Dynamic Interlinkage between ESG Factors and Stock Market Performance in GCC Countries: Pre- and Post-COVID- 19 Evidence

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Abstract: This study investigated the dynamic connectedness between the GCC region's ESG and stock market indices. The study employed the time-varying parameter vector autoregressive approach to explore the connectivity in ESG and stock market indices of GCC markets. The analysis was conducted on the daily data for the sample period from May 1, 2017, to December 29, 2023, where the data was categorically segregated into the full sample, pre-covid, and post-covid to gain in-depth insights. The empirical analysis posited a moderate level of connectedness among the selected indices, while ESG indices played the role of transmitters towards the GCC stock markets. There are significant implications for institutional investors, managers, and financial analysts interested in diversifying their portfolios by considering the ESG aspects of GCC equity markets, especially during the pandemic. This study enlightened the time-varying parameter vector autoregressive model's significance in exploring the dynamic connectedness between ESG and stock indices in three sample periods. In addition, it demonstrated the transmission role of ESG factors to the stock market, which can help to navigate.

Keywords: Environmental, social, and governance, Portfolio, COVID-19. Sustainability, Risk.

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الترابط الديناميكي بين العوامل البيئية والمجتمعية والحوكمة وأداء أسواق الأسهم في دول مجلس التعاون الخليجي: أدلة من فترتي ما قبل وما بعد جائحة كوفيد-19

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مستخلص البحث: تناقش هذه الدراسة الترابط الديناميكي بين مؤشرات الحوكمة البيئية والاجتماعية وحوكمة الشركات (ESG) ومؤشرات أسواق الأسهم في منطقة مجلس التعاون الخليجي. اعتمدت الدراسة منهجية الانحدار الذاتي للمتجهات ذات المؤشرات المتغيرة بمرور الوقت؛ لاستكشاف العلاقة الترابطية بين مؤشرات الحوكمة البيئية والاجتماعية وحوكمة الشركات ومؤشرات أسواق الأسهم في دول مجلس التعاون الخليجي. أجري التحليل باستخدام بيانات يومية تغطي المدة من 1 مايو 2017م إلى 29 ديسمبر 2023م، حيث صُنّفت البيانات إلى ثلاث فترات: العينة الكاملة، فترة ما قبل جائحة كوفيد19-، وفترة ما بعد الجائحة؛ بهدف الحصول على رؤى شاملة. أظهرت النتائج التجريبية مستوى متوسطًا من الترابط بين المؤشرات المختارة، في حين لعبت مؤشرات الحوكمة البيئية والاجتماعية وحوكمة الشركات دور الناقل للأسواق المالية في دول مجلس التعاون الخليجي. تتضمن هذه النتائج دلالات مهمة للمستثمرين المؤسسيين، ومديري المحافظ، والمحللين الماليين المهتمين بتنويع محافظهم الاستثمارية عبر النظر في جوانب الحوكمة البيئية والاجتماعية وحوكمة الشركات في أسواق الأسهم الخليجية، خصوصًا خلال فترة الجائحة. سلطت هذه الدراسة الضوء على أهمية نموذج الانحدار الذاتي للمتجهات ذات المعلمات المتغيرة بمرور الوقت في استكشاف الترابط الديناميكي بين مؤشرات الحوكمة البيئية والاجتماعية وحوكمة الشركات ومؤشرات الأسهم خلال الفترات الثلاث للعينة. علاوة على ذلك، أبرزت الدراسة دور مؤشرات الحوكمة البيئية والاجتماعية وحوكمة الشركات في نقل التأثيرات إلى سوق الأسهم؛ وهو ما يمكن أن يساعد في فهم ديناميكيات الترابط بين الأسواق، والتعامل مع حالة عدم اليقين التي تميزها.

الكلمات مفتاحية: البيئة والمجتمع والحوكمة، المحفظة الاستثمارية، كوفيد19-، الاستدامة، المخاطر.

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1. Introduction

Environmental, social, and governance (ESG) investing is a strategic approach that has highlighted its essential role in financial decision-making in global markets (Hill, 2020). There is a significant market capitalization of ESG investing over $25 billion, expected to grow to $40 billion by 2030. The surge has been noted as an essential aspect for stock markets (Wang et al., 2024), which have remained an established investment mechanism, and strong ESG performance is perceived as more resilient to market volatility and regulatory changes, thus attracting socially responsible investors (Alkaraan et al., 2022). The nexus between ESG factors and the Sustainable Development Goals (SDGs) constitutes a fundamental paradigm for shaping contemporary global development strategies. The international world expects from these SDGs that environmental, social, and governance (ESG) criteria are aligned with global development priorities. Through a meaningful alignment of these two aspects, responsible corporate practices will be put in place that will ensure the significant contribution of companies to long-term sustainable growth with the inclusion of social and environmental challenges (Cagli et al., 2023; Kakinuma, 2023)& Taşkın, 2023; Kakinuma, 2023.

The interconnectedness between ESG investment and SDGs establishes relationships where ESG-driven investment will not only contribute as a catalyst for the realization of UN goals but also ensure the perspective of corporate sustainability (Bekaert et al.,2023). This perspective motivates companies to consider ESG investments that enhance corporate sustainability while addressing global social and environmental challenges, including risk mitigation and improving long-term financial performance (Delgado-Ceballos et al., 2023). As financial markets increasingly recognize the interconnectedness of ESG criteria and the SDGs, they become vital to advancing global sustainability goals and creating a more ethical, equitable, and resilient financial market (Bekaert et al., 2023). Over time, there has been an increase in the appreciation of ESG principles, which is of great importance to investors, portfolio managers, and policymakers. They prefer aligning financial performance and sustainable practices necessary for broader environmental and social responsibilities, which align with the SDG perspective of a broader market transition towards sustainable finance.

In the historical study, there are ample evidences there which has explored the dynamic relationships among ESG factors and stock market performance especially for considering the priorities of investors trend toward the sustainable investments (Cagli et al., 2023; Wang et al.,2024). A significant and positive correlation is examined between strong ESG performance and higher financial profitability, where companies offering high ESG scores benefit from lower costs of capital, reduced risks, and improved operational efficiency (Naeem et al., 2022). Furthermore, the meta-analysis of their study presented that more than 90% of studies have examined a significant positive relationship between ESG factors and corporate financial performance. Few studies clarified the importance of sectoral and regional variations in determining the magnitude of ESG impact on performance. For example, the broad integration of ESG factors into financial decision-making has yielded significant long-term performance benefits, especially in industries with high environmental risks (Naeem et al., 2022).

In prior literature, the connectedness of ESG factors and financial markets has been explored in multiple regions of the global world, where regulatory frameworks, cultural norms, and market maturity differentiated the levels of connectedness and impact on performance (Assaf et al., 2024; Bhattacherjee et al., 2024; Shaik & Rehman, 2023). For instance, European markets are considered at the forefront of ESG adoption due to their strict regulatory requirements and investors' preferences for sustainable investments (Umar et al.,2020). Comparatively, emerging markets that are challenged by weak governance structures and less stringent environmental regulations are aware of the broad level of ESG importance; however, they have shown muted impacts of ESG factors on financial outcomes (Naeem et al., 2022). The United States shows a mixed picture, with ESG-driven investments gaining momentum but facing resistance in a few sectors due to political and ideological differences. (Naeem et al., 2022) argues that the extent to which ESG factors influence financial markets depends on regional economic development, regulatory frameworks, and stakeholder engagement, underscoring the need for region-specific approaches to sustainable investment. Sound policies and mandatory disclosures aligned with ESG practices and frameworks to drive corporate transparency and accountability have become necessary in developed

markets, particularly in the European Union (EU) and the United States (Bhattacherjee et al.,2024 ; Hoepner et al.,2024). These initiatives aim to mitigate environmental risks, improve governance, and promote social responsibility, which is increasingly considered essential for financial stability and long-term corporate performance (Hoepner et al., 2024).

