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An Analysis of Volatility and Risk-Adjusted Returns of ESG Indices in Developed and Emerging Economies

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Abstract: The importance of Environmental, Social, and Governance (ESG) aspects in investment decisions has grown significantly in today's volatile financial market. This study aims to answer the important question of whether investing in ESG-compliant companies is a better option for investors in both developed and emerging markets. This study assesses ESG investment performance in diverse regions, focusing on developed markets with high GDP, specifically the USA, Germany, and Japan, alongside emerging nations, India, Brazil, and China. We compare ESG indices against respective broad market indices, all comprising large and mid-cap stocks. This study employs a variety of risk-adjusted criteria to systematically compare the performance of ESG indices against broad market indices. The evaluation also delves into downside volatility, a crucial factor for portfolio growth. It also explores how news events impact ESG and market indices in developed and emerging economies using the EGARCH model. The findings show that, daily, there is no significant difference in returns between ESG and conventional indices. However, when assessing one-year rolling returns, ESG indices outperform the overall market indices in all countries except Brazil, exhibiting positive alpha and offering better risk-adjusted returns. ESG portfolios also provide more downside risk protection, with higher upside beta than downside beta in most countries (except the USA and India). Furthermore, negative news has a milder impact on the volatility of ESG indices in all of the studied countries except for Germany. This suggests that designing a portfolio based on ESG-compliant companies could be a prudent choice for investors, as it yields relatively better risk-adjusted returns compared to the respective market indices. Furthermore, there is insufficient evidence to definitively establish that the performance of ESG indices varies significantly between developed and emerging markets.

Keywords: ESG investing; downside risk; asymmetric volatility; risk-adjusted returns

JEL Classification: G15; G11; F65; Q01

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1. Introduction

Environmental, Social, and Governance (ESG) investing has emerged as a prominent investment strategy, garnering widespread attention in recent years. This approach to investment prioritizes non-financial factors, including a company's environmental impact, treatment of employees, and governance practices. As investors increasingly recognize the importance of these elements for long-term profitability and sustainability, the popularity of ESG investing has surged (Park and Jang 2021; Van Duuren et al. 2016). ESG investing offers investors the opportunity to align their financial interests with their ethical values, supporting companies committed to sustainability and ethical business practices (Brest et al. 2018). However, a crucial question arises: Does ESG investing truly offer a favorable risk–reward ratio, or is it merely a form of "greenwashing" and a marketing gimmick?

Previous research has delved into the connection between ESG performance and financial results, but the findings have frequently been inconclusive, with some indicating a positive impact while others show no discernible influence on performance (Naeem et al. 2022; Whieldon and Clark 2021; Sudha 2015; Jain et al. 2019; Ouchen 2022). One key challenge is the lack of standardized ESG principles, which makes it difficult for investors to compare companies and funds. Additionally, critics argue that ESG investing may limit investment opportunities and potentially result in lower returns, as even companies with subpar ESG performance can exhibit strong financial performance. The performance of ESG indices in terms of risk and return is a dynamic and evolving phenomenon influenced by various factors, including the maturity of the economy, the regulatory environment, and the commitment of companies to sustainability. In developed economies, ESG indices have demonstrated their ability to deliver competitive returns while managing risks effectively. In developing economies, ESG investments show promise, but challenges related to volatility and limited ESG disclosure must be considered (Al Amosh and Khatib 2023; Singhania and Saini 2023).

This paper seeks to provide a comprehensive assessment of the performance of ESG investments in comparison to investments in broad-based indices across different geographical regions, encompassing both developed and emerging markets with significant GDP. The analysis spans both developed and emerging markets, recognizing the unique challenges and opportunities presented by each. We hypothesize that ESG indices can offer competitive returns while effectively managing risks, particularly in developed economies. However, the performance of ESG investments may vary due to factors such as ESG disclosure standards, market maturity, and regulatory environments in different regions. Our research seeks to contribute to the ongoing discourse on ESG investing by offering valuable insights into its performance and dynamics, helping investors make informed decisions regarding their investment strategies.

To assess the performance of ESG investments, our study utilizes a multifaceted methodology. We employ a variety of risk-adjusted metrics and consider downside volatility when evaluating ESG indices' performance relative to broader market indices in each respective country. We use ARCH-GARCH analysis to measure the conditional volatility of these indices, shedding light on the dynamic nature of ESG investments. Furthermore, our research investigates the impact of news events on ESG indices compared to market indices in both developed and emerging markets.

The structure of the current study is as follows: the related literature is discussed in Section 2. Section 3 explains the data, methods, and models used. Section 4 reports the empirical results, and a discussion of the results is included in Section 5. Section 6 presents concluding remarks along with the managerial implication and future scope of this study.

2. Literature Review

The popularity and growth of ESG (Environmental, Social, and Governance) investing globally are remarkable. Many studies have contrasted the traditional index with the ESG index for various geographical regions and looked at the connection between ESG and business financial performance. A set of studies has been carried out to compare the conventional portfolios with the ESG portfolios. One study conducted by Ouchen (2022) analyzed the performance of the MSCI USA ESG Select compared to the S&P 500 from 2005 to 2020. The study found a positive impact of ESG investments on performance and risk reduction. In the Indian context, Sudha (2015) found no statistical difference in the returns of ESG and broad-based indices but observed that the ESG India Index was less volatile from 2005 to 2012. Jain et al. (2019) compared the ESG and conventional index of developed and emerging markets as a whole and not country-specific, finding no significant difference in performance. Liu et al. (2023) assert that incorporating ESG indices into an investment portfolio offers the advantage of diversification, a principle aligned with modern portfolio theory that effectively lowers overall portfolio risk. ESG factors assume a pivotal role in diversification by mitigating idiosyncratic risks. Additionally, ESG factors may influence a company's systematic risk (beta). Companies with poor ESG practices may face higher systematic risks due to regulatory changes, climate-related events, or shifts in consumer preferences. Hartzmark and Sussman (2019) found that stocks with higher sustainability rankings had higher valuations, suggesting that investors consider ESG factors when pricing assets. Friede et al. (2015) found a positive correlation between ESG factors and financial performance in most cases. This suggests that integrating ESG considerations can lead to better risk-adjusted returns.

Several studies found that ESG investing can offer downside protection during market downturns, which is an important consideration for investors seeking to manage risk in their portfolios (Albuquerque et al. 2020; Broadstock et al. 2021; Engelhardt et al. 2021; Lau 2019). On the other hand, several studies indicate that ESG investment is not necessarily a surefire strategy to perform better during a crisis (Abedifar et al. 2023; Folger-Laronde et al. 2022). Also, Lashkaripour (2023) analyzed that high ESG stocks have higher tail risk compared to low ESG stocks during a market crash. Revelli and Viviani (2015), based on a meta-analysis of 85 studies and 190 tests, have suggested that incorporating corporate social responsibility into stock market portfolios does not confer a distinct advantage or disadvantage relative to traditional investments. Bannier et al. (2023) investigated the returns of US firms from 2003 to 2017 and discovered that the return decreased more strongly than the corresponding risk with increasing corporate social responsibility activity.

