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Article

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Dynamics of Volatility Spillover between Energy and Environmental, Social and Sustainable Indices

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ABSTRACT

The purpose of this research was to examine the dynamics of volatility spillover between energy and environmental, social, and sustainable indices. COVID-19 prompted the research to select April 2019 to March 2022 as a sample period, and the respective data (daily prices) of the Nifty Energy and Nifty ESG indices were obtained from the National Stock Exchange of India Limited. The outcomes of the study confirmed that the daily returns of Nifty Energy and Nifty 100 ESG indices were not normally distributed and reached stationarity at level difference. Further, the study employed GARCH Models such as ARCH, GARCH (1,1), and GARCH-M to determine conditional volatility, and it validated the ARCH influence on the daily returns of the Nifty Energy and Nifty 100 ESG, during the study period.

Keywords: Energy Index, Environmental Sustainability, Composite Index, Energy Crisis
JEL Classifications: C32; O13; O47

1. INTRODUCTION

Sustainable investment is a method for accomplishing financial objectives while keeping an eye on the effects on the environment, society, and governance (ESG). Due to the amount of gain or decrease in the scores of distinct sustainable development goals as well as the magnitude of change in individual SDG scores, ESG boosts the tracking portfolio's performance while limiting the downside risk (Zhang et al., 2022). Following COVID-19, investors and fund managers are gradually shifting their focus to sustainable indices (Sharma et al., 2022). There is empirical evidence to support the premise that bad news has greater influence on ESG business volatility than good news (Sabbaghi, 2022). The inhibitory effect is aided by a better formal regulatory environment. ESG can be used in conjunction with other measures, to reduce financial irregularities (Yuan et al., 2022). The ESG rating of ETFs and their assets report substantial relationship. But the returns of ETFs, was found to be inversely associated with their ESG measures (Rompotis, 2022).

Environmental challenges exercise significant impact on all sectors of the economy, including financial markets (Sugirtha, R., et al. 2021). As a result, the financial sector's environmental, social, and governance (ESG) consciousness is growing (Morae et al., 2022). ESG engagement has a beneficial impact on cross-border M&A business performance, confirming stakeholder theory and demonstrating that ESG may be used as a strategy to improve cross-border M and A business efficiency (Kim et al., 2022).

Social and ethical activities have a moderating effect on the relationship between environmental disclosure and financial performance. Stakeholders and regulators agree that additional social and environmental laws must be integrated to promote sustainability (Chouaibi et al., 2022). There are no substantial differences between ESG and traditional indices (Plastun et al., 2022). There was not enough evidence for ESG factors to be a good complement to FF5 and PFPs, but they may be used as ESG indices, to measure investment portfolio sustainability risks (Naffa and Fain 2022). In terms of returns and risk, the more sustainable funds appeared to react better to the unexpected event of the epidemic (Pisani et al., 2021). Climate-related disclosure by publicly listed firms was unsatisfactory to sustainable investment professionals. This uncertainty was especially acute in the United States, Asset managers do not believe markets are regularly and accurately pricing climate risks into company and sector valuations (Amato et al., 2021). COVID-19 provided an opportunity to brainstorm and visualize new ways to support a carbon-free economic agenda, as well as to build environmentally friendly infrastructure, planned urban growth, and the transition to clean energy (Khan, 2021). During the worldwide pandemic like Covid-19, the low, medium, and high synchronization periods between the Corona virus Panic Indicator and the price movements of the ESG Leaders indexes, show the broadening possibility of ESG investing. (Umar et al., 2021).

Crude oil prices fall when GER and ESG are high. The findings are significant for investors and policymakers, who want to promote climate change mitigation and long-term economic development by, using renewable energy sources (Jabeur et al., 2021). During the last decade, there was a growing interest in corporate social responsibility (CSR) and ethical practices. The GMM approach reveals the presence of time-dependent dependencies and continuity in environmental disclosure (Chouaibi et al., 2021).

In the pandemic crisis, Islamic bonds (Sukuk) displayed safe haven features, while spillover between conventional and Islamic stock markets became greater (Yarovaya et al., 2021). During the COVID-19 crisis period, the average daily return and volatility of most currencies increased. But the EGARCH (1, 1, 1) model results showed that pandemic had no effect on the S&P ESG 100 index's return and volatility (Singh et al., 2021). There was significant variation in the financial success of socially responsible stock indexes, with SR impact strategies beating their benchmarks by a small margin. SR measures were also more stable in nations and during periods when the number of COVID-19 cases increased (Gunther et al., 2021). When a bear market prevails, investors do not have to pay the price for investments in sustainable assets and as a result, ceteris paribus, these investments appear ideal for financial-first investors. Such findings have practical implications in terms of long-term investment attractiveness and market growth (Chiappini et al., 2021). There was great performance of SRI indices during the Covid-19 pandemic (Akihiro et al., 2021).