Furthermore, empirical studies have highlighted the importance of ESG and financial markets' connectedness in the Gulf Cooperation Council (GCC) region (Alghafes et al., 2024; Kilic et al., 2022). The governments of these regions established their visions, especially Saudi Arabia because they sought to diversify away from oil dependence. In this regard, ESG's principles may help local companies align with international standards, attracting global investors interested in sustainable portfolios. In addition, the growing emphasis of this region on environmental reforms and governance improvements illuminated the critical role of ESG factors that can guarantee the improvement of market efficiency, long-term financial stability, and the promotion of international market integration (Moskovics et al., 2024).

The outbreak of the COVID-19 pandemic generated volatile behavior in investors and policymakers, which established a sound risk perspective, and it has further intensified interest in ESG-focused investments, as companies with higher ESG ratings have been observed to be more resilient during market recessions (Savio et al., 2023). Resilience is often attributed to better risk management practices and a more significant commitment to stakeholder well-being, which positions these companies to perform better in volatile markets (Albuquerque et al., 2020). They further revealed that firms in the safety zone with a slight decline in stock prices during the COVID-19 pandemic made ESG-related investments by showing socially responsible behavior. Furthermore, findings have encouraged the adoption of ESG principles, which are only ethically and financially prudent. The COVID-19 pandemic prompted investors in the GCC stock market to increasingly prioritize ESG-focused investments, motivated by the resilience and risk mitigation demonstrated by companies with strong ESG practices during the global market downturn (Said & ElBannan, 2024).

The nexus between ESG factors and financial markets has gained significant attention due to the growing recognition of the impact of sustainability on corporate performance and investment decisions (Shaik & Rehman, 2023). Furthermore, ESG factors can significantly contribute to establishing company valuation, risk management, and investor behavior (Moskovics et al., 2024). The interconnection between ESG principles and financial markets has been enhanced by digitalization, which provides better data analysis and real-time reporting where investors can have a better understanding of companies' sustainability and ethical behavior (Grewal et al., 2022). Digital platforms offer tools to collect and disseminate effective ESG data, enabling investors to make informed decisions consistent with financial objectives and social responsibility. The financial industry's increasing reliance on digital ecosystems for ESG metrics has thus established a strong link between sustainability and digital innovation, which is now essential for assessing market performance (Wang & Esperança, 2023).

The interconnectivity of ESG factors and financial markets can be examined using numerous models and methods, including panel data analysis and machine learning algorithms for predictive analysis. At the same time, the indirect effect of ESG shocks can be explored using the Total Connectedness Index (TCI), Vector Autoregression (VAR) (Lütkepohl, 2013), TVP-VAR perspective, and QVAR model (Diebold & Yilmaz, 2023; Kyriazis & Corbet, 2024; Mishra, 2024). Empirical evidence establishing the link between ESG factors and financial markets was found in previous literature in developed economies such as Europe and North America, while a notable research gap to be explored in regional economies, especially in GCC markets. This research gap is pragmatic, as understanding ESG dynamics in GCC markets could inform policymaking and investment strategies that support sustainable development in these regions, where environmental and social challenges are often more pronounced (Kilic et al., 2022).

The Gulf Cooperation Council (GCC) countries have been considered strategically important due to their vast oil reserves and substantial financial wealth, and they play a pivotal role in the global economy (Alghafes et al., 2024). These countries have their dominance in global energy markets, especially

in the supply of oil and gas, and the total market capitalization of GCC stock markets exceeded $3 trillion in 2023, with Saudi Arabia's Tadawul playing the leading role. However, the growing importance of sustainability and environmental governance has created a new paradigm in which ESG factors emerge as critical investment and corporate strategy drivers, mainly as GCC countries aim to transition towards more diversified and sustainable economies. There is growing recognition of the GCC economies' heavy reliance on natural resources, climate change, and the need to combine economic growth with sustainability. ESG factors are becoming more critical as these nations work to minimize their carbon footprint, improve governance, and boost social outcomes in line with Vision 2030 and other long-term development strategies (Alazzani et al.,2021). With their financial power, GCC countries can support sustainable investment frameworks and the integration of ESG criteria into global markets. The Saudi Green Initiative and the UAE's net-zero emissions by 2050 policy demonstrate a growing commitment to environmental sustainability and good governance (Bojarajan et al., 2024; Khayat et al.,2023).

The objective of this study is to examine the dynamic interactions between ESG factors and stock market indices in the GCC countries using the TVP-VAR approach. Therefore, through the empirical analysis of this study, researchers can gain a more comprehensive understanding of the impact of sustainability initiatives on market behavior, volatility, and investor sentiment in the GCC by integrating ESG factors and stock markets (Wang et al., 2024). Furthermore, these insights are essential to inform policymakers and investors about the financial advantages of implementing ESG practices in a region that remains indispensable to the global economy due to its strategic resources and economic influence.

This study contributed categorically, especially in terms of theoretical contribution; it expanded the existing knowledge on the interactions between ESG factors and stock market performance. There was a broad level of literature on the context of developed economies. Still, there was a need to explore the context of developing, emerging, and especially GCC countries, focusing on resource-rich developing regions. Moreover, literature is present on studies having panel data analysis and the VAR model (Lütkepohl, 2013). Still, this study provided a robust result by applying the TVP-VAR model of ESG impacts on volatility and market performance in response to external shocks (Naeem et al., 2022).

From a contextual perspective, the study provides significant insights for key stakeholders, including policymakers, investors, and corporate entities in the GCC region. As GCC countries embark on ambitious economic diversification plans, such as Saudi Arabia's Vision 2030 and the United Arab Emirates' Net Zero by 2050 strategy, understanding the financial implications of adopting ESG criteria is necessary to ensure sustainable economic growth (Bojarajan et al., 2024; Khayat et al., 2023). The findings of this study are essential for institutional investors interested in aligning their portfolios with ESG criteria while minimizing the risks associated with environmental regulations and social governance reforms (Alazzani et al., 2021). Furthermore, corporate entities in the region can benefit from these insights by adopting more robust ESG strategies, which can improve their market competitiveness and attract foreign investments, thereby contributing to the broader sustainable development goals in the region.