Most studies that have looked at the connection between ESG and corporate financial performance have discovered a positive correlation, though the strength of this correlation varies depending on the ESG factors considered, industry sector, and geographic location of the companies (Suresha et al. 2022; Kim and Li 2021; Dalal and Thaker 2019; Zhao et al. 2018).

Edmans (2023) mentioned in his research that ESG is both extremely important and nothing special. It is important not to excessively applaud companies solely for enhancing their ESG performance, as compared to other intangible aspects. ESG factors play a crucial role in determining a company's long-term financial value. Evaluating a company's long-term prospects and considering various factors beyond short-term financial gains is not exclusive to ESG investing; rather, it constitutes fundamental investing practices. The term "ESG investing" can be misleading, as it is more accurate to describe it as "ESG analysis." The process involves thoroughly assessing Environmental, Social, and Governance factors to gain a comprehensive understanding of a company's overall performance and potential risks and opportunities.

Singhania and Saini (2023) highlight that ESG disclosure in both developed and emerging markets is driven by a combination of voluntary and mandatory codes, with an emphasis on environmental commitment. Their study suggests that comprehensive governance measures, including sustainability reporting and integrated reporting, are crucial to uplift ESG practices. These practices, when adopted, can bridge the gap between unsustainability and sustainability, potentially impacting risk-adjusted returns positively by reducing information asymmetry and enhancing resilience in business operations.

With inconclusive results and limited exploration of all geographies, there is a need to understand the risk and return dynamics between sustainable and conventional indices. The variation in ESG disclosures may result in differing performance outcomes for ESG-focused companies in developed and emerging markets. Thus, this study aims to assess the performance of ESG indices in comparison to broad-based indices investments across different geographical regions, encompassing both developed and emerging markets with significant GDP. We conduct a comprehensive analysis of the performance of ESG indices relative to broad-based indices investments in key countries, including the United States, Germany, and Japan, representing the developed economies, and India, Brazil, and China, representing emerging economies. This study uses various risk-adjusted measures and captures downside volatility for evaluating the performance of ESG indices with respect to the broad market indices of that respective country. The conditional volatility of indices is measured through ARCH-GARCH analysis. The impact of news on ESG indices as compared to market indices is also captured in both developed and emerging markets. Through this comprehensive examination across different geographies, we aim to provide a thorough understanding of the risk–return profile of ESG investments relative to broad-based indices investments in both developed and emerging markets.

3. Data Analysis and Methodology

This study explores the performance of ESG investment across different geographies and from the context of developed markets having high GDP, indices of USA, Germany, and Japan are taken, and for emerging nations, indices of India, Brazil, and China are taken. To test the performance of ESG indices to the overall market, the indices reflecting the broad market in each of these countries are also taken. All the indices taken in this study are from large and mid-cap stocks (Table 1). This was carried out to obtain an unbiased result (Ahern 2009). This study captures daily data of ESG indices of six countries from the MSCI database from 1 January 2017 to 31 December 2022. The daily log return of 1564 days was taken. Log returns provide a continuous representation of the return process, which is particularly useful when dealing with continuously compounded returns. The rolling annual return for all indices has also been estimated.

$$R_{it} = \ln\left(\frac{P_{it}}{P_{i,t-1}}\right) \quad (1)$$

In Equation (1), R_{it} represents the daily log return of indices at day t, P_{it} is the closing price of indices at day t, and $P_{i,t-1}$ is the closing price of indices at day $t-1$. The treasury bill rate of each country has been taken as a proxy for the risk-free rate of return for analyzing the risk-adjusted return of ESG indices. T-Bill has been taken from www.worldgovernmentbonds.com (accessed on 4 April 2023), which is adjusted on a daily basis.

Table 1. MSCI Indices.

Symbol	MSCI Indices Description
USA	USA Standard (Large and Mid Cap.)
USAESG	USA ESG Leaders Standard (Large and Mid Cap.)
GER	Germany Standard (Large and Mid Cap.)
GERESG	Germany ESG Leaders Standard (Large and Mid Cap.)
JAP	Japan Standard (Large and Mid Cap.)
JAPESG	Japan ESG Leaders Standard (Large and Mid Cap.)
IND	India Standard (Large and Mid Cap.)
INDESG	India ESG Leaders Standard (Large and Mid Cap.)
BRZ	Brazil Standard (Large and Mid Cap.)
BRZESG	Brazil ESG Leaders Standard (Large and Mid Cap.)
CHN	CHINA Standard (Large and Mid Cap.)
CHNESG	China ESG Leaders Standard (Large and Mid Cap.)

3.1. Risk Return Analysis

For comparing the performance of ESG indices concerning the market performance, the following measures are adopted.

The Sharpe Ratio (Sharpe 1966) calculates a portfolio's risk-adjusted return. It measures how well a portfolio is doing in relation to the level of risk taken by taking into consideration both the returns and the volatility (risk) of the portfolio. The Sharpe Ratio of ESG indices will measure the amount of return ESG investment generates more than the risk-free rate relative to the amount of risk taken on by the investment.

$$\text{Sharpe Ratio } p = \frac{R_p - R_f}{\sigma_p} \quad (2)$$

where R_p is portfolio return R_f is risk-free rate of return, and σ_p is the standard deviation of the portfolio.

The Treynor Ratio (Treynor 1965) measures the amount of return ESG indices generate more than the risk-free rate relative to the amount of systematic risk taken on by the investment. Systematic risk is a risk that cannot be mitigated by diversifying one's portfolio and is tied to overall market movements. It is a non-diversifiable risk, and it is a trend regression of portfolio returns against the market return (Nurhayati et al. 2021). The Sharpe Ratio measures the excess return of an investment relative to all types of risk taken on, while the Treynor Ratio measures the excess return of an investment relative to only the systematic risk taken on.

$$\text{Treynor's Ratio } p = \frac{R_p - R_f}{\beta_p} \tag{3}$$

where β_p is the beta of the portfolio, which measures the systematic risk of the portfolio.

Jensen's alpha (Jensen 1968) measures the performance of ESG indices relative to the risk-adjusted performance predicted by the CAPM. A positive alpha indicates that the portfolio outperformed its expected return, while a negative alpha indicates that the ESG indices have underperformed. Jensen's alpha calculates a security's or portfolio's abnormal return over the theoretical expected return. It is computed as follows:

$$Jensen'sAlpha(\alpha) = (R_p - R_f) - \beta_p(R_m - R_f)$$

$$(R_p - R_f) = \alpha + \beta_p(R_m - R_f) + \epsilon_{it} \tag{4}$$

where α is the excess return of the portfolio, and R_m is the average return of the market.

