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Article

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Dynamic nexus between Sharia and ESG indices and ETFs in India

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ABSTRACT

This study aims to uncover interdependencies between two distinctive but increasingly influential dimensions in contemporary finance, namely, Environmental, Social, and Governance (ESG) and Sharia guidelines. We examine the long-term association between ESG and Sharia indices, along with ESG and Sharia Exchange-Traded Funds (ETFs) for the Indian market. We do this by employing Cointegration, Vector Auto-regression (VAR), Granger causality and dynamic connectedness analyses. We found a lack of cointegration between both the ESG and Sharia indices and ETFs. Second, we observed bi-directional causality between the chosen ESG and Sharia index and ETF pairs. Subsequently, the level of dynamic connectedness was found to be consistently high. We find that ETFs are recipients of return spillovers from the indices. In terms of applicability of findings, traders can devise hedging strategies and short-term trading scenarios based on dynamic connectedness analysis. The lack of cointegration may be attributable to the difference in the underlying asset composition of ESG and Sharia indices and ETFs. This suggests that while Sharia-based instruments cannot be a substitute for ESG-based instruments, they can be seen as a complementary asset class. Finally, this complementarity can contribute to a greater understanding of how Islamic finance principles align or diverge from ESG considerations, providing valuable insights for investors, financial institutions, and policymakers.

IMPACT STATEMENT

This study sheds light on the relationship between ESG and Sharia based financial instruments. By analysing data of ESG and Sharia based indices and ETFs from India, the research reveals that indices are transmitters and the ETFs are receivers of spillovers. The findings also show the dynamic nature of connectedness between instruments over time. Most importantly, both types of instruments can act as complementary asset classes for investors. Hence, these observations have significant ramifications for financial institutions who specialise in designing financial indices and investment instruments, such as ETFs.

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Finance; Economics;
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1. Introduction

In recent years, there has been a growing interest in socially responsible and sustainable investment strategies in global financial markets. Investors, corporations, and policymakers are increasingly recognizing the importance of aligning financial practices with ethical, social, and environmental considerations. Two prominent frameworks in this context are the guidelines offered by Environmental, Social, and Governance (ESG) guidelines and Islamic Sharia Law. This study aims to delve into the relationship between these two frameworks, shedding light on the potential associations and implications for investors and financial markets.

The need for such a study stems from the expanding influence of Sharia-compliant investments and the rising importance of ESG considerations in investment decision-making. Sharia-compliant investments adhere to Islamic principles and ensure compliance with ethical and religious norms. The ESG

guidelines evaluate companies based on environmental sustainability, social responsibility, and governance practices. While these frameworks appear to operate on distinct principles, there are lacunae in the academic literature on the potential intersections and divergences between them. This study is important because it can help inform various stakeholders about the relationship between Sharia and ESG-based investment instruments. This research addresses a critical gap in the literature by exploring the potential common ground or divergence between the Sharia and ESG criteria. In other words, this study measures the extent of association between ESG-based equity indices and Sharia-based indices. In addition, we sought to measure the association between ESG and Sharia based Exchange Traded Funds (ETFs). For this analysis, we chose the ESG and Sharia indices and ETFs available in the Indian Market. This choice is based on the fact that India is among the fastest growing economies in the recent past. As a developing economy, India also has to balance domestic growth with the global transition towards 'Principles of Responsible Investment' (UNPRI, 2006). More importantly, in the endeavour to grow the economy faster, India needs access to more capital. On the other hand, many Arab nations seek avenues to invest their surplus capital from their crude oil exports. However, Islamic tenets require such investments to follow Sharia guidelines. This is where the Indian Government and corporate sector are proactively working to increase trade and attract investments from Islamic nations. The Gulf Cooperation Council (GCC) is a regional, intergovernmental, political, and economic union comprising of several Islamic nations from middle east. As a collective entity, GCC poses a significant opportunity for India. In the recent past, GCC has emerged as an important non-crude oil based trading partner and investor for India with huge future potential. GCC countries are also host to many Indian workers. While trade has virtually doubled between India and GCC nations since 2020-21 (EoI, 2024), bilateral investment has also increased. Saudi Arabia-based Public Investment Fund (PIF) have invested in large Indian ventures, such as Reliance retail (USD 1.3 billion) and Jio Infocomm (USD 1.5 billion) (Reuters, 2020). Recently, a joint working group to channelise USD 100 billion of investment from Saudi Arabia to India has been setup and Saudi Arabia plans to set up an office of its sovereign wealth fund in India (HT, 2023; Reuters, 2023). With these new developments in view, we believe that research on exploring the potential association between Sharia and ESG guidelines in the Indian market is necessary.

It is well known that Islamic finance is a prominent domain in the World Economy. Islamic financial assets under management grew by 11% to USD 4.5 trillion in 2022 (IFDI, 2023). It is estimated that India has the third largest Muslim population in the World¹. This presents a huge potential for growth of Sharia based instruments for both Indian citizens and foreign investors looking to benefit from the growing Indian economy. As of July 2024, only one ESG ETF and one Sharia based ETF are available in the Indian market. Hence, we believe that an analysis to understand the association between ESG and Sharia indices and ETFs would be extremely useful in several ways. First, such an analysis can guide current investors in constructing more diversified and ethically aligned portfolios, thereby fostering sustainable financial practices. In addition, as investor interest grows and more financial instruments based on the ESG and Sharia frameworks are introduced, financial institutions and regulators can benefit from understanding the underlying dynamics of these frameworks.

This analysis has the following research questions:

1. Is there a long-term association between Sharia and ESG indices in the Indian market?
2. Is there a long-term association between Sharia and ESG ETFs in the Indian market?
3. If not, what is the extent of short-term association between the Sharia and ESG index and ETF pairs?

In terms of methodology, we test for the existence of long-term association using cointegration testing between ESG and Sharia indices and ETFs. In the absence of cointegration, the short-term association is measured via Vector Auto-Regression (VAR) modeling and test for Granger causality between instruments. Subsequently, we use the dynamic connectedness method to measure the extent of the return spillovers between various instruments. We found a lack of cointegration between both ESG and Sharia indices and also ESG and Sharia ETFs. However, there is evidence of short-run bidirectional causality between the ESG and Sharia indices and ETFs. This was also corroborated by the consistent and high level of connectedness between the ESG and Sharia indices and ETFs. Finally, ETFs are recipients of

return spillovers from the indices. This study contributes to the literature by shedding light on the dynamic association between these financial instruments. Such insights can help stakeholders increase their awareness of how ESG guidelines may align or conflict with Sharia principles in the realm of financial markets.