2. Literature review

Efficient Markets Hypothesis (EMH) and Financial Contagion Theory (FCT) are two important schools of thoughts which support the concept of interaction among markets and assets along with their spillover effect which tends toward the contagion effect. EMH explained that markets are efficient and can quickly incorporate new information, allowing events in one market to influence global asset prices (Malkiel, 1989). These aspects tend toward economic turbulence and investors are now moving toward the socially responsible investments which are being connected with the such contagion affects. Literature enlightened the significant growing importance of socially responsible and ESG based investments. Spillover effects are pragmatic for ESG indices containing only information from companies that follow sustainability guidelines. Any information disclosed about such ESG-based companies may directly or indirectly influence investor sentiments, leading to broader market impacts. Considering the ripple and contagion effect, such reputational and systematic risks associated with ESG failure may affect the interconnected industry, financial assets, and indices (Bhattacherjee et al., 2024; Wang et al., 2024). It highlighted the importance of understanding these dynamics for investors and policymakers in the rapidly changing sustainable investment landscape.

Empirical evidence exists regarding the static and dynamic connectedness among various markets, including stock, bond, commodity, energy, conventional currency, and cryptocurrency. Numerous statistical techniques were employed, including the Johansen-Juselius Cointegration test (Juselius, 1990), Granger causality (Shojaie & Fox, 2022), and the VAR model (Lütkepohl, 2013). In contrast, the most popular connectedness techniques, time-varying parameter vector autoregression (TVP-VAR) (Diebold & Yilmaz, 2023; Mishra, 2024), were employed to examine various datasets, periods, and methodologies. There is empirical evidence were found where dynamic connectedness among sustainable financial assets and other assets and markets has been explored. According to the first perspective, the dynamic interconnectedness between the top ten leading ESG equity markets was analyzed (Wang et al., 2024), where developed market indices contributed as transmitters towards emerging markets, and a significant increase in TCI was found during the pandemic and Eurozone crisis. As for risk factors, the fear index (VIX) is the one that sends the most shocks to ESG investments, and during the crisis period, having an ESG index recipient has little effect on investors' portfolios (Umar et al., 2020).

Akhtaruzzaman et al. (2022) analyzed the dynamic connectedness between the Media Coverage Index (MCI) and leading ESG indices in developed and emerging economies. The findings from the TVP-VAR perspective revealed that in the early times of the COVID-19 pandemic, the connectedness remained at higher levels, while in later periods, it gradually declined. The indices from Europe, the United Kingdom, the United States, and South Africa presented the transmission behavior towards the system. In contrast, the stock indices from Brazil, China, India, and Russia portrayed the reception behavior from the system. Another study considered eight regions for spillover connectedness, including four from developed countries and four from emerging countries (Gao et al.,2022). Findings of this study enlightened the significant contribution of sustainable and green finance toward the financial risk contagion.

Zhang et al. (2022) employed the DCC-GARCH and the finding revealed that five sustainability-related indices are highly interconnected. The pairwise analysis posited that green bonds remained in the recipient's behavioral category, while carbon emission futures were transmitted toward volatility. Furthermore, Iqbal et al.2024)) analyzed the dynamic connectedness among fourteen sustainable indices, and the TVP-VAR model posited that Asian markets are highly interconnected within the region, while Germany, France, the Netherlands, and the UK have shown net transmission behavior. Moreover, the results remain more robust during the COVID-19 pandemic period. It is necessary to explore the complexities of ESG in-depth because bidirectional results were presented, both in favor of and against the inclusion of ESG in the asset portfolio; furthermore, it is essential to investigate how and to what extent ESG plays a vital role in influencing the impact of returns, especially in GCC regions. Therefore, considering its importance, it is motivating to examine the dynamic relationship between global ESG indices and stock markets of GCC countries with the help of the TVP-VAR model because it captures time-varying relationships, allowing for more accurate modeling of evolving interdependencies.

3. Data and Methodology

3.1 Data

This study investigates the connectedness among ESG factors and stock market performance in the GCC region. For this purpose, we have used individual components of ESG, specifically the Environmental (STOXX global ESG Environmental Leader Index), Social (STOXX global ESG Social Leader Index), and Governance (STOXX global ESG Governance Leader Index). These indices are constructed using data from all STOXX Global 1800 index constituent firms. The choice of the environmental, social, and governance indices for this study is consistent with Wang et al. (2024). The GCC region comprises six countries and the he best-performing stock markets of these countries considered for analysis include ADX for the Abu Dhabi Stock Exchange, BAX for the Bahrain Stock Exchange, BKA for the Kuwait Stock Exchange, MSX for the Muscat Stock Exchange, QSI for the Qatar Stock Exchange, and TASI for the Saudi Stock Exchange. Daily data from the last eight years was collected from the globally accepted DataStream and the sample period categorically in three sections, including full sample (May 1, 2017 - December 31, 2023), pre-covid (May 1, 2017 - December 31, 2019) and post-covid (January 1, 2020 - December 31, 2023). Considering the research methodologies

of (Shaik & Rehman, 2023; Wang et al.,2024), the initial start of COVID-19 will be assumed from January 1, 2020. The returns of the ESG and GCC Stock indices have been computed by $R_{i,t} = (lnP_t - lnP_{t-1}) * 100$, while in Figure 1(a, b & c), returns trend analysis is represented over the time for the full sample, pre-covid and post covid.

Figure 1 (a) Trend Analysis of returns of ESG and GCC Indices – Full Sample (May 01, 2017 to Dec 31, 2023)

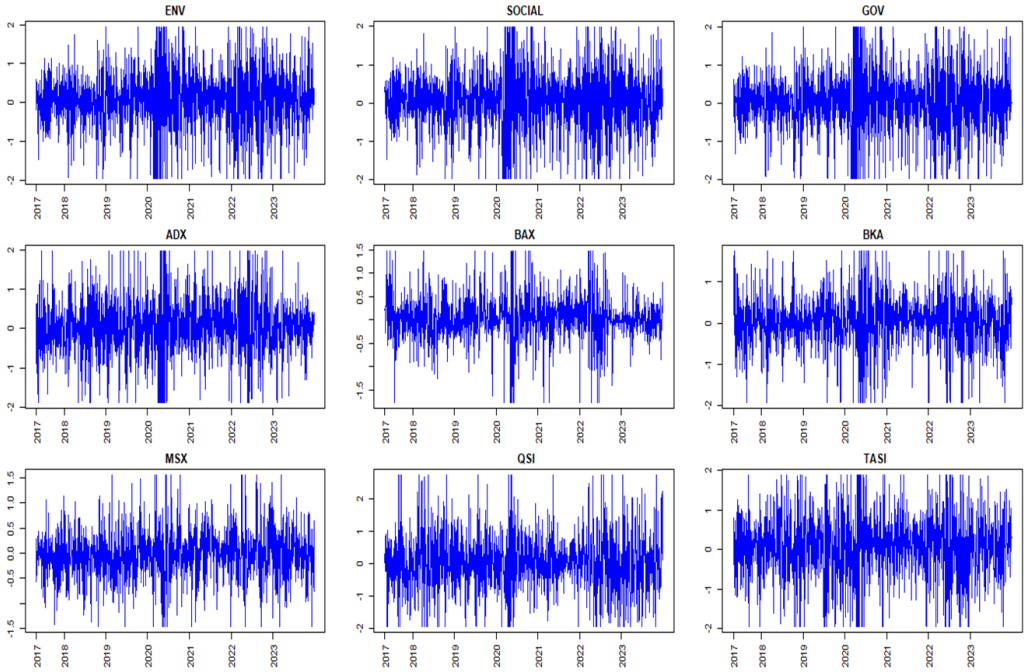


Figure 1(b) Trend Analysis of returns of ESG and GCC Indices – Pre-Covid (May 01, 2017 to Dec 31, 2019)

