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RESEARCH ARTICLE

Assessing risk profiles of ESG portfolios in global financial markets

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Abstract The incorporation of environmental, social and governance (ESG) factors into private investments is transitioning from a risk management strategy to a catalyst for innovation and novel prospects that benefits both business and society in the long run. The growing prominence of such investments necessitates a comprehensive assessment of their risk under varying market conditions. This research aims to provide a thorough analysis by examining the risk of ESG portfolios across global financial markets (categorised as developed and emerging) during distinct market regimes. The study utilises daily data of representative ESG equity portfolios from developed markets (US and Japan) as well as emerging markets (China and India). The portfolios are divided into sub-periods to accommodate the disparity between the Covid and post-Covid regimes. The study compares and contrasts the volatility patterns of all the ESG portfolios using a GJR-GARCH model that takes into consideration both the conditional variance and asymmetricity in the financial time series. Although the results reveal no clear distinction when comparing return and risk between developed and emerging markets, there is presence of varying performance across market regimes, with all the portfolios showing higher returns and lower risk during the Covid, reflecting dynamic market conditions. Additionally, the asymmetricity in volatility is more during Covid period as compared to the post-Covid period for all the portfolios. The findings provide valuable guidance to asset managers and investors seeking to mitigate portfolio risk by engaging in ESG investing.

Keywords ESG · Covid pandemic · Comparative risk assessment · GJR-GARCH model · Sustainable finance

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Introduction

In recent years, environmental, social and governance (ESG) investing has garnered significant attention as a transformative approach to financial decision-making, reflecting broader societal demands for social reforms, environmental sustainability, fair labour practices and transparent corporate governance (Bhuian and Sharma 2017). The increasing awareness of climate change's adverse impacts has fuelled a growing focus on environmental sustainability among investors worldwide (MacAskill et al. 2021). This shift underscores a fundamental re-evaluation of the traditional perception of finance, emphasising role of

investments in addressing pressing global concerns. Sustainable and responsible investing (SRI) represents a departure from conventional financial paradigms, where ESG factors are intrinsic to investment decisions (Azmi et al. 2019). This approach recognises that investment success is not solely measured by financial returns but also by positive societal and environmental impacts. ESG investing integrates considerations such as climate change, energy efficiency, corporate governance standards and social welfare into investment strategies (de Souza Cunha and Samanez 2013).

The outbreak of the Covid pandemic in 2020 significantly disrupted global demand and supply (Seetharaman 2020) thus in turn impacting financial markets. This mandated the investors to change their strategies across sectors. During crises, investors often seek refuge in assets perceived as more resilient, leading to heightened interest in ESG investments (Bagh et al. 2024). The pandemic highlighted the interplay between sustainability considerations and financial risk, prompting a re-evaluation of investment strategies. Although studies suggest a positive correlation between higher-rated ESG funds and better financial performance, particularly during economic downturns and crises (Becchetti et al. 2015; Pástor and Vorsatz 2020). The impact of varying market regimes on the risk and performance of ESG portfolios remains a critical area of investigation.

While ESG investing has gained traction, empirical studies exploring its risk dynamics across diverse market conditions remain limited, particularly in the context of the Covid pandemic. The research seeks to address the key question: How do ESG portfolios perform in terms of return and risk in different financial markets during distinct market regimes? We have segregated global financial markets into developed and emerging to account for distinct market structure and regulatory frameworks. On the basis of GDP, two countries in each category have been selected, wherein USA and Japan represent developed markets and China and India represent emerging markets.

The paper addresses the need for empirical research that comprehensively assesses the risk profiles of ESG portfolios in global financial markets, particularly during periods of market uncertainty induced by global crises like the Covid pandemic. By examining the risk characteristics of ESG portfolios using advanced quantitative methods, this study bridges existing research gaps and provides evidence-based investment strategies amidst evolving market landscapes and contributes to the advancement of sustainable finance.

Literature review

ESG investing has seen significant growth in the capital markets due to increasing concerns about sustainability (Schröder 2007). This has attracted substantial scholarly attention, particularly in analysing the relationship between incorporation of ESG aspects and corporate financial performance and the disparities in risk–return of ESG and conventional investments (Pérez-Gladish et al. 2013; Durán-Santomil et al. 2019). This literature review provides a comprehensive synthesis of key studies and research perspectives in these areas.

Studies have explored the relationship between ESG and corporate financial performance and concluded a positive correlation. In the meta-analysis of more than 50 studies, Orlitzky et al. (2003) concluded similar results. Nevertheless, the strength of this correlation varies based on factors such as ESG considerations and location of the companies (Suresha et al. 2022; Kim and Li 2021; Dalal and Thaker 2019; Zhao et al. 2018). Kurtz (2020) and Cheng et al. (2014) have also found that the firms incorporating ESG principles into their business have lower financial risk than the counterparts.