Section 2 discusses the extant literature and emphasizes the contributions of this research. Section 3 provides the theoretical framework for econometric analyses. Section 4 provides details on the data used and explains the results of the analyses. Section 5 interprets and provides potential causes of the results with potential avenues of future research. Finally, Section 6 explains the relevance and usefulness of the findings for various stakeholders, based on contemporary developments in financial markets.

2. Review of literature

A comprehensive review of the existing literature reveals a burgeoning body of research on both Sharia-compliant and ESG investments. We classify the extant literature in four categories. First, work on Sharia finance is reviewed. Next, ESG based analyses are summarised. At the third stage, we look at studies on analysing the potential overlap between Sharia and ESG frameworks. Finally, we look at any related studies specifically for the Indian market.

It is known that Sharia finance finds its roots in Islamic tenets. Literature on Sharia finance ranges from studies on Islamic banking, investments and capital markets. A important aspect of literature on Sharia finance is based on comparison with conventional financial practices. Studies can be further categorised into accounting standards, corporate finance, banking and characteristics of financial instruments (Khan et al., 2021). Various studies look at the risk-return profiles of Sharia Finance and related assets with traditional market indices and instruments. Findings highlight the growing importance of Islamic finance and its positive impact on financial performance (Haddad & Souissi, 2022; Jaballah et al., 2018; Karimov et al., 2020; Rabbani et al., 2023; Salisu & Shaik, 2022; Sandwick & Collazzo, 2021; Shaharuddin et al., 2017). Newer studies look at the adoption of fintech in Islamic finance towards goals like financial inclusion and literacy (Alshater et al., 2022).

ESG guidelines find their roots in Corporate Social Responsibility (CSR) initiatives (Matos, 2020; Rau & Yu, 2024). A similar pattern emerges when we look at the literature on ESG. Literature can be categorised into strands ranging from financial reporting to performance of firms and ESG-based financial assets versus conventional assets and indices (Cerqueti et al., 2021; Giese et al., 2019; Shaik & Rehman, 2023; Umar et al., 2020; Wen et al., 2022). The findings underscore that ESG disclosure quality is positively linked to increased firm value and reduced systemic risk. Both threads have branched into various country-level studies to compare and contrast regional differences (Alsharif, 2021; Cao et al., 2023; Chen et al., 2024; Ishak et al., 2022; Van Nguyen et al., 2022). Most studies highlight the positive benefits of ESG- or Sharia-based assets over conventional assets for investors and stakeholders.

However, limited attention has been paid to the potential correlations and interplay between Sharia and ESG criteria. A few studies compare ESG-based compliance or financial performance between Sharia and conventional assets (Ghaemi Asl et al., 2023; Katterbauer et al., 2024; Lee & Isa, 2023; Qoyum et al., 2021, 2022). The findings highlight the superior ESG performance of Islamic assets over conventional assets or indices. Nevertheless, the convergence of these two dimensions remains an under-explored area, and very few studies have analysed the intersection between Sharia and ESG criteria. Even among these, prior work analyses the risk and additional cost of compliance for portfolios (Erragragui & Revelli, 2016; Hassan et al., 2021; Paltrinieri et al., 2020; Peng & Isa, 2020). van Aaken & Buchner (2020) provide a survey of work at the intersection of various religious norms and Corporate Social Responsibility. The most related work was done by Naeem et al. (2023), who studied the connectedness between various Islamic, sustainability and conventional equity markets using MSCI and Dow Jones Sustainability indexes. The authors find varying levels of connectedness across several markets and cross-country spillovers. Our analysis is different from this in several ways. First, our analysis does not measure cross-country spillovers. Second, we use domestic Sharia indices and ESG indices prepared by National Stock Exchange (NSE) of India and also ETFs based on these domestic indices. This distinction is important since results can be dependent on the manner of design of the underlying index and/or choice of underlying assets in the index.

When it comes to extant literature on Islamic finance in the Indian context, we found very few studies that appear to focus on the relative performance of Sharia based instruments with the conventional market indices. Most extant literature is based on analyses of either developed markets or Islamic nations (Alam & Ansari, 2020; Dharani et al., 2019; Kalimuthu & Shaik, 2024). Hence, our analysis contributes to the extant literature in three ways. The most important contribution of our analysis is to address the critical gap in understanding the potential long term association between the two frameworks of Sharia and ESG. The implication is to show whether Sharia and ESG frameworks are substitutable or complementary. The second contribution is to show the direction of information spillover between the index and ETF pairs. Finally, our analysis adds to the literature of Sharia and ESG Finance, thereby contributing to a more holistic understanding of sustainable and ethical investment practices in the Indian market.

3. Theoretical framework

3.1. Cointegration and vector autoregression

We employ two related methodologies cointegration and connectedness to measure the association between ESG and the Sharia indices and ETFs. The cointegration analysis is a well established methodology to prevent wrong interpretations of spurious correlation between two or more non-stationary time series. Moreover, it can assist in measuring the rate of correction in situations of disequilibrium in the system. If a linear combination of a set of time-series variables, which are integrated of order d , is integrated of order less than d , then the time-series variables are said to be cointegrated with each other. The detection of cointegration leads to an estimation of an error correction model, which helps to estimate the short and long-term effects of one variable on another.

For a set of two variables, the error correction model is estimated as

$$\Delta y_t = y_0 \Delta x_t - (1 - \alpha_1)[y_{t-1} - \beta_0 - \beta_1 x_{t-1}] + \epsilon_t \quad (3.1)$$

Here, $(1 - \alpha_1)$ denotes the speed of adjustment, and $y_{t-1} - \beta_0 - \beta_1 x_{t-1}$ measures the extent of disequilibrium. In the absence of cointegration, VAR is used to measure the relationship between variables over time. We estimate the p th-order VAR model as follows:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \epsilon_t \quad (3.2)$$

As robustness checks, we conduct the cointegration and VAR estimations with various lag lengths returned as per Akaike Information Criterion (AIC), Schwarz Criterion (SC) and Hannan Quinn (HQ). Residuals were tested for autocorrelation to ensure that the estimated model was a good fit.