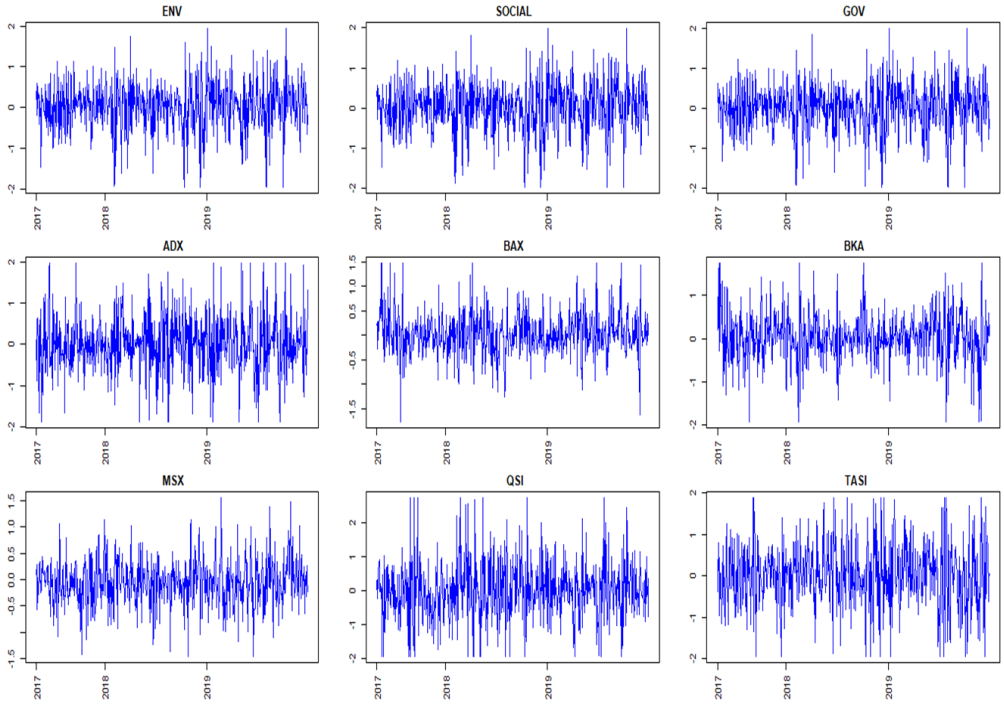
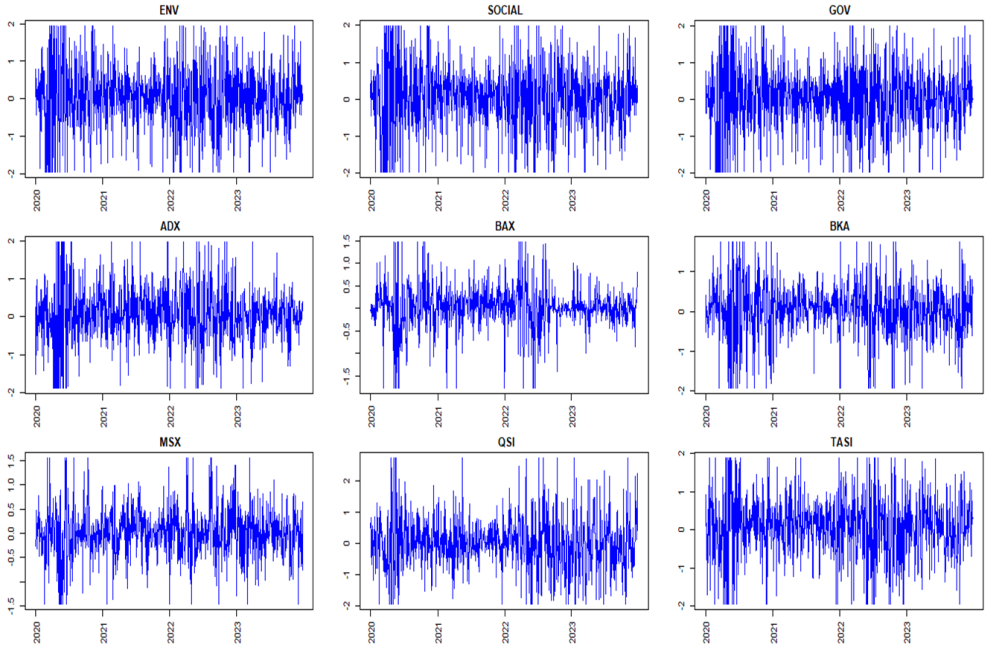


Figure 1 (c) Trend Analysis of returns of ESG and GCC Indices – Post-Covid (Jan 01, 2020 to Dec 31, 2023)



3.2 Methodology

In this study, the TVP-VAR model proposed by (Antonakakis et al., 2020) was applied to analyze the connectedness between ESG stocks and GCC stock markets. This technique has a competitive advantage over conventional connectedness methods (Diebold & Yilmaz, 2023), including eliminating the requirement of arbitrary window size selection and preserving critical information, making it ideal for analyzing short and low-frequency time series data sets. Furthermore, this methodology has been validated in the studies of time series connectedness between financial markets and various assets literature (Assaf et al., 2024; Bhattacherjee et al., 2024). The TVP-VAR model has been described as follows;

$$v_t = C_t v_{t-1} + u_t, \; u_t \sim N(0, \tau_t) \quad (1)$$

$$vec(C_t) = vec(C_{t-1}) + \gamma_t , \; \gamma_t \sim N(0, \epsilon_t) \quad (2)$$

In the above equations, v_t, v_t-1, and represent $n\times1$ dimensional vectors, while $\boldsymbol{C}_t$ and $\boldsymbol{\mathcal{T}}_t$ are $n\times n$ dimensional matrices. Moreover, $vec(\boldsymbol{C}_t)$ and $\boldsymbol{\gamma}_t$ are $n^2 \times1$ dimensional vectors, $\boldsymbol{\epsilon}_t$ and $n^2\times n^2$ is an $\times$ dimensional matrix. The variance-covariance matrices are presented as and , which may vary over time. In addition, the study applied the Generalized Forecast Error Variance Decomposition (GFEVD) for analyzing the pairwise directional connectedness, which is represented as follows;

$$\tilde{\theta}_{i,j}(h) = \frac{\sum_{t=1}^{h-1}((\Psi_k \sum_{\epsilon} e_j)_i)^2/\sigma_{jj}}{\sum_{k=0}^{h-1}((\Psi_k \sum_{\epsilon} \Psi'_k)_{ii})} \quad , \quad (3)$$

In equation 3, $(\Psi_k \sum_{\epsilon} e_j)_i$ expressed the i-th element of the vector $\Psi_k \sum_{\epsilon} e_j$, and $((\Psi_k \sum_{\epsilon} \Psi'_k)_{ii}$ expressed the i-th diagonal element of the matrix $\Psi_k \sum_{\epsilon} \Psi'_k$. Additionally, the total connectedness index (TCI) is measured by summing the off-diagonal elements of the connectedness matrix and normalizing the result by the total number of elements in the matrix. The equation is expressed as follows;

$$TCI(h) = \frac{1}{N}\sum_{i=1}^{N}\sum_{i=1,i\neq1}^{N}\theta_{i,j}(\mathrm{h}) \, , \quad (4)$$

