it is noticed that there existed a Saudi-led relationship between mid-2022 and the third quarter of 2023 as illustrated by the arrow direction (\uparrow). The said relationships are also positive and statistically significant at 5%. In the short run, the relationship inferred based on the direction of the arrows (\uparrow) in the 4-8 frequency range is found to occur under the leadership of Saudi Arabia. However, it would be right to conclude that assessing the variables in question with long-term cycles, there is no association to speak of individually in the long term, this superiority of the blue region over the relevant graph.

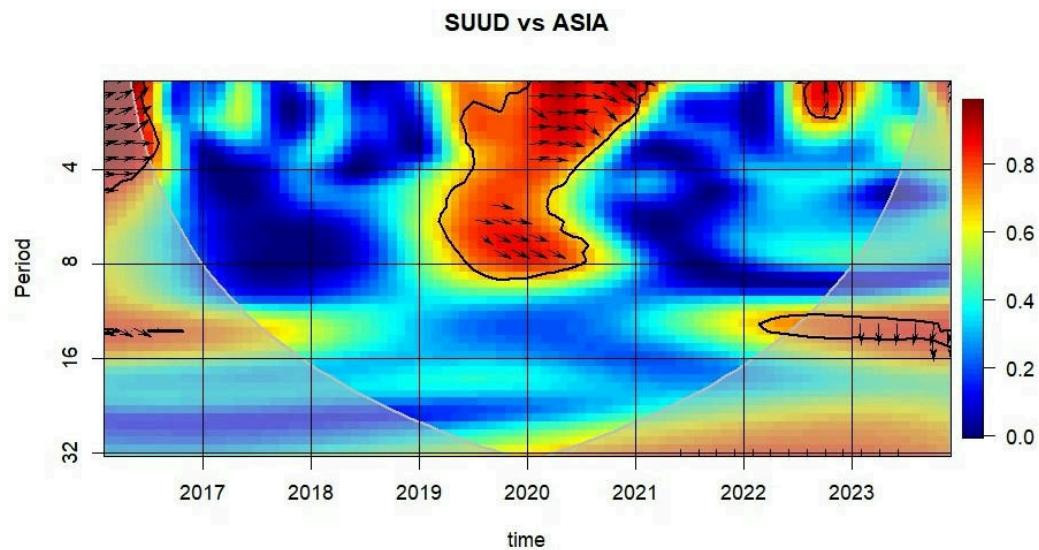
As presented in Figure 2 of the analysis findings, while there are indications of relationships in the short-term for the year 2022, they are not at levels to be interpreted clearly. Consequently, the variables did not show any long-term relationships among the frequencies tested. Nevertheless, a relationship existed from the mid of year 2019 to the year 2021, and this relationship in 0-4 frequency range is affirmative as per the direction of the arrows (\uparrow) and occurs under Saudi Arabia dominance. However, the leadership during those same years in the 4-8 frequency range showed a relationship as per the direction of the arrows (\searrow) opposite of the Saudis, led by Europe instead. Also, throughout the end of the year 2022 and during the third quarter of the year 2023, there is still movement of the variables together i.e. the variables co-moved with this relationship being positive based on the direction of the arrows (\uparrow). The islands demarcated by black lines within the wedge of influence mechanisms showcase that the embedded relations are significant at the 5% level.

Figure 2

Wavelet Coherence: Saudi Arabia vs. Europe

**Figure 3**

Wavelet Coherence: Saudi Arabia vs. Asia



The results of the Wavelet Coherence analysis between the ESG scores of Saudi Arabia and Asia are illustrated in [Figure 3](#). Within the figure, in the frequency range 0-4, it is indicated that in the middle of 2016, there is a short-term positive relationship with Asia at the center (\uparrow), while between mid-2019 and the beginning of 2021, there is again a positive relationship with Asia, but the arrows point in a downward direction (\downarrow). Furthermore, in the second half of 2022, under the 4-8 frequency range, a temporary positive effect of Saudi Arabia's impact on Asia was observed (\uparrow). The results reached the statistical significance at the 5% level. However, in the long-term frequency range, there was no correlation between the ESG scores of Saudi Arabia and Asia.