Prospect theory is widely regarded as the best available theory to describe people's decisions under risk and uncertainty (Wakker 2010; Barberis 2013; Ruggeri et al. 2020). One of its central components is loss aversion, the assumption that people are more sensitive to losses than to commensurate gains (Kahneman and Tversky 1979; Tversky and Kahneman 1992). Maximum drawdown is a measure of the largest loss an investment has experienced from its peak value to its lowest point. It is often used to evaluate the risk of an investment. Maximum drawdown is an important measure for investors because it indicates the potential losses that could occur in a portfolio. A higher maximum drawdown implies greater risk and volatility, whereas a lower maximum drawdown suggests a more stable and consistent return profile. In the context of our indices, maximum drawdown refers to the largest percentage decline in the value of an index from its peak to its trough over a specific period. It was calculated by comparing the highest point of the index to the lowest point of the index during that period.

While traditional measures of volatility, such as standard deviation, capture the variability of an investment's returns in both positive and negative directions, downside volatility focuses only on the negative returns, which are typical of greater concern to investors. We have taken the standard deviation of negative returns of indices. This provides a measure of the investment's downside risk ($d\sigma_p$) .

The Sortino Ratio calculates an investment portfolio's excess return in relation to its downside risk (Sortino and Van Der Meer 1991). The portfolio's risk-adjusted performance improves with a larger Sortino Ratio. Unlike the Sharpe Ratio and the Treynor Ratio, which use the standard deviation or beta as the risk measure, the Sortino Ratio uses the downside deviation as the risk measure. This makes it particularly useful for evaluating investments that have a skewed or asymmetric distribution of returns, such as investments that have a higher likelihood of generating negative returns.

$$\text{Sortino's Ratio } p = \frac{R_p - R_f}{d\sigma_p} \tag{5}$$

where $d\sigma_p$ is the downside risk of the portfolio.

We also investigated the sensitivity of ESG indices to the up and down movement of the market. Upside beta and downside beta are essential risk measures that provide insights into an investment's behavior during bull and bear market phases. Upside beta measures the sensitivity of return of security when there is a positive change in the market. Downside beta measures the change in return of security when there is a fall in the market. By using upside beta and downside beta, investors can better understand the characteristics of investment risk and make more informed decisions about portfolio development and management (Estrada 2002; Gupta 2020).

$$r_i \ = \alpha + \beta_{1i} r_m + \beta_{2i}\ D_0 r_m + e_i \tag{6}$$

where $D_0 = 1$ when $r_m < 0$ and $D_0 = 0$ when $r_m > 0$.

In the downside market, $D_0 = 1$, and the coefficient of r_m will be $\beta_{1i} + \beta_{2i}$ and will be referred to as downside beta, whereas in the upside market, the coefficient of r_m will be only β_{1i}, which will be upside beta. The significance of β_{2i} will indicate whether a difference exists between upside and downside beta. Furthermore, if the value of β_{2i} is positive, it indicates that the downside beta is more than the upside beta, and if its value is negative, it indicates that the downside beta is less than the upside beta.

3.2. Unit Root Test

Stationarity is a statistical property of a time series, meaning that the time series has a constant pattern of mean, variance, and autocorrelation over time. The Augmented Dickey–Fuller test (ADF) (Baum 2000) is a statistical test used to determine whether a time series is stationary or nonstationary. The null hypothesis for the ADF test is that the time series has a unit root and is nonstationary, whereas the alternative hypothesis is that the time series is stationary.

$$\Delta y_t \ = \propto_0 + \beta y_{t-1} + \sum_{i=1}^{n} \delta_i \Delta y_{t-i} + e_t \tag{7}$$

In Equation (7), 'Δy_t' indicates data in time t, 'n' is the optimum number of lags, $\propto_0$ is constant, and 'e_t' is an error term. β is the coefficient on y_{t-1}, which tests for the presence of unit root, and δ_i are coefficients on lagged differenced values of the time series, which capture the autocorrelation structure of the data.

3.3. Volatility Models

The term "heteroscedasticity" refers to a situation where the variance of a variable is not constant over time but instead varies with the level of the variable or with time. This contrasts with "homoscedasticity", which refers to a situation where the variance of a variable is constant over time or across different levels of the variable.

Instead of assuming that a time series variance is constant through time, the ARCH model (Engle 1982) models variance as a function of past values, allowing for heteroscedasticity. Specifically, the model implies that an error term, which is supposed to have a normal distribution with a mean of zero and a constant variance, determines the variance of a time series at time t.

The ARCH model in Equation (9) is often used in conjunction with other time series models, such as autoregressive integrated moving average (ARIMA) models, to model financial and economic time series data that exhibit heteroscedasticity. In this ARIMA (1,1), Equation (8) is taken as simple mean model that combines autoregressive (AR), differencing (I), and moving average (MA) components to capture and predict patterns in time series data.

$$y_t = c + \phi_1\ y_{t-1} + \theta_1 \epsilon_{t-1} + \epsilon_t \tag{8}$$

where Y_t is the value of the time series at time t, c is a constant or drift term. ϕ_1 is the autoregressive parameter, representing the influence of the previous value Y_{t-1} on the current value Y_t. θ_1 is the moving average parameter, representing the influence of the previous error term ϵ_{t-1} on the current value Y_t. ϵ_t is a white noise error term at time t.

$$u_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \gamma_2 u_{t-2}^2 + \ldots + \gamma_p u_{t-p}^2 + v_t \tag{9}$$

In Equation (9), u_t^2 represents the conditional variance or volatility at time t. γ_0 represents the intercept term, which is the constant component of conditional variance. γ_p are the coefficients associated with the lagged conditional variances. u_{t-p}^2 coefficients determine the extent to which past squared returns influence the current conditional variance. v_t represents the white noise error term at time t, often assumed to be normally distributed with mean zero and constant variance.

The null hypothesis in the ARCH-LM test is to check the significance of coefficients of squared residual and if these coefficients are insignificant $\gamma_0 = \gamma_1 = \gamma_2 = \gamma_p = 0$ it implies that there is no heteroscedasticity in data, indicating the absence of the ARCH effect. However, ARCH of higher order may pose complexity in the model; therefore, Bollerslev (1986) proposed the generalized autoregressive conditional heteroscedasticity (GARCH) model.

In addition, the ARCH model called GARCH (generalized autoregressive conditional heteroscedasticity) provides for the possibility that a time series' variance may also be influenced by its historical volatility. The GARCH (p,q) model is a model representation with 'p' lagged squared residual terms and 'q' lagged conditional variance terms. The GARCH (1,1) model is a relatively simple and parsimonious model, yet it is flexible enough to capture some key features of financial time series data, such as volatility clustering and the persistence of volatility shocks. Financial time series often exhibit volatility clustering, where periods of high volatility tend to follow periods of high volatility, and periods of low volatility tend to follow periods of low volatility.