Green energy expenditures have increased in recent years, but they are still insufficient to keep global warming below two degrees Celsius (Capelle, B.G., et al 2021). Several problems, most notably lack of knowledge, impede investors' commitment to support green initiatives. The study strongly advises the government to recover from the pandemic issue, by establishing greener society and implementing ambitious environmental measures (Nobletz 2022). International political, economic, and other events have an impact on the dynamic connectedness between the stock markets (Sugirtha, R., et al. 2021). Further, for investors who are concerned about stock market volatility, having a long position in carbon emission contracts and a short position in renewable energy stock, might provide the optimum hedging benefit (Zhang et al., 2022). During crises, green bonds and the S&P 500 index were closely correlated. The study also found that the, the prices of green bond index are less volatized (Mensi et al., 2022). Green bonds and fixed-income assets revealed greater bilateral information transmission, in both return and volatility spillovers, whereas equities assets reported the most significant risk spillovers (Su et al., 2022). Each country's primary concern must be economic growth without compromising environmental sustainability. As a result, investors seek opportunities such as investing in clean energy stocks, which provide considerable social, economic, and environmental benefits to society. (Fu et al., 2022). Volatility spillovers, across financial markets, contribute to a clear awareness of market risk contagion. As a result, deeper analysis may need to focus on the volatility spillovers between Carbon Emission Trading and other markets (Wu et al., 2022).

The study proved that asymmetry, fat tails, and long memory existed in GCC energy price volatility, and that the three exogenous repressors did not play significant effect in GCC daily returns volatility (Alkathery et al., 2022). Investor attitude in the energy market was significantly greater in the context of the events, reflecting that international investors resorted to put choices and spent an excessive premium to protect them against extraordinary volatility in the energy market (Babu et al., 2022). The study revealed that the environmental issues such as rural population, urbanization, CO_2 emissions, energy usage, and energy production will have the greatest impact on attaining long-term economic growth (Ijaz et al., 2022). In view of investors' unwillingness to invest in green projects, the introduction of the innovative financial instrument would greatly enhance the amount and value of investments in energy efficiency and renewable resources (Celic et al., 2022). The commodities futures market plays a vital role in minimizing price risk for investors (Srinivasan et al., 2022). While investing in the stock market, investors should pay close attention to daily market moves, especially during these kinds of macroeconomic events (Babu et al., 2019). The rest of the paper is organized as follows. Section 2 describes the data and the econometric methodology Section 3 presents the results and discussion Section 4 concludes this paper with some policy implications.

2. METHODOLOGY

In this study, the conditional volatility, among Nifty Energy and Nifty ESG index returns, was examined by using Nifty Energy and Nifty ESG index returns, from National Stock Exchange of India Ltd. COVID-19 prompted the study to use the sample period of April 2019 to March 2022, and the related data (daily prices) of the Nifty Energy and Nifty ESG indices were retrieved from the National Stock Exchange of India Ltd.'s official website. In order to assess the study's goals, the following statistical methods were employed.

a. A descriptive statistic was used, to characterize the daily returns of the Nifty Energy and Nifty ESG indices
b. Nifty Energy and Nifty ESG index returns were determined, by using the Augmented Dickey-Fuller test (ADF)
c. GARCH Model was used to assess the volatility of Nifty Energy and Nifty ESG index.

2.1. Model Specifications

The ARCH (q) model uses its own historical innovation, to explain variance in conditional volatility.

(a) The ARCH model is based on the idea that a variable's present value is determined by its previous value (s).

$$y = \lambda_0 + \lambda_1 y_{t-1} + \mu_t \quad (1)$$

$$h_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-1}^2 \quad (2)$$

The conditional mean and variance are represented by equations (1) and (2), respectively. The letter "q" denotes the order of the previous conditional variance. The "p" represents the order of the previous error term, whereas the "q" represents the order of the preceding conditional variance.