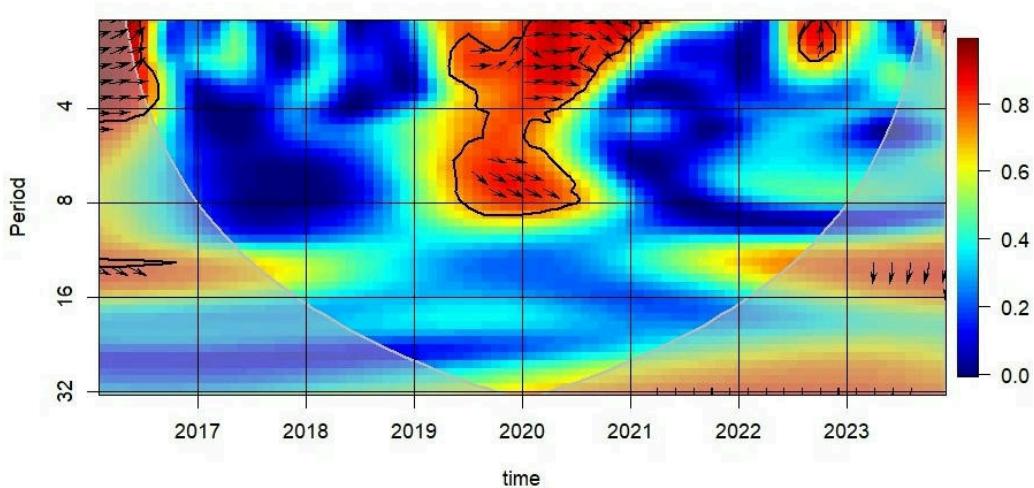
As per the findings obtained through the wavelet coherence analysis illustrated in [Figure 4](#), a short-term correlation was noted in the year 2016 under the control of Saudi Arabia in the 0-4 frequency band with reference to the notations (\uparrow , \downarrow) used for the arrows. From the mid-year 2019 till the early year 2021, a positive correlation was noted again under the leadership of Saudi Arabia with reference to the notations (\uparrow , \downarrow) used for the arrows in the 0-4 frequency band. However, in the middle of the year 2020, a very brief

negative correlation was developed under the control of the Far East with reference to the notation (\nearrow) used for arrows. Once again in the second half of the year 2022, with reference to arrows notation (\uparrow , \searrow) the Saudis positively influenced the Far East in the 0-4 frequency band. More also in the range of 4-8 frequency, between the period of late 2019 to the mid of 2020, movement in the positive direction was observed under the headship of Far East as per the arrows used (\searrow). The results are recognized as statistically significant at the 5% level because the black line encircled the beaches lie within the cone of influence. In contrast, it was found that Saudi Arabia and the Far East do not have any relationship on a long-term basis.

Figure 4

Wavelet Coherence: Saudi Arabia vs. the Far East

SUUD vs FAR EAST



Conclusion

This study was conducted to examine the short- and long-term relationships between Saudi Arabia's Environmental, Social, and Governance (ESG) scores and those of other major regions worldwide (USA, Europe, Asia, and the Far East). The research, using Wavelet Coherence analysis, revealed that Saudi Arabia's ESG performance shows positive correlations, particularly during short-term economic cycles, but that long-term relationships are weaker. These results provide important insights into how Saudi Arabia aligns with global ESG trends and fill gaps in the literature.