The GARCH (1,1) can be represented as

$$h_t^2 = \omega + \alpha\, \varepsilon_{t-1}^2 + \beta\, h_{t-1}^2 \tag{10}$$

As for the variance h_t^2 in Equation (10), h_t^2 depends on both the mean volatility level (ω) and the prior day's news (ε_{t-1}^2), as well as the variance (h_{t-1}^2). The coefficients α and β correspond to the ARCH and GARCH terms, respectively, with α representing the ARCH effect that gauges the reaction to any shock or message, while β identifies the persistence of volatility through the GARCH effect. A high value of GARCH(β) indicates the presence of enduring volatility, requiring a more extensive duration for the decay in volatility. Conversely, a high coefficient for ARCH (α) implies an increase in volatility sensitivity to incoming news (Rastogi 2014). The sum of α and β must be less than one for the GARCH model to remain stable; otherwise, the data manifest an explosive nature (Endri et al. 2021). Nevertheless, the GARCH model's symmetrical treatment of the impact of both positive and negative shocks on conditional variance is a significant limitation of the model.

3.4. Modelling Asymmetric Volatility

As an extension of the GARCH model, the EGARCH model (exponential generalized autoregressive conditional heteroscedasticity) provides for the possibility that the effects of both positive and negative shocks on the conditional variance of a time series may be asymmetric.

The importance of the EGARCH model (Nelson (1991)) comes from its capacity to indicate the conditional variance's unequal response to positive and negative shocks, which is frequently seen in time series data in the financial and economic sectors. Leverage effects, which the model also leaves open, lead to negative shocks having a higher influence on conditional variance than positive shocks of the same magnitude. The model is commonly used to capture the impact of shocks on various financial markets. Baur (2012), Gupta et al. (2022), and Campbell and Hentschel (1992) also observed that bad news causes higher volatility than positive news. This behavior in financial markets is mostly due to the leverage effect on volatility.

$$\ln\left(h_t^2\right) = \omega + \alpha \left\lfloor \frac{u_{t-1}}{h_{t-1}} \right\rfloor + \lambda \frac{u_{t-1}}{h_{t-1}} + \beta \ln h_{t-1}^2 \tag{11}$$

The log of return data variance $\ln\left(h_t^2\right)$ has an exponential leverage impact instead of a quadratic one. This modification ensures that the estimations remain non-negative. In Equation (11), ω is constant; the ARCH effect is captured by α, which models the influence of previous news (u_{t-1}) and the size effect of the news. The λ coefficient identifies the asymmetric effect of news on volatility. If $\lambda > 0$, it indicates that positive news in the past tends to increase market volatility more than negative news. Conversely, if $\lambda < 0$, negative shocks in the series cause more volatility than positive shocks. Thus, bad news has an impact of $\alpha - \gamma$, and good news has an impact of $\alpha + \gamma$ on the volatility. The coefficient of the GARCH term (β) indicates the persistence of volatility. Nevertheless, it is generally expected that negative shocks in financial markets further increase volatility (Urom et al. 2021).

4. Empirical Results

This study explores the performance of ESG indices with the broad market indices of the respective countries. The summary statistics of all the indices are given in Table 2, and the correlation matrix of indices is given in Table 3. The performance of indices by estimating a one-year rolling return across the period has been evaluated, and the summary is given in Table 4.

Table 2. Descriptive analysis of daily return.

	USA	USAESG	GER	GERESG	JAP	JAPESG	IND	INDESG	BRZ	BRZESG	CHN	CHNESG
Mean	0.0004	0.0004	0.0001	0.0001	0.0001	0.0001	0.0004	0.0005	0.0001	−0.0001	0.0001	0.0001
Median	0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0007	0.0007	0.0004	0.0000	0.0002	0.0000
Maximum	0.0899	0.0946	0.1024	0.0969	0.0710	0.0698	0.0917	0.0979	0.1516	0.1317	0.1358	0.1565
Minimum	−0.1292	−0.1292	−0.1509	−0.1421	−0.0652	−0.0642	−0.1550	−0.1467	−0.1942	−0.1923	−0.0853	−0.0963
Std. Dev.	0.0126	0.0126	0.0136	0.0132	0.0106	0.0106	0.0127	0.0124	0.0218	0.0224	0.0151	0.0178
Skewness	−0.8998	−0.8257	−0.7770	−0.6678	−0.0573	−0.0492	−1.6390	−1.3557	−1.2376	−0.9264	0.2739	0.3308
Kurtosis	18.7801	19.1406	18.3359	17.0106	6.8516	6.6468	24.0091	22.9574	16.6722	12.7294	9.7472	9.4038
No. of Days	1564	1564	1564	1564	1564	1564	1564	1564	1564	1564	1564	1564

Table 3. Correlation matrix.

	USA	USA ESG	GER	GER ESG	JAP	JAP ESG	IND	IND ESG	BRZ	BRZ ESG	CHN	CHN ESG
USA	1.0000	0.9941	0.5629	0.5464	0.1635	0.1581	0.2930	0.2911	0.5139	0.4822	0.3229	0.2704
USA ESG	0.9941	1.0000	0.5626	0.5476	0.1594	0.1541	0.2910	0.2891	0.5070	0.4777	0.3107	0.2608
GER	0.5629	0.5626	1.0000	0.9906	0.3002	0.2932	0.4725	0.4708	0.4547	0.4230	0.3830	0.3418
GER ESG	0.5464	0.5476	0.9906	1.0000	0.2918	0.2849	0.4702	0.4696	0.4416	0.4111	0.3671	0.3272
JAP	0.1635	0.1594	0.3002	0.2918	1.0000	0.9921	0.3047	0.3139	0.1823	0.1660	0.3030	0.2855
JAP ESG	0.1581	0.1541	0.2932	0.2849	0.9921	1.0000	0.3044	0.3136	0.1768	0.1598	0.3054	0.2883
IND	0.2930	0.2910	0.4725	0.4702	0.3047	0.3044	1.0000	0.9803	0.3303	0.3102	0.3967	0.3672
IND ESG	0.2911	0.2891	0.4708	0.4696	0.3139	0.3136	0.9803	1.0000	0.3239	0.3049	0.3987	0.3682
BRZ	0.5139	0.5070	0.4547	0.4416	0.1823	0.1768	0.3303	0.3239	1.0000	0.9694	0.3068	0.2597
BRZ ESG	0.4822	0.4777	0.4230	0.4111	0.1660	0.1598	0.3102	0.3049	0.9694	1.0000	0.2692	0.2270
CHN	0.3229	0.3107	0.3830	0.3671	0.3030	0.3054	0.3967	0.3987	0.3068	0.2692	1.0000	0.9689
CHN ESG	0.2704	0.2608	0.3418	0.3272	0.2855	0.2883	0.3672	0.3682	0.2597	0.2270	0.9689	1.0000

Table 4. Descriptive analysis of one-year rolling return.