3.2. Connectedness

The connectedness methodology is related to the forecast error variance decomposition (FEVD) for a p th order VAR for a set of variables (Diebold & Yilmaz, 2009, 2012; Diebold & Yilmaz, 2014). While Antonakakis et al. (2020) used a combination of TVP-VAR approach of Koop & Korobilis (2014) and connectivity approach of (Diebold & Yilmaz, 2012; Diebold & Yilmaz, 2014), Chatziantoniou & Gabauer (2021) present a TVP-VAR-based spectrum connectivity method that extends Baruník & Krehlík (2018) approach. Thus, the representation of an order one TVP-VAR model is as follows:

$$Y_t = \beta_t Y_{t-1} + \epsilon_t; \quad \epsilon_t | F_{t-1} \sim N(0, S_t) \quad (3.3)$$

$$\text{vec}(\beta_t) = \text{vec}(\beta_{t-1}) + \nu_t; \quad \nu_t | F_{t-1} \sim N(0, \Xi_t) \quad (3.4)$$

where Y_t is an endogenous variable vector ($N \times 1$); where ϵ_t ($N \times 1$) is the perturbation with variance-covariance matrix of size ($N \times N$), S_t ; β_t is the VAR coefficient matrix ($N \times N$); ν_t is an $N^2 \times 1$ perturbation vector with variance-covariance matrix ($N^2 \times N^2$), Ξ_t ; $\text{vec}(\beta_t)$ is the vector form of β_t .

The TVP-VAR is recast into a Vector Moving Average representation (or VMA) to obtain the generalised FEVD (GFEVD) as follows:

$$Y_t = \sum_{j=0}^{\infty} A_{jt} \epsilon_{t-j} \quad (3.5)$$

Where A_{jt} is an $N \times N$ dimensional matrix that follows the ordinary Wald representation theorem. Consequently, the unscaled GFEVD ($\theta_{ij,t}^g(H)$) is defined as

$$\theta_{ij,t}^g(H) = \frac{s_{ii,t}^{-1} \sum_{t=1}^{H-1} (e_i' A_t S_t e_j)^2}{\sum_{j=1}^k \sum_{t=1}^{H-1} (e_i' A_t S_t A_t' e_i)} \quad (3.6)$$

To ensure that each row sums to one, meaning that the selected variable explains all the variance of the error of i , we compute a scaled GFEVD ($\tilde{\theta}_{ij,t}^g(H)$) as

$$\tilde{\theta}_{ij,t}^g(H) = \frac{\theta_{ij,t}^g(H)}{\sum_{j=1}^N \theta_{ij,t}^g(H)} \quad (3.7)$$

where, $\sum_{j=1}^N \theta_{ij,t}^g(H) = 1$; $\sum_{i,j=1}^N \tilde{\theta}_{ij,t}^g(H) = k$; $\tilde{\theta}_{ij,t}^g(H)$ measures bidirectional connectedness from component j to component i at perspective H .

The GFEVD is used to calculate various connectedness factors, such as the overall directional connectedness of variable i to other variables ($C_{\blacksquare \leftarrow i,t}(H)$) in 3.8, overall directional connectedness of all variables to variable i ($C_{i \leftarrow \blacksquare,t}(H)$) in 3.9, net total directional connectedness ($C_{i,t}(H)$) in 3.10, and pairwise directional connectedness ($C_{ij,t}$) in 3.11 (Diebold & Yilmaz, 2014).

$$C_{\blacksquare \leftarrow i,t}(H) = \frac{\sum_{j=1, j \neq i}^N \tilde{\theta}_{ji,t}^g(H)}{\sum_{i,j=1}^N \tilde{\theta}_{ji,t}^g(H)} \times 100 \quad (3.8)$$

$$C_{i \leftarrow \blacksquare,t}(H) = \frac{\sum_{j=1, j \neq i}^N \tilde{\theta}_{ji,t}^g(H)}{\sum_{i,j=1}^N \tilde{\theta}_{ji,t}^g(H)} \times 100 \quad (3.9)$$

$$C_{i,t}(H) = C_{\blacksquare \leftarrow i,t}(H) - C_{i \leftarrow \blacksquare,t}(H) \quad (3.10)$$

$$C_{ij,t}(H) = C_{i \leftarrow j,t}(H) - C_{j \leftarrow i,t}(H) \quad (3.11)$$

If $C_{ij,t} > 0$ ($C_{ij,t} < 0$), this implies that variable i exerts an influence on (or is influenced by) variable j more than being affected by (or influencing) it. An additional relevant statistic that shows the degree of network interconnectivity and, hence, market risk is the total connectedness index (TCI) (Rabbani et al., 2023). Subsequently, Chatziantoniou & Gabauer (2021) and Gabauer (2021) shows that the TCI is within $[0, (K-1)/K]$, because, by design, the variances are always higher than or equal to all of the cross-variance. To acquire a TCI within $[0, 1]$, the modified/adjusted TCI is:

$$C_t^g(H) = \frac{\sum_{i,j=1, i \neq j}^k \tilde{\theta}_{ij,t}^g(H)}{k-1} \quad 0 \leq C_t^g(H) \leq 1 \quad (3.12)$$

Since VAR estimates may be effected by breaks, we also conduct a dynamic connectedness analysis. In addition to stability check, this also helps to look for nuances that may be missed in a static full sample analysis.

4. Empirical analysis

4.1. Data description

We used the daily closing index values of the Nifty500 Sharia and NIFTY100 ESG indices. In addition, we also take the daily closing prices of the Nippon India ETF Nifty 50 Sharia BeES (Sharia ETF) and Mirae Asset Nifty 100 ESG Sector Leaders ETF (ESG ETF). These ETFs are chosen because they are the only two India-based ETFs available to investors. The index values were taken from 1-Dec-2017 to 31-Jul-2024 and the ETF prices were taken from 24-Nov-2020 to 31-Jul-2024. As of July 2024, both the Nippon Sharia ETF and Mirae ESG ETF are the only instruments of their kind in the Indian market. Moreover, the Mirae ESG ETF was launched in Nov 2020, which affects the choice of time period used for the analysis. Data were