2.2. Conditional Variance Equation

The GARCH model is illustrated below.

$$\varepsilon_t \left| \Omega_{t-1} \sim N(0, h_{t-j}^2) \right. \quad (3)$$

$$h_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{i-2}^2 + \sum_{j=1}^{q} \beta_j h_{t-j}^2 \quad (4)$$

$$\omega > 0, a_i, \beta_j \geq 0, \rightarrow h_t^2 \geq 0, i = 1,.....p, \text{ and } j = 1,....q \quad (5)$$

2.3. GARCH-in-Mean

The GARCH-M model captures the link between risk premium and conditional volatility of returns. It is intended to investigate the security market and acknowledge that risk may be evaluated using a measure of variation in security returns. In GARCH-in-mean, the security's return may be determined by its volatility or conditional variance. The following is the condition of the GARCH-M (1,1) model:

$$r_t = \lambda_0 + \lambda \sigma t_t^2 + \varepsilon_t \quad (6)$$

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \beta \sigma_{t-1}^2 + \sum_{j=1}^{q} \alpha \varepsilon_{t-1}^2 \quad (7)$$

2.4. Decision Rule

The risk premium is represented by equation (5). A positive indicates an increase in mean return as a result of an increase in conditional variance, which is represented by greater risk.

3. EMPIRICAL RESULTS AND DISCUSSION

The results of the normality test and descriptive statistics for daily returns, are shown in Table 1. The series have asymptotic distributions under normality, skewness, and kurtosis assumptions. As can be seen in the results, the mean values of Nifty Energy and Nifty 100 ESG were positive, during the study period. The regular return distributions deviated significantly from the normal distribution. Further, during the study period, the daily returns of the Nifty Energy and Nifty 100 ESG were negatively skewed, meaning that negative values or losses were considerably more frequent (i.e., the left tail was particularly extreme) and the Histogram Figure 1 also confirmed the same. In our sample, the leptokurtic aspect of the return distribution was obvious. The daily returns of the Nifty Energy and Nifty 100 ESG were not normally distributed over the research period, according to the Jarque-Bera test.

The Augmented Dickey Fuller Test was used to determine the unit root of the daily returns of the Nifty Energy and Nifty 100 ESG index. Table 2 displays the comparable results. Each Nifty Energy and Nifty 100 ESG index achieved stationarity at level difference (i.e., the daily returns of the sample Asian Pacific Countries' emerging indices recorded I(0) process). During the research period, the Q-Q Plots (Figure 2) indicated the daily returns of Nifty Energy and Nifty 100 ESG index to be negatively skewed and had reported unit root.

Table 3 displays the outcomes of the three distinct models. The ARCH coefficient indicated that the square lagged error

Table 1: Results of descriptive statistics

	Nifty energy index	Nifty100 ESG
Mean	0.000601	0.000619
Std. Dev.	0.015415	0.013638
Skewness	–0.735879	–1.635832
Kurtosis	10.23431	22.45928
Jarque-bera	1684.997	12037.94