In equation 4, N is the number of variables in the system, while the TCI expresses the average impact of shocks across all variables in the system. The "TO" connectedness represented the extent to which shocks in a particular variable i contribute to the forecast error variance of other variables j≠i. This equation is presented as follows;

$$C_{\mathrm{i}\rightarrow\cdot}(h) = \sum_{j=1, j\neq \mathrm{i}}^{N} \theta_{ji}(\mathrm{h}) \quad , \tag{5}$$

In equation 5, $C\mathrm{i}\rightarrow\cdot(h)$ expressed the total impact of variable i on all other variables over the forecast horizon h. Additionally, the "FROM" connectedness observed the extent to which the forecast error variance of a particular variable i is influenced by shocks from other variables j≠i. This equation is presented as follows;

$$C_{\cdot\rightarrow \mathrm{i}}(h) = \sum_{j=1, j\neq \mathrm{i}}^{N} \theta_{ij}(\mathrm{h}) \quad , \tag{6}$$

In equation 6, $C.\rightarrow\mathrm{i}(h)$ expressed the total impact of all other variables on variable i over the forecast horizon h. Furthermore, the "NET" connectedness is the difference between the "TO" and "FROM" connectedness, indicating whether a variable is a net transmitter or receiver of shocks. This equation is presented as follows;

$$C_i^{NET}(h) = C_{\mathrm{i}\rightarrow\cdot}(h) - C_{\cdot\rightarrow \mathrm{i}}(h) \quad , \tag{7}$$

In equation 7, $C_i^{NET}(h)$ elaborated on whether variable i is a net contributor or net recipient of forecast error variance over the forecast horizon h.

4. Empirical Analysis

4.1 Preliminary Analysis

Preliminary analysis was conducted to examine the normality of the data considering the descriptive statistics and initial results presented in Table 1 (full sample, pre-covid and post-covid). In Panel A, the descriptive statistics indicators are presented for the full sample period, from May 1, 2017, to December 29, 2023, for ESG and GCC stock indices. There are 1716 observations considered for this full sample analysis. Positive mean values indicated an upward trend in most indices except Muscat Stock Market. In contrast, the trend of high mean values, i.e., 0.047, 0.030, 0.037, and 0.047, remained persistent in UAE, Bahrain, Kuwait, and Saudi Arabia stock indices. In contrast, the highest levels of standard deviations, i.e., 0.793, 0.784, 0.847 and 0.792 indicated that investors should consider risk while making investment decisions. Moreover, the skewness and kurtosis values elaborated the normal distribution of the data. The findings underline the trade-off between prospective gains and related risks, thereby underlining the importance of a well-balanced and informed investment strategy.

In the case of the pre-COVID-19 period (Panel B), which includes the period from May 1, 2017, to December 31, 2019, a preliminary analysis was conducted in which a total of 686 observations were kept under analysis. Descriptive statistics showed that positive mean values indicated an upward trend in most of the indices except for the Muscat stock market, while the trend of high mean values i.e., 0.016, 0.031, 0.032, and 0.017 remained persistent in the environmental index and the stock indices of Bahrain, Kuwait, and Saudi Arabia. In contrast, the highest standard deviations i.e. 0.853 and 0.865 for the stock indices of Qatar and Saudi Arabia indicated that investors should consider risk factors while making investment decisions. Skewness and kurtosis showed the normality of the data, and risk measures illustrated their importance for developing well-balanced and informed investment strategies for the post-COVID-19 period, which includes January 1, 2020, to December 29, 2023, where there was a total of 1,030 observations. Descriptive statistics detailed that the highest mean values were maintained in the case of the UAE and the stock market, while the environmental, social, and governance indices of the risk markets remained at a high level, highlighting how to develop a well-diversified portfolio.

Table1: Descriptive Statistics

Preliminary Analysis

Variables	ENV	SOCIAL	GOV	ADX	BAX	BKA	MSX	QSI	TASI
Panel A: Full Sample (May 01, 2017 to Dec 29, 2023)									
nobs	1716	1716	1716	1716	1716	1716	1716	1716	1716
Minimum	-1.963	-1.985	-1.971	-1.886	-1.775	-1.935	-1.465	-1.955	-1.953
Maximum	1.936	1.981	1.993	1.967	1.470	1.746	1.552	2.733	1.879
1. Quartile	-0.399	-0.411	-0.422	-0.340	-0.176	-0.272	-0.270	-0.450	-0.417
3. Quartile	0.475	0.494	0.502	0.435	0.252	0.380	0.250	0.459	0.544
Mean	0.027	0.028	0.029	0.047	0.030	0.037	-0.010	0.018	0.047
Median	0.069	0.075	0.076	0.032	0.022	0.059	-0.008	0.006	0.070
Variance	0.597	0.630	0.614	0.528	0.210	0.403	0.226	0.717	0.627
Stdev	0.773	0.793	0.784	0.727	0.458	0.635	0.476	0.847	0.792
Skewness	-0.238	-0.203	-0.192	0.001	-0.277	-0.339	0.066	0.272	-0.170
Kurtosis	0.516	0.461	0.518	0.860	2.812	1.374	1.254	0.900	0.237
Panel B: Pre-Covid (May 01, 2017 to Dec 31, 2019)									
nobs	686	686	686	686	686	686	686	686	686
Minimum	-1.963	-1.985	-1.971	-1.886	-1.775	-1.935	-1.465	-1.955	-1.953
Maximum	1.936	1.981	1.993	1.967	1.470	1.746	1.552	2.733	1.879
1. Quartile	-0.314	-0.333	-0.335	-0.352	-0.210	-0.263	-0.302	-0.458	-0.420
3. Quartile	0.386	0.395	0.384	0.388	0.263	0.334	0.206	0.460	0.482
Mean	0.016	0.014	0.014	0.015	0.031	0.032	-0.053	0.008	0.017
Median	0.059	0.058	0.050	0.009	0.011	0.057	-0.054	-0.030	0.032
Variance	0.363	0.384	0.360	0.475	0.186	0.318	0.188	0.727	0.585
Stdev	0.602	0.620	0.600	0.689	0.431	0.564	0.433	0.853	0.765
Skewness	-0.386	-0.358	-0.363	-0.001	0.230	-0.210	0.022	0.345	-0.066
Kurtosis	0.957	0.850	0.978	0.787	1.684	1.407	0.884	0.892	0.227
Panel C: Post-Covid (Jan 01, 2020 to Dec 29, 2023)									
nobs	1030	1030	1030	1030	1030	1030	1030	1030	1030
Minimum	-1.963	-1.985	-1.971	-1.886	-1.775	-1.935	-1.465	-1.955	-1.953
Maximum	1.936	1.981	1.993	1.967	1.470	1.746	1.552	2.733	1.879
1. Quartile	-0.465	-0.486	-0.495	-0.328	-0.148	-0.276	-0.246	-0.444	-0.409
3. Quartile	0.551	0.578	0.578	0.467	0.244	0.412	0.283	0.456	0.592
Mean	0.034	0.037	0.039	0.068	0.030	0.041	0.019	0.025	0.067
Median	0.080	0.093	0.090	0.045	0.037	0.064	0.013	0.023	0.098
Variance	0.754	0.794	0.784	0.563	0.226	0.461	0.250	0.711	0.654
Stdev	0.868	0.891	0.886	0.750	0.475	0.679	0.500	0.843	0.809
Skewness	-0.206	-0.175	-0.165	-0.012	-0.527	-0.388	0.043	0.221	-0.236
Kurtosis	0.069	0.031	0.041	0.856	3.237	1.196	1.295	0.901	0.242

This table reports the descriptive statistics along with preliminary analysis for three periods: full sample, Pre COVID-19 and Post COVID-19.