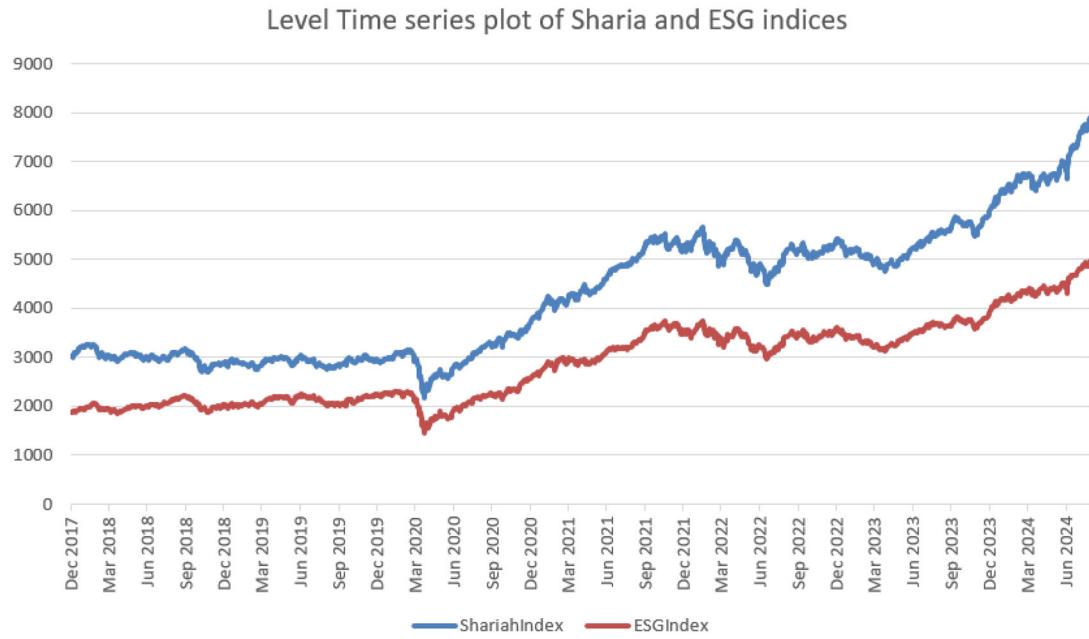


Figure 1. Time series plots of Sharia and ESG indices.

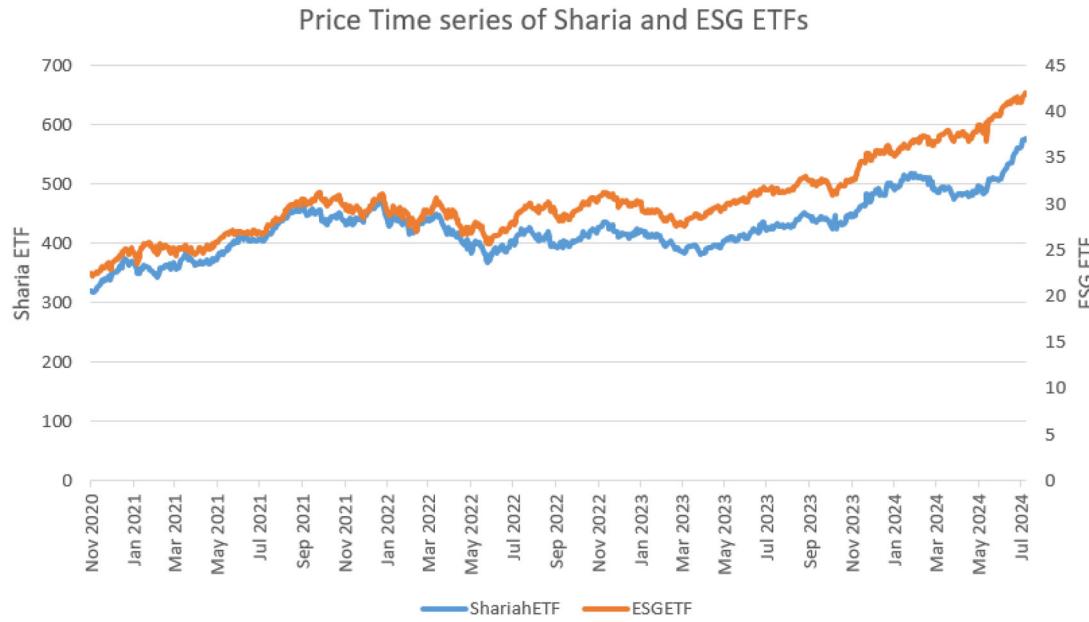


Figure 2. Time series plots of Sharia and ESG ETFs.

downloaded from Bloomberg and the NIFTY Indices website. Figures 1 and 2 show the time-series visualisations of the index levels and ETF prices.

4.2. Analysis results

At the outset, we examine the existence of cointegration between select Sharia and ESG indices, along with related ETFs. First, we test for nonstationarity in the selected individual time series. We do this using the augmented Dickey-Fuller (ADF), Phillips-Perron (PP) Test and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests. While the ADF and PP tests have a null hypothesis of nonstationarity, the KPSS test has a null hypothesis of stationarity in the time series. Next, we used Johansen's cointegration test on the bi-variate system of various Indices and ETFs. If there is evidence of cointegration, we subsequently estimate the error correction model (VECM) to determine the speed of adjustment to

shocks. If there is no evidence of cointegration in the level time series, we estimate a Vector Autoregression model (VAR) for the same variables using their return time series after confirming stationarity. In addition to the VAR estimation, we also check for Granger causality along with the impulse response function (IRF).

The second stage of analysis measures the connectedness between the ESG and Sharia indices and ETFs. We begin by measuring the overall connectedness of the system of all four series (i.e. ESG and Sharia indices and ETFs) and find the average dynamic connectedness. Subsequently, we measured the net directional connectedness of each asset. Next, we measure the pairwise connectedness between the Indices and ETFs. We do so for the ESG - Sharia indices and ETFs as well as the respective ESG Index - ESG ETF and Sharia Index - Sharia ETF. Finally, we measured the network pairwise connectedness between all four assets as a single system.

4.3. Cointegration and VAR results

We find that all Index level and ETF price time series are indeed non-stationary based on the results of all the three tests and various model specifications (no intercept or trend, with intercept and with trend). Subsequently we run Johansen's test for cointegration for two bivariate systems, namely the Sharia Index with the ESG index and the Sharia ETF with ESG ETF, using the log price time series. [Table 1](#) shows the results of the following tests. Firstly, we find that the null hypothesis of non-stationarity is not rejected for both ADF and PP tests. This is supported by the rejection of null hypothesis of KPSS test for all time series. Johansen's cointegration test checks for rank of bivariate series of Sharia and ESG indices and ETFs respectively and the first test of rank = 0 denotes the null hypothesis of no cointegration.