	USA	USAESG	GER	GERESG	JAP	JAPESG	IND	INDESG	BRZ	BRZESG	CHN	CHNESG
Mean	0.1333	0.1369	0.0127	0.0189	0.0408	0.0411	0.1124	0.1304	0.0357	−0.0253	0.0333	0.0548
Median	0.1364	0.1407	0.0177	0.0220	0.0485	0.0646	0.0635	0.1059	0.0270	−0.0265	−0.0192	0.0028
Max	0.8079	0.7681	0.8806	0.8467	0.6507	0.6034	1.0454	1.0573	0.7977	0.5944	0.6527	0.8002
Min	−0.2166	−0.2367	−0.3864	−0.3965	−0.2987	−0.3158	−0.3937	−0.3372	−0.4874	−0.4565	−0.4832	−0.5488
St. Dev	0.1669	0.1626	0.2157	0.2107	0.1607	0.1599	0.2278	0.2050	0.2287	0.2201	0.2720	0.3339
Skew	0.3575	0.2325	0.6138	0.5415	0.2785	0.0286	1.0004	0.9986	0.1221	0.3147	0.2062	0.2384
Kurtosis	0.5455	0.3781	0.7088	0.8859	−0.0825	−0.3221	0.8973	1.4110	−0.3413	−0.6439	−1.0238	−1.1492
Count	1306	1306	1306	1306	1306	1306	1306	1306	1306	1306	1306	1306
C.L(95.0%)	0.0091	0.0088	0.0117	0.0114	0.0087	0.0087	0.0124	0.0111	0.0124	0.0119	0.0148	0.0181

It is observed that the average and median daily returns for both ESG and market indices in each country are comparable (Table 2). However, when examining one-year rolling returns, ESG demonstrates relatively superior mean and median returns compared to the broader index. USAESG (13.69%) and India ESG (13.04%) provide the best returns among the six nations. Even the volatility measured by standard deviation on one-year rolling data in ESG indices is lower than the diversified market for all nations except the Chinese market (Table 4). Furthermore, the T-Test shows that there is a significant difference between the one-year rolling returns of the market with ESG indices across all six countries. This indicates that, daily, there seems to be no difference between the performance of broad market indices and ESG indices across both developed and emerging nations. However, when assessing one-year rolling returns, ESG indices outperform the overall market indices in all countries except Brazil (Table 5). The correlation matrix (Table 3) also indicates the same result as in all six countries; the correlation value between the respective broad and ESG index was more than 0.9, even though different markets among themselves showed varied correlations in which the correlation between the USA and Germany is the highest (0.56), and the lowest is between the USA and Japan (0.16). In comparing the performance of indices on an annual rolling returns basis, in all countries besides Brazil, it is observed that the performance of ESG indices is better, thus indicating that ESG indices outperform.

Table 5. T-Test: two sample mean comparison test.

	Daily Returns			Rolling Annual Return		
	Diff of Mean	**T-Value**	**Prob**	**Diff of Mean**	**T-Value**	**Prob**
USAESG-USA	−0.0002	0.5553	0.5788	0.003546 *	6.5427	0.000
GERESG-GER	0.0000	−0.1675	0.8670	0.006199 *	8.59408	0.000
JAPESG-JAP	0.0000	−0.2031	0.8391	0.000301 ***	1.9238	0.0546
INDESG-IND	0.0000	0.2442	0.8071	0.018006 *	12.9403	0.000
BRZESG-BRZ	0.0001	−0.8517	0.3945	−0.06093 *	−28.11454	0.000
CHNESG-CHN	−0.0002	1.5071	0.1320	0.021499 *	10.5262	0.000

1% Sig. *, 10% Sig. ***.

On analyzing the performance of ESG indices for one-year rolling returns on risk-adjusted return parameters (Table 6(ii)), we observe that the USA and India have comparatively better Sharpe, Treynor, and Sortino Ratios than the other countries. One of the key motivations for investors is to invest in the portfolio to generate superior returns from the market and to generate positive and significant alpha. As seen from Table 7, in none of the markets were ESG indices able to generate positive alpha on analyzing daily returns. Even the beta of all ESG indices was close to one, and the adjusted R square was close to one, which indicates the ESG index almost replicates the broad indices other than the USAESG index, whose beta (0.38) signifies lower systematic risk. However, on analyzing the performance for one-year rolling returns (Table 8), we observe that ESG indices across all countries other than Brazil generate positive significant alpha, with the Indian ESG index having the highest alpha of 4.82%, followed by China with an alpha of 1.49%. It is evident that by evaluating performance on a one-year rolling return, we see a significant difference in the ESG index and overall market index, which is not so with daily return observations.

Table 6. Risk adjusted return measures of ESG Indices.

(i). Performance of ESG Indices on Daily Returns						
	USAESG	**GERESG**	**JAPESG**	**INDESG**	**BRZESG**	**CHNESG**
Sharpe Ratio	0.0033	0.0276	0.0116	−0.0082	0.0000	0.0026
Treynor's Ratio	0.0001	0.0003	0.0002	−0.0001	0.0000	0.0001
Sortino's Ratio	0.0055	0.0419	0.0180	−0.0136	0.0001	0.0041
(ii). Performance of ESG Indices on Annual Rolling Returns						
	USAESG	**GERESG**	**JAPESG**	**INDESG**	**BRZESG**	**CHNESG**
Sharpe Ratio	0.5458	−0.0645	0.2573	0.2955	−0.7146	0.0988
Treynor Ratio	0.0871	−0.0131	0.0387	0.0745	−0.1467	0.0281
Sortino Ratio	1.8405	−0.1262	0.5374	1.1756	−1.2348	0.2193

Table 7. Result of CAPM—daily return.

	Alpha	**T-Value**	**Beta**	**T Value**	**Adj. R^2**	**F-Value**
USAESG	0.0001	0.1624	0.3861	13.3892	0.1024	179.2694
GERESG	0.0000	0.3447	0.9659	286.1195	0.9813	81,864.3412
JAPESG	0.0000	−1.6001	1.0007	312.7198	0.9843	97,793.6859
INDESG	0.0001	1.1453	1.0007	195.9558	0.9609	38,398.6906
BRZESG	−0.0002	−1.6001	0.9967	156.0876	0.9397	24,363.3440
CHNESG	0.0000	−0.1458	1.1437	154.7615	0.9397	23,951.1113

Table 8. Result of CAPM—annual rolling return.

	Alpha	**T-Val**	**Beta**	**T-Val**	**Adj. R^2**	**F-Value**
USAESG	0.0012 *	2.4881	1.0195	313.0370	0.9921	97,992.1872
GERESG	0.0098 *	28.2001	1.0341	163.0579	0.9793	26,587.8813
JAPESG	0.0020 *	6.0156	1.0644	192.3274	0.9793	36,989.8455
INDIAESG	0.0482 *	61.0526	0.8129	112.4432	0.9417	12,643.4685
BRAZESG	−0.0415 *	−33.1035	1.0717	56.7976	0.8046	3225.9622
CHINAESG	0.0149 *	29.4931	1.1761	189.3385	0.9786	35,849.0637

1% Sig. *.