Table 2 presented the correlation matrices for three different sample periods. In the case of Panel-A, the sample period of the full sample considered from May 1, 2017, to December 29, 2023, was examined, which reported that there are highly significant and positive correlations between environmental and social indices and social and governance indices with a value of 0.991 and 0.993 respectively. While a moderate and weak relationship was found between GCC stock markets, it was shown to be significant. Findings remain consistent with past study where significant and positive correlation was examined among ESG and stock market performance (Deng & Cheng, 2019). In Panel B, the pre-Covid sample period from May 1, 2017, to December 31, 2019, reported a high level of significant and positive correlation between environment and social with a value of 0.99, while the relationship between social and governance remained persistent for 0.99. Regarding internal correlation between GCC indices, mixed results were found with weak and moderate correlations. Furthermore, Panel C considered the sample period from January 1, 2020, to December 29, 2023, where strong positive correlations were found between ESG indicators and the environmental-to-social correlation remained at the level of 0.992, while the social-to-governance correlation remained at the highest level of 0.994. The internal correlation in GCC indices remained at a moderate level. These correlation results suggest that while ESG indices exhibit strong interrelationships, the dynamics across GCC countries may be influenced by several factors, including global events. Investors should carefully consider these correlations to make informed decisions regarding portfolio diversification and risk management strategies.

Table2: Correlation Matrix

Panel A: Full Sample (May 01, 2017 to Dec 29, 2023)									
	ENV	SOCIAL	GOV	ADX	BAX	BKA	MSX	QSI	TASI
ENV	1.000	0.991*	0.987	-0.018*	0.027*	0.025*	-0.047*	0.022*	-0.03*
SOCIAL	0.991*	1.000	0.993*	-0.016*	0.029*	0.024*	-0.047*	0.019*	-0.027*
GOV	0.987	0.993*	1.000	-0.018*	0.029*	0.023*	-0.043*	0.015*	-0.020
ADX	-0.018*	-0.016*	-0.018*	1.000	-0.046*	0.038*	0.008*	0.108	0.097*
BAX	0.027*	0.029*	0.029*	-0.046*	1.000	0.108*	0.040	0.021*	0.002*
BKA	0.025*	0.024*	0.023*	0.038*	0.108*	1.000	0.068*	-0.002*	-0.046*
MSX	-0.047*	-0.047*	-0.043*	0.008*	0.040	0.068*	1.000	-0.013*	-0.006*
QSI	0.022*	0.019*	0.015*	0.108	0.021*	-0.002*	-0.013*	1.000	0.126*
TASI	-0.03*	-0.027*	-0.020	0.097*	0.002*	-0.046*	-0.006*	0.126*	1.000
Panel B: Pre-Covid (May 01, 2017 to Dec 31, 2019)									
ENV	1.000	0.99*	0.988	0.019*	0.026*	-0.019*	0.004*	0.054*	-0.048*
SOCIAL	0.99*	1.000	0.99*	0.012*	0.027*	-0.026*	0.001*	0.044*	-0.042*
GOV	0.988	0.99*	1.000	0.011*	0.025*	-0.024*	-0.002*	0.044*	-0.036
ADX	0.019*	0.012*	0.011*	1.000	0.024*	0.025*	-0.022*	0.150	0.043*
BAX	0.026*	0.027*	0.025*	0.024*	1.000	0.044*	0.034	-0.014*	0.065*
BKA	-0.019*	-0.026*	-0.024*	0.025*	0.044*	1.000	0.038*	-0.039*	-0.079*
MSX	0.004*	0.001*	-0.002*	-0.022*	0.034	0.038*	1.000	0.01*	-0.042*
QSI	0.054*	0.044*	0.044*	0.150	-0.014*	-0.039*	0.01*	1.000	0.116*
TASI	-0.048*	-0.042*	-0.036	0.043*	0.065*	-0.079*	-0.042*	0.116*	1.000

Panel C: Post-Covid (Jan 01, 2020 to Dec 29, 2023)									
ENV	1.000	0.992*	0.986	-0.035*	0.027*	0.042*	-0.069*	0.007*	-0.022*
SOCIAL	0.992*	1.000	0.994*	-0.029*	0.03*	0.044*	-0.068*	0.007*	-0.022*
GOV	0.986	0.994*	1.000	-0.031*	0.032*	0.04*	-0.061*	0.002*	-0.014
ADX	-0.035*	-0.029*	-0.031*	1.000	-0.084*	0.045*	0.02*	0.081	0.127*
BAX	0.027*	0.03*	0.032*	-0.084*	1.000	0.14*	0.043	0.042*	-0.034*
BKA	0.042*	0.044*	0.04*	0.045*	0.14*	1.000	0.082*	0.018*	-0.03*
MSX	-0.069*	-0.068*	-0.061*	0.02*	0.043	0.082*	1*	-0.027*	0.011*
QSI	0.007*	0.007*	0.002*	0.081	0.042*	0.018*	-0.027*	1.000	0.131*
TASI	-0.022*	-0.022*	-0.014	0.127*	-0.034*	-0.03*	0.011*	0.131*	1.000

This table reports the Pearson correlation between the ESG and GCC equity market for three periods: full sample, Pre COVID-19 and post-COVID-19.

Note. represents significance at 5%

4.2 Returns Spillover effect

Return spillover connectedness is referred to in Table 3, which indicates the transmission of shocks from ESG to GCC stock indices, which were assessed through TVP-VAR models (Diebold & Yilmaz, 2023). The analysis is presented categorically for three different sample time periods where the values are present in percentage format to elaborate the spillover dynamics. Over the full sample period, which includes May 1, 2017, to December 29, 2023, the environmental, social, and governance indices indicated a transmission behavior of 33.26%, 32.50%, and 32.31%, respectively. These spillover effects are comparable to the pairwise spillover effects between ESG indices, while stock indices in the GCC region are interconnected to a lesser extent (Alazzani et al., 2021; Alghafes et al., 2024). However, the Muscat Stock Exchange has indicated 91.63% with the highest level of self-spillover, meaning that past shocks affect their returns. Among the GCC stock markets, the Bahrain stock market has dominated in terms of "TO" spillover to the system, amounting to 10.53%. In contrast, the Muscat stock market attributed lesser "TO" spillover to the system, amounting to 6.28%. On the other hand, ESG stocks indicated net transmitter behavior in the full sample, especially in the pre-COVID and post-COVID analysis. In contrast, in GCC stock indices, they remained net receivers within the system. The Total Connectedness Index (TCI) remained at 29.49%, indicating a moderate level of connectivity (Figure 2). The findings remained consistent with the previous literature. Cagli et al. (2023) and Wang and Esperança (2023) reported that ESG and developed equity markets are highly interconnected and may report a moderate correlation with other assets and markets.