Neither bivariate systems showed any evidence of cointegration and the null hypothesis (H_0) of rank = 0 was not rejected at 5% significance level. This establishes that the bivariate systems are not cointegrated. The tests were run for lag lengths returned as per AIC, SC and HQ. Hence, we estimate a VAR for two bivariate systems using the log return time series.

[Tables 2](#) and [3](#) provide the coefficients of the estimated VAR models as per AIC. As a stability check, we confirm that the roots of the characteristic equation of the VAR are all found to be less than 1. The VAR model estimated for the lag length as per AIC was found to be a better model as per residual analysis. Next, we check for Granger causality between the Index and ETF pairs for various lag lengths. We find bi-directional Granger causality between both the Sharia and ESG index and ETF return series at a significance level of 5%.

The IRF plots are shown in [Figures 3](#) and [4](#), respectively.

The IRF plots show the effect of a one-standard deviation shock in one time series on the other. We can see that the shocks quickly die down and are non-significant.

The lack of cointegration suggests that there is no long term association between the Sharia Index and ESG index. Similarly, there is no evidence of a long-term relationship between the Sharia and ESG ETF. However, the Granger causality tests also suggest that over the short term, there is some association between ESG and the Sharia indices and ETFs. The autocorrelation in the residuals was not found to be significant, as shown by the *p*-values for all the lag values in [Tables 4](#) and [5](#), which suggests a good fit for the VAR model.

Table 1. Cointegration testing.

	Sharia Index - ESG Index	Sharia ETF - ESG ETF
ADF Test, $H_0 : I(1)$	can't reject	can't reject
PP Test, $H_0 : I(1)$	can't reject	can't reject
KPSS Test, $H_0 : I(0)$	reject	reject
Johansen's Cointegration Test rank	0	0

Lag values (k) are chosen based on AIC.

Table 2. VAR model estimates for ESG index and Sharia index.

	Log-Return Sharia Index	Log-Return ESG Index
Constant	0.0005*	0.0005
ESG.I1	-0.027	0.014
ESG.I2	-0.012	-0.061
ESG.I3	-0.064	-0.155*
ESG.I4	0.026	0.069
ESG.I5	0.002	0.052
ESG.I6	-0.182**	-0.205**
ESG.I7	0.131	0.127*
ESG.I8	-0.056	-0.008
Sharia.I1	0.035	-0.049
Sharia.I2	0.064	0.11
Sharia.I3	0.087	-0.194**
Sharia.I4	-0.021	0.064
Sharia.I5	0.071	0.053
Sharia.I6	0.077	0.121
Sharia.I7	-0.077	-0.067
Sharia.I8	0.056	0.038

I1 to I8 refer to the first eight lagged VAR estimates of the respective time series. *, ** and *** denote significance at 5%, 1% and 0.1% levels respectively.

Table 3. VAR model estimates for ESG ETF and Sharia ETF.

	Log-Return Sharia ETF	Log-Return ESG ETF
Constant	0.0006	0.0006*
ESG.I1	0.124*	-0.063
Sharia.I1	-0.066	0.084

I1 refers to the first lagged VAR estimate of the respective time series. * denotes significance at 5% level.

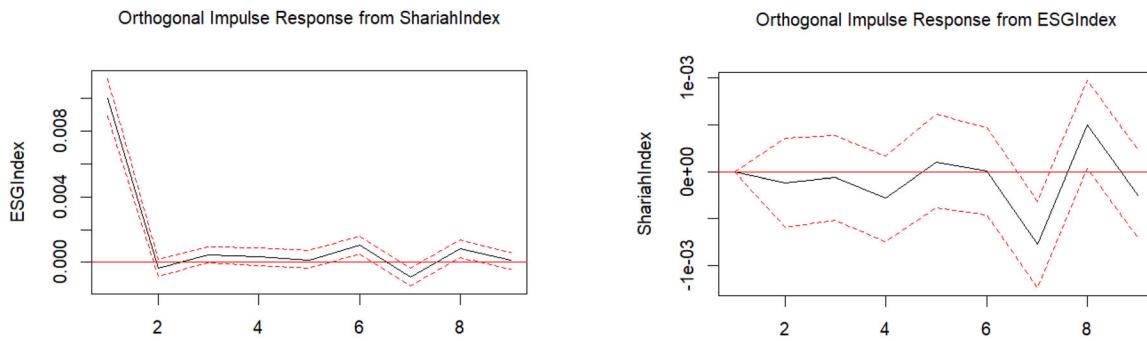
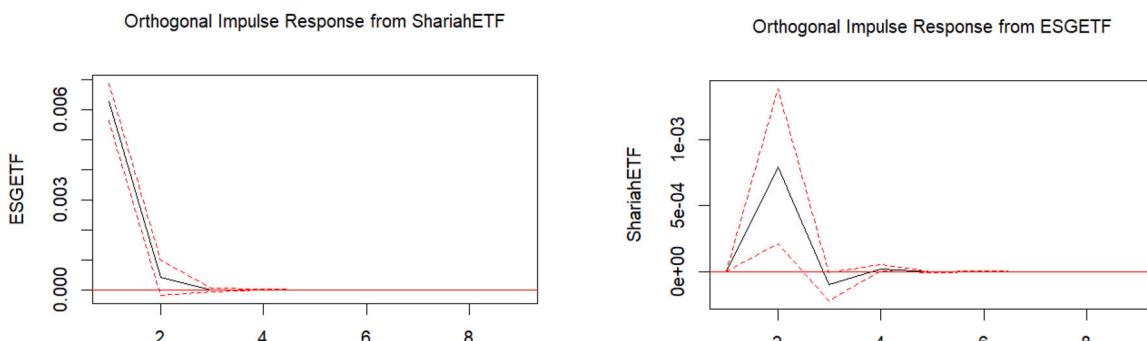
**Figure 3.** IRF for index pair.**Figure 4.** IRF for ETF pair.

Table 4. VAR residual portmanteau tests for autocorrelations (indices).

Lags	Chi-squared Statistic	p-value	df
9	3.0448	0.5504	4
10	10.616	0.2244	8
11	17.101	0.1458	12
12	19.758	0.2313	16
13	23.058	0.286	20

H_0 : No residual autocorrelations up to lag h .