Investors are also apprehensive about the maximum drawdown that can happen to their portfolio. It is an important measure of risk that can help investors understand the potential downside of their investments and make informed decisions about their portfolio allocations. We observe from (Table 9) that other than the China ESG index, the max drawdown is relatively less than the benchmark indices. The Sortino Ratio (Table 6(ii)) of all ESG indices was more than the Sharpe Ratio, which also indicated that downside volatility in ESG indices is less than the overall volatility.

Table 9. Max drawdown.

USA	GER	JAP	IND	BRZ	CHN
−34.16%	−46.56%	−35.42%	−43.14%	−57.08%	−62.54%
USAESG	**GERESG**	**JAPESG**	**INDESG**	**BRZESG**	**CHNESG**
−34.07%	−43.37%	−35.12%	−39.42%	−55.79%	−67.68%

In evaluating the performance of a portfolio, investors do look for downward risk associated with their investment, as any volatility on the upside may not be of much concern to investors, but any loss in the portfolio is an important criterion in investors' decision-making. We have estimated the downside and upside sensitivity of ESG indices concerning the market. Investors like to prefer an upside beta higher than a downside beta to capitalize on upside volatility and to minimize the loss in a downtrend. There is no significant difference between the upside and downside beta of the Indian ESG and USA ESG indices. However, in Germany, Japan, Brazil, and China, ESG indices downside beta was marginally lower than the upside beta (Table 10).

Table 10. Upside and downside beta of ESG indices.

		Coefficients	T Statistics	*p*-Value
USAESG	Upside Beta	0.3492	7.1413	0.0000
	Dummy	0.0689	0.9345	0.3502
	Downside Beta	0.4181		
GERESG	Upside Beta	1.0014	214.5653	0.0000
	Dummy	−0.0166 *	−2.3625	0.0183
	Downside Beta	0.9848		
JAPESG	Upside Beta	0.9754	166.9043	0.0000
	Dummy	−0.0167 ***	−1.8523	0.0642
	Downside Beta	0.9588		
INDESG	Upside Beta	1.0010	178.9532	0.0000
	Dummy	−0.0004	−0.0485	0.9613
	Downside Beta	1.0005		
BRZESG	Upside Beta	0.9900	109.5731	0.0000
	Dummy	−0.0454 *	−3.3879	0.0007
	Downside Beta	0.9446		
CHNESG	Upside Beta	1.0270	88.6815	0.0000
	Dummy	−0.0519 *	−2.9265	0.0035
	Downside Beta	0.9750		

Significance level for 1% level *, 10% level ***.

Volatility clustering is a prominent phenomenon that is observed in financial time series, in conjunction with variance measures that capture the risk in index return series. Clustering denotes the occurrence of high volatility followed by subsequent periods of high volatility, as well as low volatility followed by times of low volatility. Consequently, studying this phenomenon is of paramount importance. Index series, being financial stochastic series, are susceptible to exhibiting a unit root. A financial series is considered to possess a unit root when a systematic pattern is detected, resulting in the possibility of a spurious relationship. To establish the presence of a unit root in the closing values of all the index series, the ADF tests have been employed, wherein the null hypothesis posits that a unit root exists in the series.

At level, all the series were nonstationary; however, at first difference series were stationary. The stationarity was tested by Augmented Dickey–Fuller (ADF) unit root test (Table 11).

Table 11. Unit root test for stationarity Augmented Dickey–Fuller test.

	USA	USAESG	GER	GERESG	JAP	JAPESG	IND	INDESG	BRZ	BRZESG	CHN	CHNESG
ADF	−11.9007	−11.8307	−25.5862	−25.4116	−40.9784	−40.9756	−16.1878	−16.249	−42.7107	−42.029	−36.0809	−37.0997
p Val	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

As seen in Figure 1, heteroscedasticity is present in all the series, which is further tested using the ARCH-LM test. The LM test statistic, along with the probabilities (Table 12), suggests the presence of an ARCH effect in all the indices and confirms that the corresponding residuals constitute white noise. Consequently, the current study proceeds to estimate the GARCH (1, 1) model for all the indices. Upon examining the GARCH model (Table 13), it is observed that both the ARCH coefficient (α) and GARCH coefficient (β) are significant at the 1% level. The sum of these coefficients for all the indices is less than one. This indicates the presence of both short and long-term persistency in volatility for all the indices.