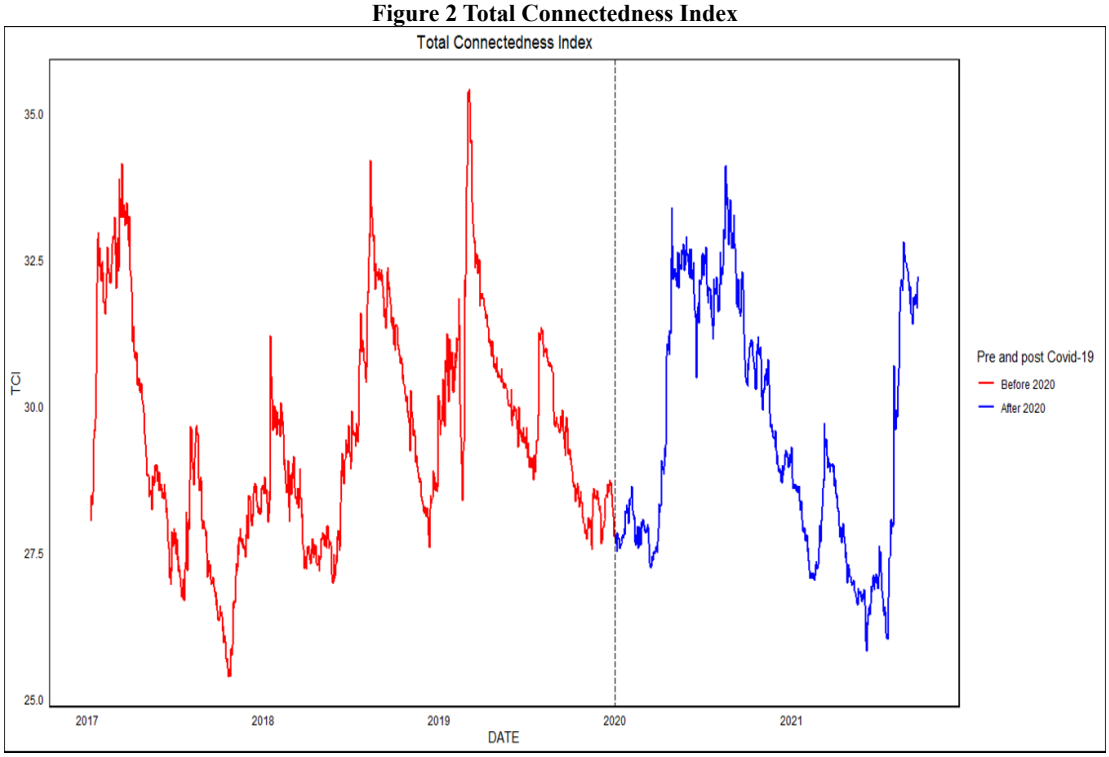
Panel-B presented the return spillover connectedness for the pre-COVID-19 period, where the sample period remained under analysis from May 1, 2017, to December 31, 2019. Here, the results, such as Panel A, indicated that the ESG indices remained as net transmitters to the system and self-spillover effects amounting to 33.32%, 32.54%, and 32.43%, respectively. At the same time, all GCC stock markets have shown net receiver behavior from the system. The overall TCI was posited as 29.22%, showing a moderate level of connectivity. Panel C presented the spillover returns connectedness for the post-COVID-19 period, which includes January 1, 2020, to December 29, 2023, where the ESG indices remained as net transmitters to the system and spillover effects amounting to 33.13%, 32.40%, and 32.15% respectively (Figure 3). Moreover, the GCC stock markets have shown a net receiver behavior from the system consistent for the pre-COVID-19 and full-sample periods. The TCI for the post-COVID-19 period remained at 30.11%, indicating moderate connectedness.

Table 3: Returns Spillover

Panel A: Full Sample May 01, 2017 to Dec 29, 2023)										
Variable	ENV	SOCIAL	GOV	ADX	BAX	BKA	MSX	QSI	TASI	FROM
ENV	33.26	32.57	32.24	0.28	0.28	0.42	0.4	0.27	0.3	66.74
SOCIAL	32.5	33.1	32.5	0.28	0.27	0.4	0.39	0.26	0.3	66.9
GOV	32.31	32.65	33.13	0.29	0.27	0.43	0.35	0.26	0.3	66.87
ADX	0.65	0.65	0.65	89.95	2.14	0.76	1.01	2.5	1.68	10.05
BAX	0.93	0.97	0.93	1.7	87.63	4.84	1.21	0.89	0.91	12.37
BKA	0.97	0.89	0.89	1.15	4.6	87.91	1.36	1.05	1.18	12.09
MSX	1.18	1.2	1.28	0.79	1.1	1.26	91.63	0.75	0.82	8.37
QSI	1.29	1.17	1.17	3.15	0.92	0.7	0.76	88.9	1.94	11.1
TASI	0.79	0.85	0.8	1.47	0.95	1.08	0.8	4.16	89.1	10.9
TO	70.62	70.96	70.45	9.1	10.53	9.89	6.28	10.14	7.42	265.39
Inc.Own	103.88	104.06	103.58	99.05	98.16	97.8	97.91	99.05	96.52	cTCI/TCI
NET	3.88	4.06	3.58	-0.95	-1.84	-2.2	-2.09	-0.95	-3.48	33.17/29.49
Panel B: Pre-Covid (May 1, 2017 to Dec 31, 2019)										
ENV	33.32	32.53	32.33	0.32	0.28	0.31	0.4	0.24	0.26	66.68
SOCIAL	32.54	33.24	32.46	0.34	0.29	0.28	0.37	0.23	0.24	66.76
GOV	32.43	32.56	33.21	0.33	0.3	0.34	0.37	0.23	0.24	66.79
ADX	0.72	0.78	0.75	89.89	2.5	0.66	0.55	2.93	1.22	10.11
BAX	0.98	1.06	1.01	1.99	88.69	2.92	1.37	0.82	1.17	11.31
BKA	1.4	1.23	1.2	0.8	1.61	89.77	0.98	1.43	1.58	10.23
MSX	1.3	1.27	1.45	0.97	1.32	1.74	90.35	0.68	0.91	9.65
QSI	1.69	1.5	1.45	2.39	0.52	0.78	0.42	89.6	1.66	10.4
TASI	1.21	1.27	1.14	1.15	1.28	1.45	0.95	2.59	88.97	11.03
TO	72.26	72.2	71.79	8.29	8.09	8.49	5.42	9.14	7.28	262.97
Inc.Own	105.58	105.44	105	98.18	96.78	98.26	95.77	98.74	96.25	cTCI/TCI
NET	5.58	5.44	5	-1.82	-3.22	-1.74	-4.23	-1.26	-3.75	32.87/29.22
Panel C: Post-Covid (Jan 01, 2020 to Dec 29, 2023)										
ENV	33.14	32.53	32.1	0.27	0.26	0.52	0.45	0.38	0.34	66.86
SOCIAL	32.4	32.93	32.47	0.27	0.25	0.51	0.46	0.36	0.35	67.07
GOV	32.15	32.65	33.01	0.28	0.25	0.52	0.38	0.37	0.36	66.99
ADX	0.63	0.61	0.64	89.73	1.98	0.84	1.47	2.16	1.93	10.27
BAX	1.1	1.13	1.08	1.6	85.8	6.16	1.11	1.09	0.93	14.2
BKA	0.82	0.81	0.81	1.66	6.28	85.51	2.2	0.88	1.03	14.49
MSX	1.16	1.22	1.2	0.63	1.08	0.9	92.11	0.76	0.95	7.89
QSI	0.87	0.8	0.82	4.8	1.43	0.62	1.01	87.67	1.98	12.33
TASI	0.51	0.57	0.58	1.82	0.76	0.96	0.65	5.07	89.09	10.91
TO	69.64	70.33	69.7	11.33	12.29	11.03	7.73	11.07	7.88	271.01
Inc.Own	102.79	103.26	102.72	101.06	98.09	96.54	99.83	98.74	96.97	cTCI/TCI
NET	2.79	3.26	2.72	1.06	-1.91	-3.46	-0.17	-1.26	-3.03	33.88/30.11

This table reports the returns spillover between the BRICS equity market and Cryptos for three periods: full sample, Pre COVID-19 and post-COVID-19.