*Test is valid for lags larger than VAR lag order. df is degrees of freedom for (approximate) chi-square distribution.

Table 5. VAR residual portmanteau tests for autocorrelations (ETFs).

Lags	Chi-squared Statistic	p-value	df
2	6.154	0.1879	4
3	13.261	0.1032	8
4	15.761	0.2024	12
5	16.281	0.4335	16
6	17.746	0.6041	20

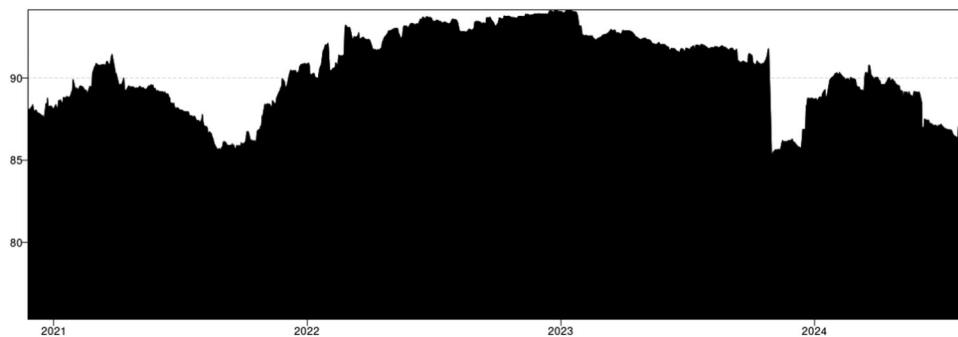
H_0 : No residual autocorrelations up to lag h .

*Test is valid for lags larger than the VAR lag order. df is the degree of freedom for the (approximate) chi-square distribution.

Table 6. Average dynamic connectedness table.

	ESG Index	Sharia Index	ESG ETF	Sharia ETF	FROM
ESG Index	30.30	25.82	27.11	16.77	69.70
Sharia Index	26.14	30.38	22.75	20.73	69.62
ESG ETF	28.57	23.63	31.71	16.08	68.29
Sharia ETF	20.38	25.00	18.48	36.14	63.86
TO	75.08	74.45	68.34	53.58	271.46
Inc. Own	105.38	104.83	100.06	89.73	cTCI/TCI
NET	5.38	4.83	0.06	-10.27	90.49/67.87
NPT	3	2	1	0	

Values reported are variance decompositions based on 100-day ahead forecasts. NPT represents the Net Pairwise Transmitter.

**Figure 5.** Dynamic total connectedness.

The X- and Y-axes denote time and TCI index (0% to 100%), respectively.

4.4. Connectedness results

4.4.1. Dynamic connectedness measures

The averaged dynamic connectedness measures are shown in **Table 6**. The total connectedness index (TCI) and corrected total connectedness index (cTCI) are found to be at 67.87 and 90.49 respectively. We clearly observe that volatility connectedness is strong among the ESG Index, Sharia Index, ESG ETF, and Sharia ETF indices during the period of our study. Furthermore, the statistics indicate that ESG index and Sharia index are found to be net transmitters of volatility whereas Sharia ETF is observed to be major net recipients of volatility. Furthermore, **Figure 5** displays the dynamic total connectedness (Chatziantoniou & Gabauer, 2021; Gabauer, 2021) measure, which ranges between 85% and 95% for the

overall sample period from 2020 to 2024. This practically implies that connectedness across the financial assets is strong and time-varying, a fact that is often obscured by the static nature of the TCI.

4.4.2. Directional connectedness measures

The direction of the net transmitter of return spillovers to all the other variables will be towards the positive side whereas the net recipient of return spillovers from all the other variables will be towards the negative side as per the net directional connectedness measure plot. [Figure 6](#) shows that ESG index and Sharia index are positive and hence net transmitters of return spillovers; and Sharia ETF is negative in direction and hence is found to be net receiver of return spillovers. However, we observe ESG ETF index fluctuates from net recipient to net transmitter of return spillover and vice-versa during different periods.