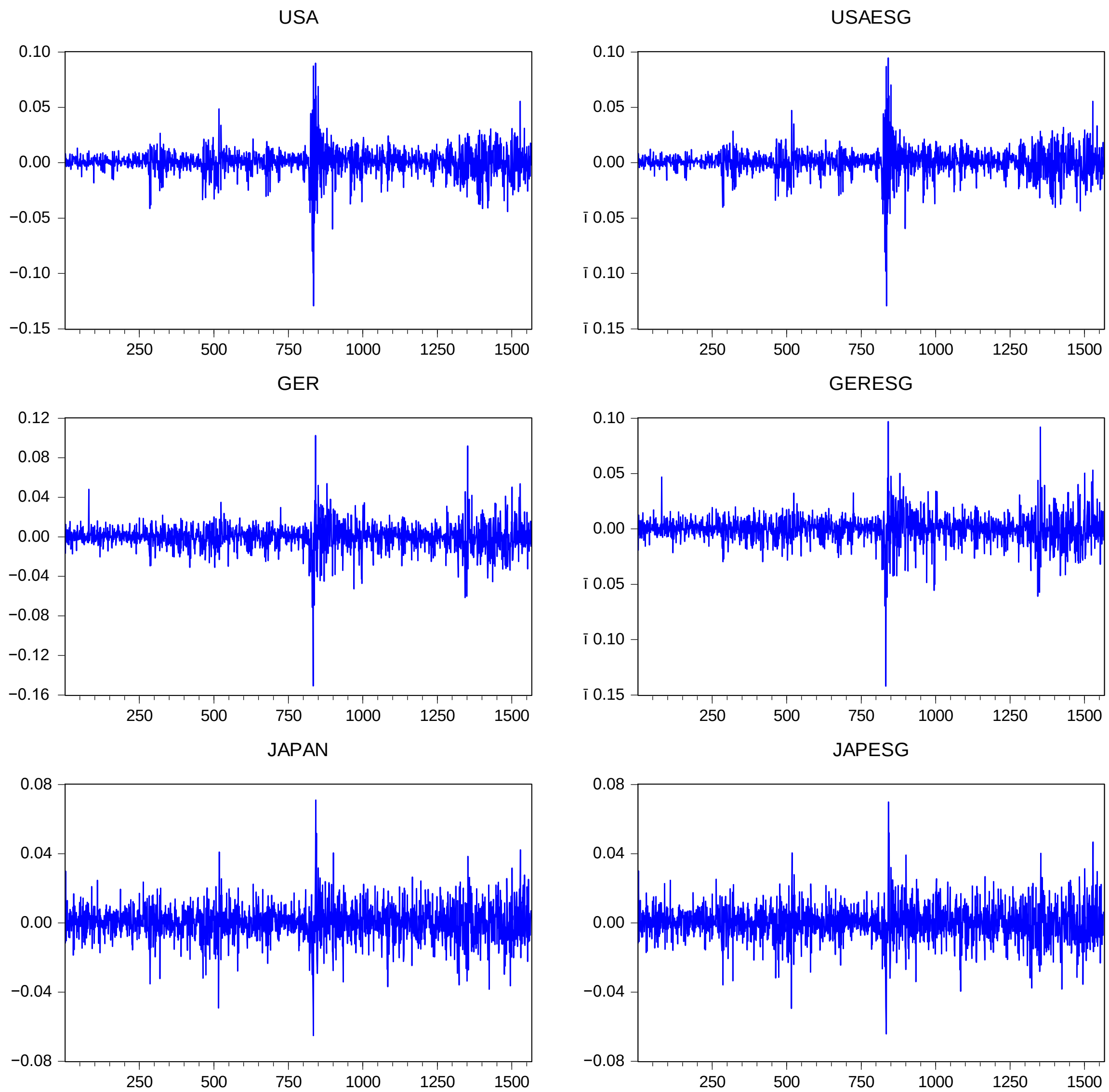

Figure 1. *Cont.*

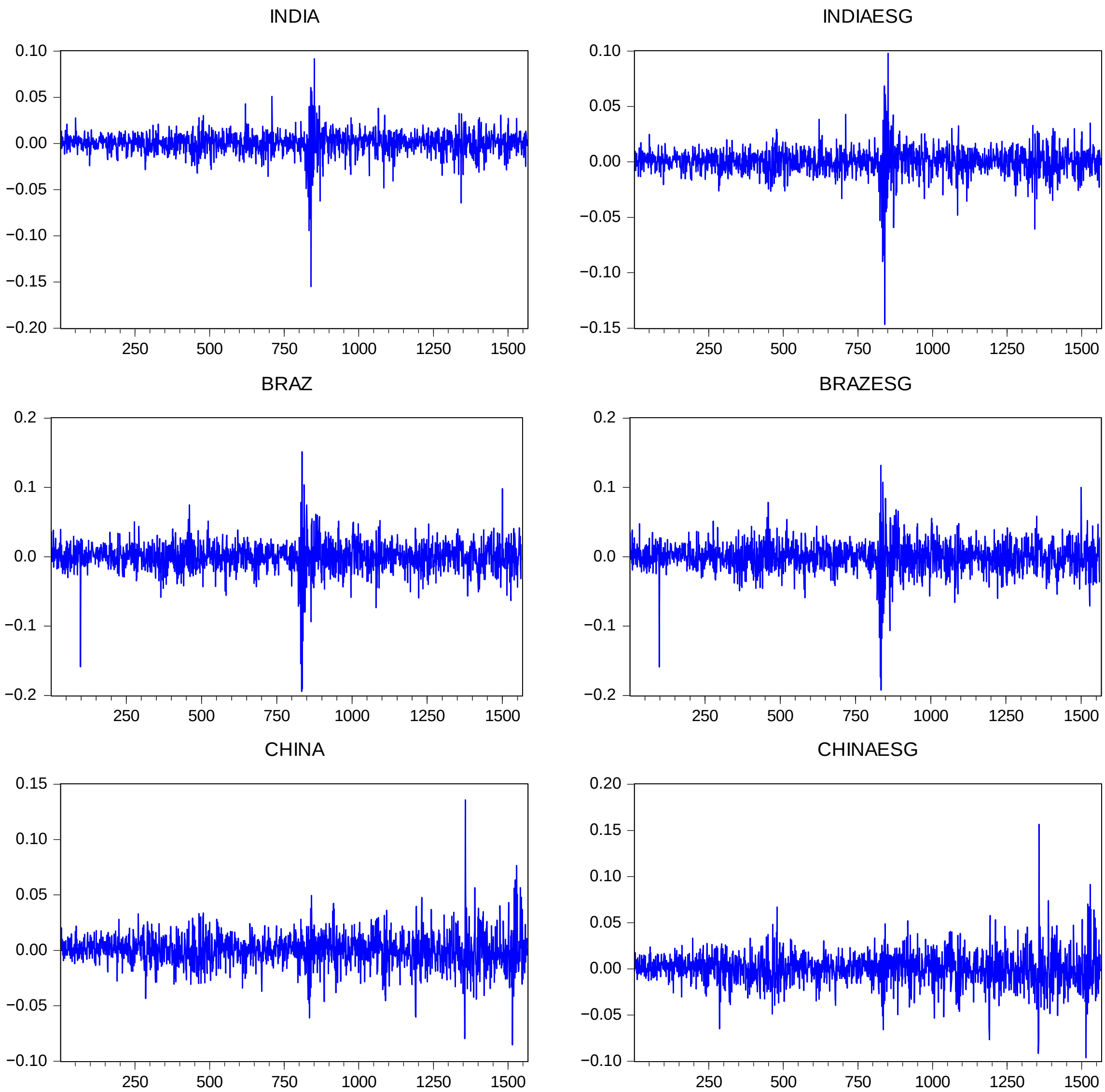

Figure 1. Daily Return of all Indices.

Table 12. ARCH LM test.

	USA	USA ESG	GER	GER ESG	JAP	JAP ESG	IND	IND ESG	BRZ	BRZ ESG	CHN	CHN ESG
F Stats	233.66	227.48	9.50	13.72	72.59	62.28	44.87	64.82	228.65	185.86	58.46	84.37
p-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 13. GARCH (1,1).

	USA		USA ESG		GER		GERESG		JAP		JAPESG	
	Coef.	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
α	0.2138	11.5218	0.2032	11.6048	0.0996	11.6513	0.0971	11.4961	0.1278	7.5722	0.1302	7.6498
β	0.7842	45.9354	0.7896	51.3306	0.8799	81.0020	0.8823	82.0020	0.8151	31.5392	0.8090	31.1521

Table 13. *Cont.*

	IND		INDESG		BRZ		BRZESG		CHN		CHNESG	
	Coef.	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
α	0.0949	8.4068	0.0908	8.4852	0.0901	10.7204	0.0926	8.9018	0.0894	10.0118	0.0852	10.0061
β	0.8748	55.8517	0.8860	61.8466	0.8567	70.0976	0.8552	66.2503	0.8936	74.6527	0.9051	89.3514

To identify the presence of any asymmetric behavior in the volatility of indices, we observe in EGARCH Table 14 that the λ coefficient of the model is negative and significant for all the indices, which indicates that volatility tends to increase more with negative news in both the broad market indices as well as in ESG indices. This is in line with the existing literature (Fostel and Geanakoplos 2012; Gupta and Chaudhary 2022) that negative news brings more volatility in financial markets, and similar findings are observed in ESG indices across all countries. A larger absolute value of gamma implies a greater degree of asymmetry, meaning that negative shocks have an even greater impact on volatility. In comparing the absolute value of λ coefficient of the broad market with the ESG indices of each country, we observe that in all other countries (other than Germany), the impact of asymmetry was less in the ESG index as compared to the respective market.