The findings indicate that Saudi Arabia's ESG scores have a positive short-term relationship with other regions. Specifically, between 2019 and 2021, a strong short-term alignment was observed between the ESG scores of Saudi Arabia and other regions, especially during the COVID-19 pandemic. These short-term interactions highlight the effects of global economic crises on ESG practices. While Saudi Arabia led in the 0-4 frequency range, other regions (particularly Europe and the USA) influenced Saudi Arabia in the 4-8 frequency range. In response to another research question, Saudi Arabia's ESG scores exhibited positive and short-term co-movements with other regions. This short-term correlation, which persisted until 2022, intensified during periods of economic crises. However, in the long term, no significant relationship was found between Saudi Arabia's and other regions' ESG scores. This suggests that Saudi Arabia struggles to align with global ESG trends over the long term due to its economic structure, especially its dependence on oil. Compared to other regions, Saudi Arabia's ESG performance does not fully match global standards. In response to the final research question, the economic reforms implemented under Saudi Arabia's Vision 2030 contributed to short-term improvements in ESG scores, but long-term sustainability strategies have not been sufficiently effective. Although Saudi Arabia's pledge to reach its Net Zero target by 2060 and the

ESG guidelines issued by the stock exchange have led to positive short-term outcomes, it is clear that these reforms require a deeper structural transformation for long-term success. More comprehensive reforms are needed in areas such as governance, environmental policies, and social responsibility.

This study largely aligns with the existing findings in the literature. Revelli and Viviani (2015) suggested that ESG scores support short-term economic growth and financial performance, and this study demonstrates that Saudi Arabia's ESG scores align with those of other regions in the short term. However, the weak long-term correlation identified in this study does not fully align with findings in research on developed countries, which emphasize sustained ESG performance in the long term (Ng et al., 2020; Nogueira & Madaleno, 2021). This means that Saudi Arabia's economic structure and ESG practices have not aligned fully with global standards. A similar study on OECD countries by Diaye et al. (2022) showed that in the short term, ESG performance contributed positively to economic growth, while this relation is weakening in the long term. Likewise, the results here indicated a low long-term ESG correlation between Saudi Arabia and other regions. These results indicate that, in the long run, the sustainability reforms of Saudi Arabia require longer structural adjustments.

These results of Saudi Arabia's performance in ESG, as reported by Kouaib (2022), further indicate how corporate ESG practices are still developing. This therefore supports the need for further reforms according to Saudi Arabia's Vision 2030.

Policy Recommendations, Future Research Suggestions and Limitations

The findings show that Saudi Arabia moves with the rest of the world in terms of ESG performance in the short run, but it must pursue more structural reforms in the long run. More comprehensive regulations are in order, particularly in the areas of corporate governance, environmental sustainability, and social responsibility. According to the literature, although ESG improves financial performance in the short term, more profound structural changes must attain long-lasting economic growth.

It is recommended that regarding ESG policy institutionalization, Saudi Arabia should enhance its policies of board independence, transparency, and auditing processes. This is the reason why, in particular, they should develop strategies of sustainability that can enable them to survive economic crises and support development over the long term. Saudi Arabia should develop more targeted ESG strategies at a sectoral level to enhance the long-term impacts of ESG. As a result, Saudi Arabia needs to take a long-term view of ESG practices and evaluate the multidimensional impacts of ESG with a holistic approach. Future studies could explore the ESG performance of different sectors in Saudi Arabia in detail, identifying which sectors benefit more from sustainability strategies and which require more improvement. Additionally, the social dimensions of ESG (labor rights, gender equality, etc.) and how they are shaped in the context of Saudi Arabia, and how these relate to global ESG scores, should be further examined.

In conclusion, this study shows that Saudi Arabia strongly aligns with global ESG performance in the short term but needs more structural reforms in the long term. Saudi Arabia's economic and institutional reforms should be deepened in line with sustainable development goals, enhancing the long-term impacts of ESG. The findings of this study emphasize that ESG strategies should aim not only at short-term economic growth but also at long-term sustainable development.

This study has some limitations. (i) The study focuses mainly on the relations and interactions between ESG scores. However, there are also many factors that may affect the interactions between ESG scores; therefore, future studies may consider other macro and micro factors affecting ESG interactions. (ii) This study involves Saudi Arabia, the USA, Asia, Europe and the Far East regions. Hence, we do not consider all regions of the world and the results are limited to the analyzed regions. (iii) The study uses monthly

data from January 2016 to November 2023. A data set with a higher frequency can produce deeper results. Moreover, future studies should consider new econometric models and machine learning algorithms. Thus, the existing literature can be enriched.



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