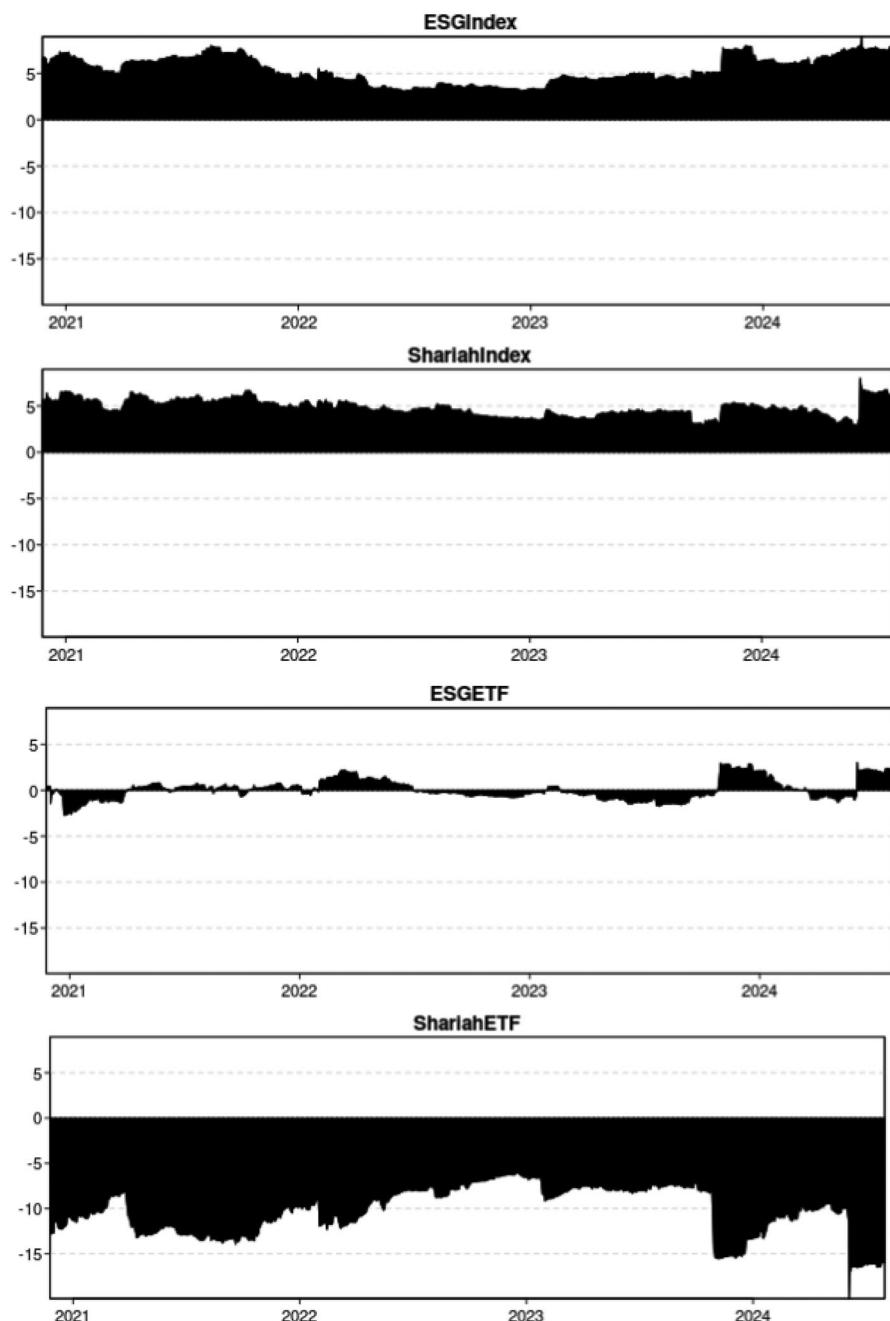


Figure 6. Net total directional connectedness.

Figure 7 shows that the pairwise directional connectedness among the pair of assets among ESG index, Sharia index, ESG ETF, and Sharia ETF are strong and positive throughout the sample period. However, we observe that the pairwise directional connectedness gradually decline during March 2021 to October 2021, and further increase in the pairwise directional measure especially among ESG Index and Sharia ETF pair, ESG ETF and Sharia ETF pair, Sharia Index and Sharia ETF pairs. Also, sudden decline during November 2023, and June-July 2024 among the same pair of assets.

Figure 8 displays the network plot of return spillover connectedness. The net transmitters of volatility are displayed in blue color and the net recipients are shown in yellow color. The node's size shows the magnitude of the contribution of each variable to system connectedness. The thicker lines exhibit greater extent of return spillover compared to the thinner lines. Figure 8 shows that ESG index and Sharia index are net transmitters of return spillover, whereas Sharia ETF is observed to be net recipients of return spillover during the full sample period. It can be seen that return spillovers are strong between Sharia Index – Sharia ETF, and ESG index- Sharia ETF. Interestingly, we find that return transmission from Sharia Index is limited to only Sharia ETF, whereas, the ESG index transmits spillover to both ESG ETF, and also Sharia ETF.

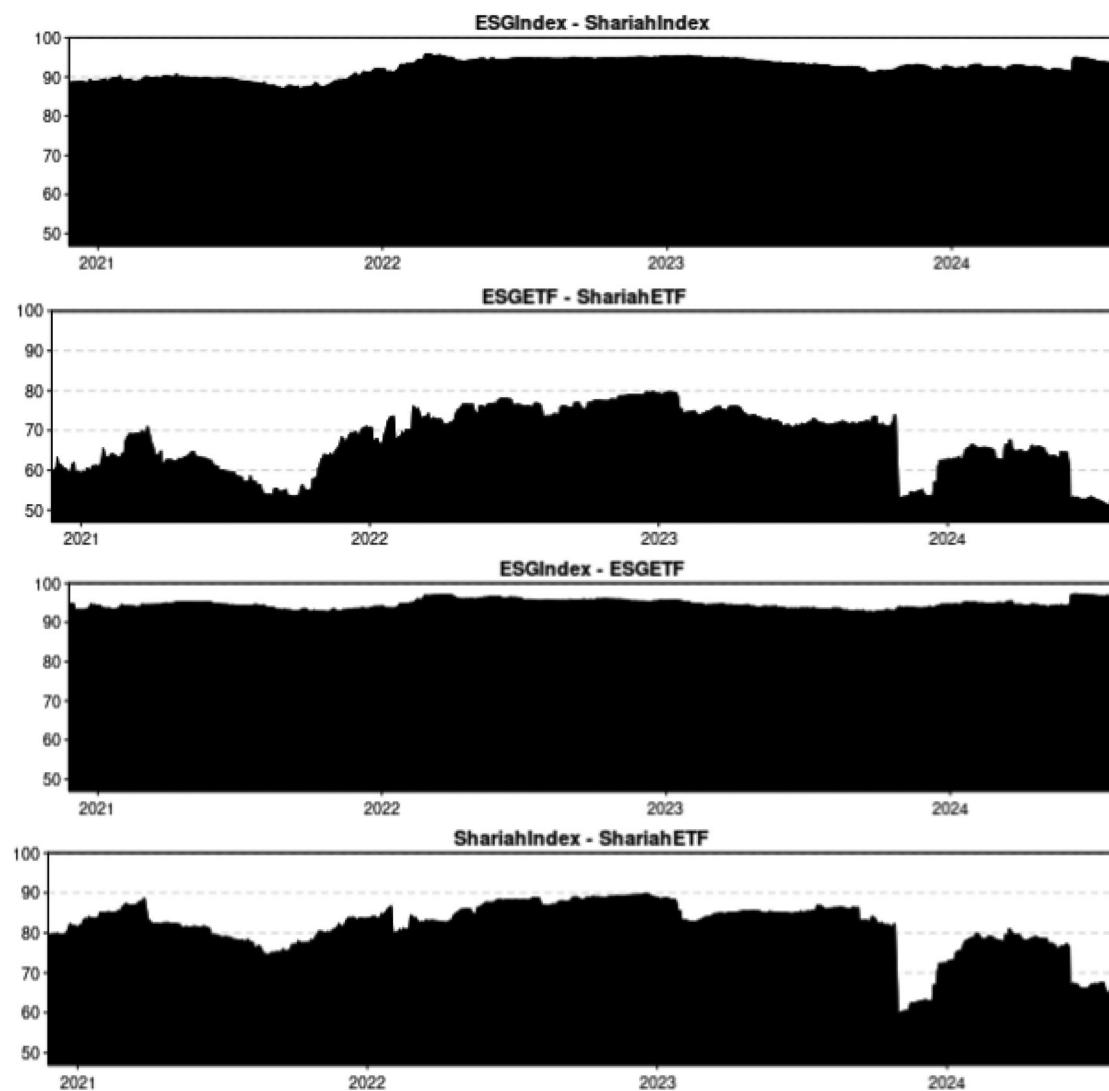


Figure 7. Dynamic pairwise connectedness.