Table 14. EGARCH.

	USA		USA ESG		GER		GERESG		JAP		JAPESG	
	Coef.	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
ω	−0.6435	−10.3504	−0.5595	−10.5624	−0.2918	−6.8933	−0.1408	−5.6156	−0.4488	−5.9448	−0.4397	−6.1535
α	0.2887	13.9810	0.2864	14.0582	0.1146	7.4087	0.0655	5.2731	0.1504	7.6351	0.1480	7.8673
λ	−0.1395	−11.9187	−0.1304	−11.6487	−0.1226	−15.9075	−0.1478	−13.3448	−0.0930	−7.4241	−0.0893	−7.3271
β	0.9546	167.2299	0.9635	201.1148	0.9769	246.6733	0.9896	410.1815	0.9641	136.0620	0.9649	142.6274
	IND		**INDESG**		**BRZ**		**BRZESG**		**CHN**		**CHNESG**	
	Coef.	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
ω	−0.2512	−5.9149	−0.2520	−5.9053	−0.6729	−6.6409	−0.6641	−7.4643	−0.3952	−6.8627	−0.3320	−6.9612
α	0.0880	4.9953	0.1067	5.5289	0.1703	10.7506	0.1785	9.2771	0.1500	8.0830	0.1537	8.4181
λ	−0.1301	−13.2545	−0.1119	−11.6267	−0.1099	−6.8081	−0.0973	−6.0064	−0.1029	−7.7307	−0.0885	−7.7769
β	0.9795	262.8863	0.9812	267.1397	0.9312	76.6134	0.9323	89.2361	0.9676	166.9113	0.9742	195.2432

5. Discussion

Our study is an attempt to investigate the ESG investment dynamics in high GDP developed and emerging markets by conducting a comparative analysis. Specifically, we analyze the performance of ESG indices in these countries in relation to their respective broad market indices. This study encompasses different facets of risk and returns for evaluating whether ESG investing is justified or is an eyewash. While comparing the performance on a daily return basis, there has been no significant difference in the performance of ESG and the market indices. However, on comparing rolling annual returns, we have observed that other than Brazil's ESG index, all other ESG indices perform better than their respective broad index. This implies that the impact of investing in ESG indices can be observed in the long term, and daily, there is no difference with broad indices. This is primarily because, in daily returns, both indices follow the mean reversion trend; thus, there is no statistical difference in the returns of indices across all the countries (Górka and Kuziak 2022). The USA and India ESG indices show better risk-adjusted returns compared to the other ESG indices. Further, there is no conclusive evidence that developed countries' risk-adjusted returns significantly vary compared to emerging countries.

This study also assesses whether ESG portfolios can effectively mitigate overall portfolio risk, particularly during periods of financial market crises. The maximum drawdown, a key indicator to assess downside risk, shows that of all ESG indices in all of the studied countries other than China, the maximum drawdown value is relatively less than the respective market index. Also, in all countries except the USA and India, it has been observed that the downside beta of ESG indices is notably lower than the upside beta. In the cases of the USA and India, there is no significant difference between the upside and downside beta. Overall, this indicates that the downside sensitivity in ESG indices is less than the upside sensitivity. This is desirable for building a portfolio for investors as rational investors will prefer limited downside risk.

Furthermore, there has been a high presence of volatility clustering across all indices, as shown by GARCH models, and a presence of asymmetric behavior across all indices, as indicated by EGARCH models, but what is observed is that the impact of asymmetricity is less in ESG indices, with Germany being the only exception (Ashwin Kumar et al. 2016). It shows that ESG-compliant stocks depict lower volatility. The findings add relevance to building a portfolio for investors, as negative news coming into the market has a lesser impact on the ESG portfolios.

In our study, we have observed varying responses in both developed and emerging markets. While ESG indices have often outperformed broad market indices, it is important to note that ESG factors are not fixed; they can evolve due to factors like regulatory shifts, changing consumer preferences, and evolving industry norms. Dynamic ESG investment strategies seek to respond to these fluctuations, aiming to enhance risk management and maximize returns (Singhania and Saini 2023).

6. Conclusions

In today's volatile financial landscape, the significance of Environmental, Social, and Governance (ESG) factors in investment choices has surged. This study seeks to address a pivotal query: Does opting for investments in companies that adhere to ESG principles offer a superior choice for investors, regardless of whether they are operating in well-established or emerging markets? To address the query, this study focuses on comparing the performance of ESG indices to broad-based indices investments in various geographies, considering both developed and emerging markets with high GDP. This includes the countries of the USA, Germany, and Japan, which represent developed economies, as well as India, Brazil, and China, which represent emerging economies. The performance of ESG indices across geographies has been compared by using risk-adjusted returns metrics, including the Sharpe Ratio, Treynor's Ratio, and Jensen's alpha. The downside risk involved in investing in ESG indices has been studied by using Sortino's Ratio, maximum drawdown, and comparing upside and downside beta. This study has also explored the impact of negative news by using the EGARCH model on ESG indices as compared to conventional indices in each respective country.

The performance of ESG indices in developed and emerging markets has yielded varied outcomes, and there is no conclusive evidence to suggest that ESG indices exhibit distinct performance patterns in either of these market types. We have not observed any significant difference in daily returns between ESG indices and conventional indices. However, when estimating one-year rolling returns, it is observed that ESG indices of all countries, other than Brazil, provide superior risk-adjusted returns indicated by positive alpha as compared with the overall market indices of that country. ESG portfolios provide better downside risk protection than conventional portfolios, as for most countries, the downside beta was significantly lower than the upside beta. In the cases of the USA and India, there is no significant difference between the upside and downside beta. The negative news appears to have a relatively lower effect on the volatility of all ESG indices other than Germany.

The results indicate that investing in ESG compliance companies can lead to better risk management in portfolio designing as it helps in lowering volatility and protecting the downside risk. This is primarily due to the long-term sustainability of these companies, as these companies are more resilient to potential shocks. The stakeholders tend to value these companies more as they demonstrate a commitment to ethical practices, social responsibility, and environmental stewardship. It thus makes sense to design a portfolio around ESG compliance companies as investors relatively obtain better risk-adjusted returns than the respective markets. This is a positive indicator as it will motivate the companies to push themselves to improve their ESG scores. Consequently, socially responsible companies may attract both domestic and foreign capital at a lower cost compared to their counterparts that are not socially responsible. This creates an opportunity for investors to exert pressure on socially "irresponsible" corporate entities, urging them to adopt suitable strategies and excel in Environmental, Social, and Governance aspects. Ultimately, this contributes to the sustainable development of the economy. There are many regulatory changes taking place for ESG compliance, and also the criterion for ESG compliance is evolving; hence, further research can explore these changes and their impact on the performance of ESG indices. Investigating the influence of specific ESG factors (e.g., climate change, social governance) on investment performance could provide deeper insights into the ESG landscape in diverse global markets.

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