Figure 1: Histogram

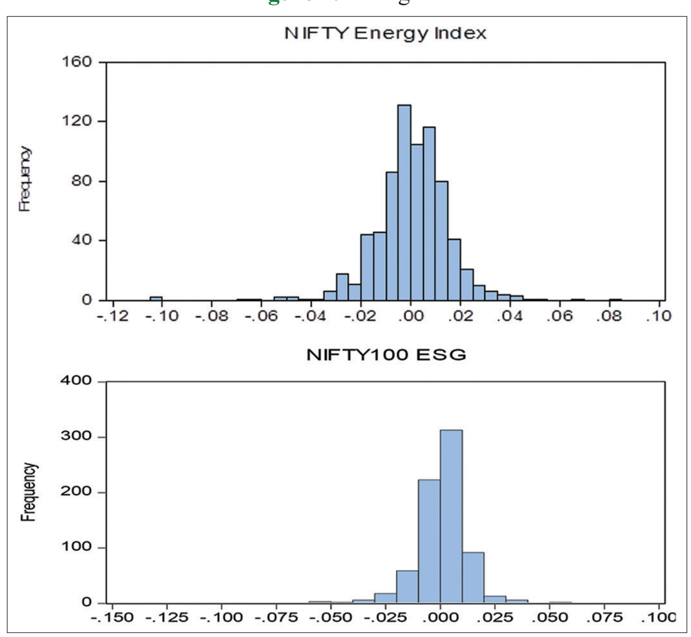


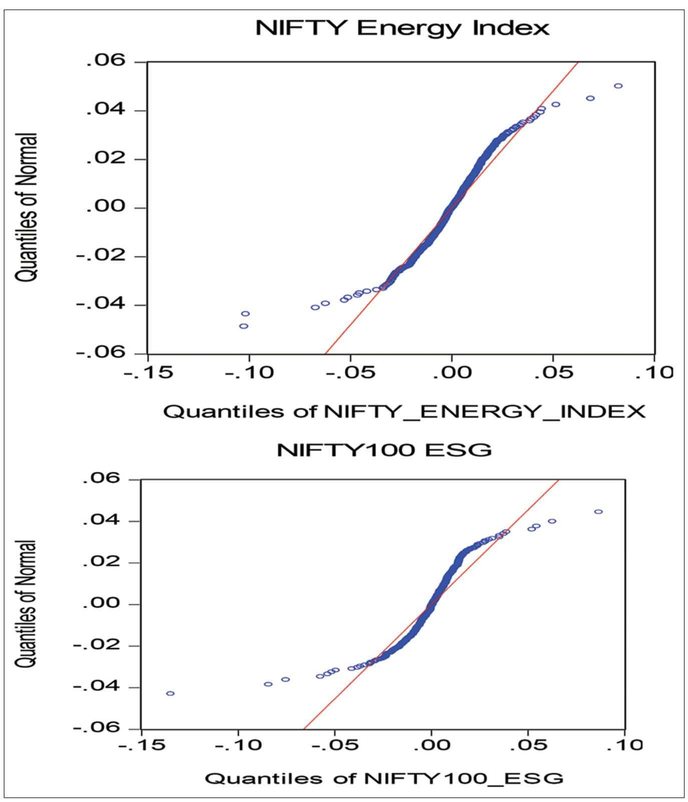
Table 2: Results of unit root test

	ADF (F-Statistics)	Test critical values			Prob.
		1% level	5% level	10% level	
NIFTY ENERGY INDEX	–10.04598	–3.439	–2.86525	–2.5688	0
NIFTY100 ESG	–9.937707	–3.439	–2.86525	–2.5688	0

Table 3: Results of GARCH models

Nifty energy index						
Parameter	ARCH	P-value	GARCH (1,1)	P-value	GARCH-M	P-value
Constant (c)	0.000174	0	0.0000112	0.0029	0.0000115	0.0017
Risk premium (ʎ)					5.598008	0.0214
ARCH term $\beta 1$	0.247987	0	0.098034	0	0.101908	0
GARCH term $\alpha 1$			0.848639	0	0.843227	0
$\beta 1 + \alpha 1$			0.946673		0.945135	
log L	2081.411		2131.697		2134.562	
AIC	–5.60488		–5.737729		–5.742755	
Nifty100 ESG						
Parameter	**ARCH**	**P-value**	**GARCH (1,1)**	**P-value**	**GARCH-M**	**P-value**
Constant (c)	0.000104	0	0.0000046	0.0006	5.01E-06	0.0002
Risk premium (ʎ)					7.152127	0.0066
ARCH term $\beta 1$	0.437028	0	0.134522	0	0.136872	0
GARCH term $\alpha 1$			0.84086	0	0.834909	0
$\beta 1 + \alpha 1$			0.975382		0.971781	
log L	2230.211		2314.422		2318.834	
AIC	–6.00596		–6.230249		–6.239444	