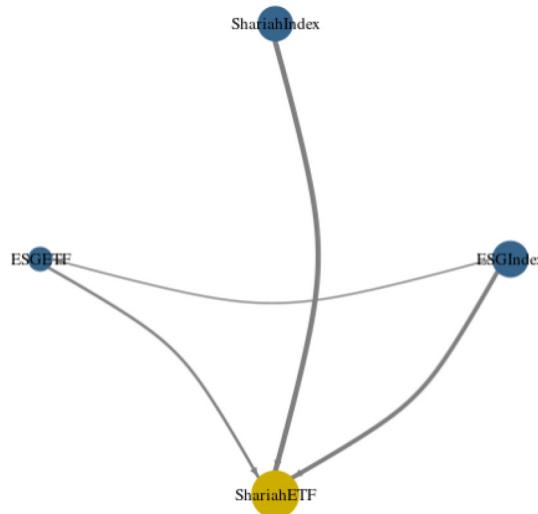


Figure 8. Network connectedness plot.

5. Discussion of findings

The lack of cointegration between the ESG and Sharia indices and ETFs may be attributed to differences in the underlying assets that form these indices and ETFs. An examination of the underlying assets of the indices and ETFs shows the difference in composition. While the ESG index has Financial Services firms as the single largest sector at 30.97%, the Sharia index holds a minuscule 0.37%. In addition, 'Capital goods' and 'Oil, Gas & Consumable Fuels' form a significant portion of the Sharia index (11.71% and 8.18% respectively). By contrast, the ESG index holds less than 6% cumulatively from these sectors (NSE, 2024a,b).

When we examine the results of our connectedness analysis, another important observation comes to light. In contrast to earlier findings of Naeem et al. (2023), who reported sustainable and responsible investment (SRI) and sharia-compliant equity indices being less connected in several emerging markets including India, than in other nations, we find that ESG Index and Sharia Indices being highly connected as per our results shown in Figure 7. Further, the cTCI value from Table 6 and the dynamic overall connectedness plot in Figure 5 show that overall connectedness is high and remains above 90% most of the time. The plots in Figures 6 and 8 show that the indices are transmitters and the ETFs are receivers. This is intuitive because ETFs should follow the indices. The pairwise connectedness between the ESG Index and Sharia index is also high as shown in Figure 7. The ESG index and ETF were also highly connected. However, we also see that compared to the ESG-Sharia index connectedness, ESG and Sharia ETF connectedness levels are lower. This additional nuance can help explain the difference between our results and earlier findings. Indices and ETFs with different asset compositions can cause the data-generating process to diverge, leading to differences in connectedness levels. Finally, the observed drop in connectedness in the overall system in November 2023 and July 2024 may be attributed to the changes induced in the Sharia Index during Sep-Oct 2023 and May-June 2024. Several constituents of the Nifty500 Sharia index were removed or replaced consecutively on 28-Sep-2023, 26-Oct-2023, 22-May-2024, 21-Jun-2024 and 24-Jul-2024 (NSE, 2023b,a, 2024e, 2024d, 2024c). Hence, these observations have significant ramifications for financial institutions who specialise in designing financial indices and investment instruments, such as ETFs.

While our findings are limited by the number of available ETFs in the Indian market, they can help financial institutions design future indices and ETFs to tailor the needs of various investor classes. Finally, there are several avenues of further research in this context. Future work can analyse various profitability measures or risk measures such as systemic risk or contagion risk for firms across various sectors. While there are notable works in this field as pointed out in the literature review, various new

developments such as new metrics to measure ESG and Sharia compliance and economic shocks due to evolving regulatory policies require more research in this domain.

6. Conclusion

This paper explores the relationship between ESG and Sharia indices and ETFs by using several related econometric techniques such as cointegration and dynamic connectedness. We find a lack of cointegration between both ESG and Sharia index and ETF pairs which highlight the absence of long term co-movement. However, the presence of bi-directional causality between the Index and ETF pairs along with high dynamic connectedness suggest short-term association. A potential cause of lack of cointegration is the difference in the underlying asset composition of both the ESG and Sharia indices and the ETFs. These findings form the basis of the following potential implications for various stakeholders. Firstly, short-term traders can use dynamic connectedness analysis for hedging decisions and trading opportunities. Secondly, Sharia-based financial instruments can be seen as a complementary investing avenue for long-term investors looking for ethical and sustainable investment opportunities. Further, financial institutions stand to benefit from a deeper understanding of underlying asset profiles, enabling them to tailor new investment products to cater to the evolving preferences of socially conscious investors. In other words, since the asset classes are not very similar, these asset classes can help diversify portfolios by decreasing non-systemic risks. More importantly, policymakers can gain valuable insights into the regulatory implications of converging Sharia and ESG principles, fostering the development of a more sustainable and inclusive financial ecosystem. This is especially important as global pension funds increase their search for investment avenues in Indian equity assets in search of better returns (Mascarenhas, 2023).

In conclusion, this research contributes to the ongoing discourse on sustainable finance by unravelling the cointegration and connectedness dynamics between the Sharia and ESG dimensions in both index and ETF contexts. These findings have the potential to shape the future landscape of ethical investing, providing stakeholders with a robust foundation to navigate the intricate interplay between Islamic finance principles and ESG considerations.

Note

1. https://en.wikipedia.org/wiki/List_of_religious_populations.

Authors' contributions

Kunal Saha: Conception and design; review of literature; data collection; analysis and interpretation of the data; drafting of the manuscript, revising it critically for intellectual content; and the final approval of the version to be published. Muneer Shaik: Conception and design; review of literature; data collection; analysis and interpretation of the data; drafting of the manuscript, revising it critically for intellectual content; and the final approval of the version to be published. All authors agree to be accountable for all aspects of this study. All authors have read and approved the final manuscript.

Disclosure statement

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Data availability statement

The data that support the findings of this study are also available on the Google Finance website and in the public domain: [<https://www.google.com/finance>]. In addition, the data are available from the authors, upon reasonable request.

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