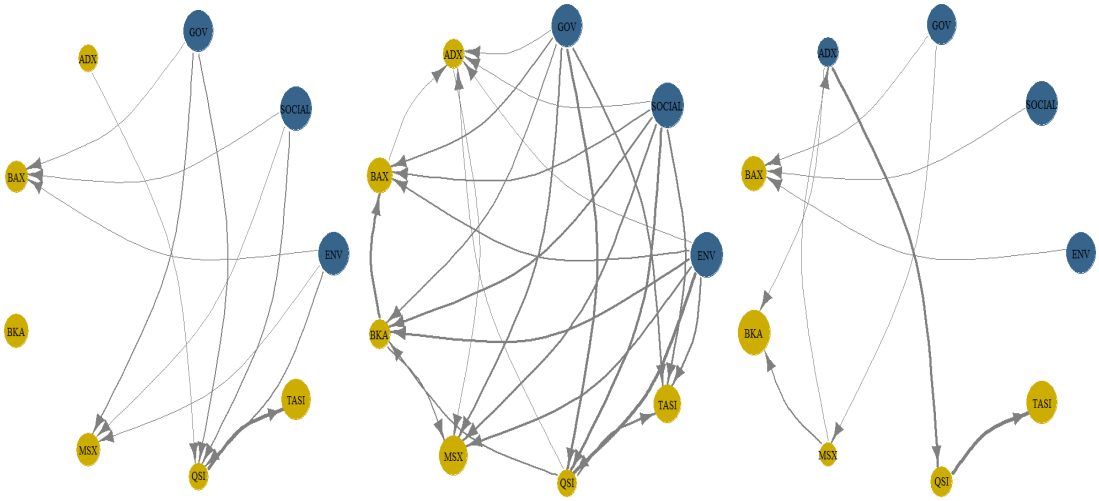
Figure 2 Total Connectedness Index



Note. This figure displays the time varying total connectedness of the system.

Where higher values correspond to a higher level of connectedness among the variables.

Figure 3 Net pair wise directional return spillover



(a) Full sample (b) Pre-Covid-19 (c) Post-Covid-19

Note. These figures demonstrated the net pair wise return spillover among ESG and GCC equity indices for three different periods.

This study's results align with the findings of historical research studies showing that there have been implications and traditions for investors and policymakers to diversify their portfolios and set asset policies considering economic vulnerabilities. This is valuable information for policymakers, particularly when developing and implementing their investment and financing plans. The observed interconnection implies that measures to improve asset availability in a particular financial market may have substantial spillover effects in the contemporary global scenario. Furthermore, during the COVID-19 era, which can be considered a valuable case study, there has been a remarkable flexibility in the overall connectivity between stock markets. This phenomenon can be examined to gain insights into enhancing stability and mitigating systemic risks in times of crisis. Financial institutions and investors can analyze the observed patterns and formulate their investment strategies accordingly. Still, they may also need to review their risk models and consider any alterations in market dynamics.

5. Conclusions, Implications and Limitations

5.1 Conclusions

The main objective of this study was to find a static connection between ESG factors and GCC stock indices, where the sample period includes the full sample (May 1, 2017, to December 31, 2023), pre-COVID-19 (May 1, 2017, to December 31, 2019) and post-COVID-19 (January 1, 2020, to December 31, 2023). An initial trend analysis was performed to analyze the graphical behavior of returns on daily data from 2017 to 2023, followed by a comprehensive statistical analysis, including preliminary analysis through descriptive statistics, correlation matrices, and returns spillover analysis; it has been sought to unravel the interconnection and patterns within these both markets. In comparison, a moderate level of mean returns was observed throughout the sample period for ESG and GCC, with a high level of standard deviation indicating the volatile behavior of the markets. Furthermore, significant correlation levels were found between ESG and GCC, while a strong positive correlation was observed among environmental, social, and governance indices. Different spillover effects were found for the full sample, pre-covid and post-covid for the markets. At all levels, the environmental, social, and governance indices posited the transmission behavior towards the system, and the GCC stock markets were found as receivers. During the post-COVID period, the level of interconnected spillover among GCC stock markets remained at a lower level, which may be the reason why energy and oil consumption declined, and the crisis gripped the global economic world, which has significant implications for establishing diversified portfolios.

5.2 Implications of the Study

The findings of this study have important practical, managerial, and theoretical implications for stakeholders. It is initially important for institutional investors, portfolio managers, and financial analysts interested in diversifying their portfolios by considering the ESG aspects of GCC stock markets. ESG indices have clarified that they can serve as shock absorbers or amplifiers during market volatility and that investors can seek benefits in the transmission dynamics of shocks to mitigate risks. Secondly, for corporate managers, especially in the GCC region, the findings of this study underscore the growing importance of ESG practices in shaping market behavior and investor sentiment. Positive correlations between environmental, social, and governance indices suggested that companies should prioritize integrating ESG principles into their strategic frameworks to attract responsible investments and enhance market resilience. Managers should also recognize that their markets receive shocks from ESG indices, requiring better risk management to mitigate global economic instability, especially in energy-dependent economies. Finally, the study contributes significantly to the theoretical literature by providing empirical evidence on the dynamic spillover connectedness of ESG factors and stock market indices, particularly in the context of GCC countries, which have been underrepresented in previous studies. Furthermore, the findings strengthen the theoretical discourse on how ESG factors can act as transmitters of market shocks, offering a significant perspective for future research on the interconnectedness of ESG factors and the financial market.

5.3 Limitations and Future Directions

Despite the valuable insights provided by this study, few limitations have been recognized to contextualize its findings. The period was limited and can be extended in future studies to understand the evolving role of ESG better and address long-term structural changes. This study only considered the GCC region, while cross-regional studies could provide more comprehensive

and generalized insights in future studies. The TVP-VAR model effectively captures dynamic spillover effects but may not account for potential nonlinearities in market relationships. Therefore, in future studies, more advanced models, including Markov-Switching VAR (MS-VAR), Nonlinear Autoregressive Distributed Lag (NARDL), Machine Learning Models (LSTM and Random Forest), and the GARCH models along with their variants, may provide more robust results. Future studies could investigate the sector-specific effects of ESG factors on equity markets, particularly in industries highly exposed to environmental risks, such as energy or mining.

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