Figure 2: Q-Q plots

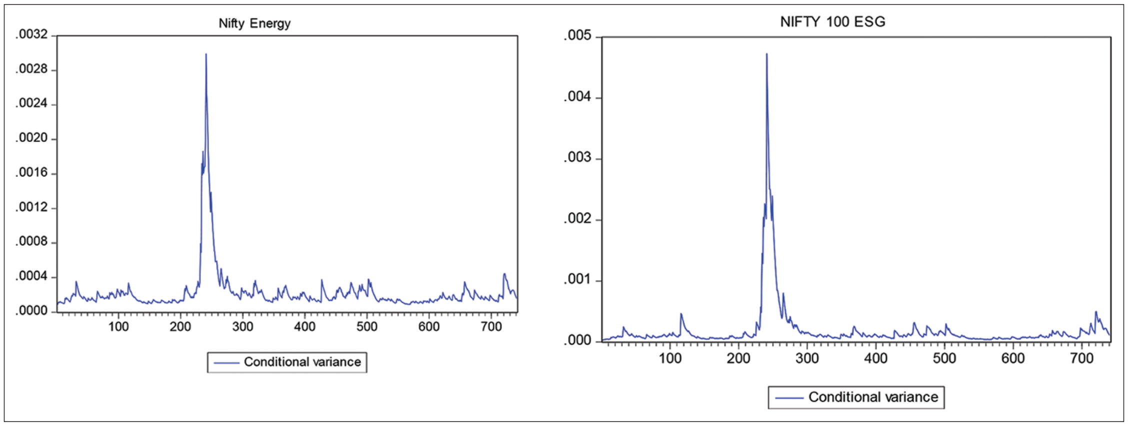


terms have did positive and substantial influence on the present volatility of stock returns, showing that the rate of stock volatility reaction to market activity to strong. The variance coefficients in the GARCH (1, 1) model were positively significant at 5% level, indicating that prior period volatility exercised considerable impact on conditional volatility in the present time frame. According to the ARCH coefficient, the last error terms have done positive and large influence on present period volatility, which was extremely persistent. The overall volatility for the studied models was substantial, and shocks on these returns eventually faded away. As predicted, volatility persistence was maximum with $\beta 1 + \alpha 1 = 0.946673$ for Nifty Energy Index and $\beta 1 + \alpha 1 = 0.975382$ for Nifty ESG Index, implying that it revealed volatility persistence and that the persistence faded progressively.

By allowing the mean condition of the return series to rely on an element of the conditional variance, the GARCH-M (1, 1) model was assessed. The constant in the mean equation was not significant, indicating that the market reported typical return. Table 3 shows that the coefficient of conditional variance (λ) in the mean equation value was positive and statistically significant, implying that conditional volatility did influence on the expected return. In other words, there was risk-return trade-off within the time horizon. The parameters in the variance equation of GARCH-M (1,1) were extraordinarily high and statistically significant, at the 1% level. The sum of $\beta 1$ and $\alpha 1$ for Nifty Energy was 0.945135 and for Nifty ESG, it was 0.971781, indicating that shocks persisted later in the timeframe.

The model was chosen based on its performance, as measured by the information criterion. To get AIC values, all estimations were estimated and evaluated. As mentioned in the previous section, preference should be given to the model, that provides the least amount of information. The GARCH-M model outperformed all other conventional models. Figure 3 also confirmed the conditional volatility of stock market returns.

Figure 3: Graphical representation of conditional variance



4. FINDINGS AND IMPLICATIONS OF THE STUDY

Energy Sector played a major role in implementing the ESG factors in the corporate as well as in country. In the past few years, the Indian government could concentrate on implementing various procedures for energy transformation. This study was focused on analyse the impact of energy transformation on ESG factors, through the stock market. In this regard, the study selected Nifty Energy and Nifty 100 ESG indices from National Stock Exchange of India Ltd. The daily prices of Nifty Energy and Nifty 100 ESG indices were collected from the official website of NSE, for investigating the impact of energy transformation on Indian economy through testing the conventional Volatility of Nifty Energy and Nifty 100 ESG stock indices. The pre analysis of the study confirmed that daily returns of both Nifty Energy and Nifty 100 ESG indices were not normally distributed and attained stationarity at level difference. Further, the study used GARCH Models such as ARCH, GARCH (1,1) and GARCH-M, for discovering the conditional volatility and it confirmed the ARCH effect on the daily returns of Nifty Energy and Nifty 100 ESG, during the study period. According to the empirical study, under the GARCH (1,1) model, the coefficients ($\beta 1 + \alpha 1$) for Nifty Energy and Nifty 100 ESG clearly revealed that volatility typically strong and persistent. In other words, previous volatility news did have informative effect on the present volatility. As a result of this finding, the volatility of the Indian stocks market may be attributed to effect of energy transformation. The risk premium (λ) in the GARCH-M was positive and significant; indicating that increased market risks, from conditional variation, inevitably supported high returns or that the expected return was affected by the variance. In other words, it indicated the existence of risk-return trade-offs, and investors may continue keeping these assets despite their high risk. This will enable policymakers and market players to better understand these assets and evaluate securities hedging strategies and portfolio management. From the empirical results, the study concluded that energy transformation and COVID-19 news caused high risk in the Indian Energy Stock Index as well as in the Indian ESG Index. Hence this study suggests that policymakers and market players evaluate a number of assets, portfolio management, and hedging methods, by using diverse strategies.

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