Research has indicated that ESG funds have the potential to achieve better financial performance compared to traditional investment funds (Derwall et al. 2005; Renneboog et al. 2008) and have lower degrees of risk as well (Sharma et al. 2023). However, there are studies that contradict the above-mentioned findings. Cummings (2000) and Kreander et al. (2005) have found no significant difference between the ESG and conventional funds. Caporale et al. (2022) compared the ESG indices with market benchmark in both developed and emerging economies and concluded that the two set of indices performed identically. However, the volatility is slightly higher in emerging markets than the developed ones. Similarly, Sudha (2015) found that there was no significant distinction in the returns of ESG and broad-based indices in the

Indian landscape. However, the ESG index exhibited lower volatility.

Research suggests notable divergences in the performance characteristics of ESG and conventional funds, with implications for risk management and portfolio diversification strategies (Cunha et al. 2020). Tripathi and Kaur (2020) and Sharma et al. (2021) have underscored the feasibility of transitioning to ESG investments without incurring significant financial penalties, highlighting the evolving landscape of sustainable investment practices. Notwithstanding the presence of empirical evidence, ongoing debates persist regarding the precise relationship between ESG integration and financial performance as well as the factors that affect it (Anson et al. 2020; Brunet 2019).

Although individual market studies provide useful insights, conducting comparative research that directly compares ESG investing in emerging and developed markets offers a more thorough knowledge of the dynamics of ESG investing (Khan 2022). The global context of ESG investing unveils substantial variations between developed and emerging markets, influenced by distinct market structures, availability of information, regulatory frameworks and investor behaviours (Jamali and Neville 2011; Hopp and Dreher 2013; Bing and Li 2019). Ur Rehman et al. (2016) have also observed that ESG indices exhibit market specific characteristics, suggesting limited global integration compared to conventional market indices. Similarly, Badia et al. (2020) reported that performance of ESG investments is geographically dependent.

A critical aspect of contemporary ESG research pertains to the risk–return profiles of ESG portfolios during periods of market stress, such as the global financial crises and Covid pandemic. Singh and Maurya (2021) concluded that returns on ESG index had positive growth trend even during the period of high market volatility and rising fear in the market. Ouchen (2022) has identified specific ESG portfolios demonstrating lower volatility relative to market benchmarks, hinting at potential risk mitigation benefits in crisis scenarios. Similarly, Albuquerque et al. (2020) found that companies with better ESG ratings experienced increased returns, reduced volatility and improved operating profit margins during the Covid pandemic. On the other hand, Wadhwa (2017) documented that the ESG index performed better during the post-crisis period.

This research compares the returns and risk of ESG portfolios between different market structure and regimes. As per the knowledge of the researchers, no paper has focused on comparing the volatility of ESG portfolios in different markets during different market regimes. Research such as Jain et al. (2019), Caporale et al. (2022) and Ur Rehman et al. (2016) have primarily focused on comparing either returns or risk (or both) of ESG indices with conventional indices. Also, the time period considered in previous research is different. We were unable to find relevant studies that have taken Covid and post-Covid period into account.

Data and methodology

This study employed four ESG equity indices as representative indicators of ESG portfolios in various market scenarios. Indices are preferred over mutual funds because they reduce the potential influence of the fund manager's investment style and strategy (Maitra 2019). More precisely, we have selected the MSCI India ESG Leaders Index and MSCI China ESG Leaders Index to serve as representatives of emerging markets, whereas the MSCI USA ESG Leaders Index and MSCI Japan ESG Leaders Index have been chosen to represent developed markets.

The MSCI Country ESG Leaders Index consists of a selection of companies from the MSCI Country Index, known as the 'Parent Index', which is especially created to reflect the overall performance of the stock market in that particular country. The MSCI Country ESG Leaders Index includes companies that have undergone a thorough evaluation process, which follows strict ESG requirements. The aforementioned criteria consist of eliminating enterprises associated with specific economic activity, as well as evaluating ESG ratings and exposure to ESG issues.

The closing prices of chosen indices are converted into returns to deal with non-stationarity. We have taken 30 January 2020, the day WHO declared the Covid outbreak—a Public Health Emergency of International Concern (PHEIC), as start date of Covid (Sahoo and Kumar 2023) and the study period ranges till 31 December 2023. We have divided the whole period into two sub-periods—during and post-Covid—to account for structural break present in the indices due to Covid pandemic.

1 January 2022 afterwards has been treated as post-pandemic period following other empirical papers (Peng et al. 2024). The specified period has been chosen with the intention of offering a current examination of the volatility of the ESG portfolios within the designated markets.

We utilise the GJR-GARCH model proposed by Glosten et al. (1993) which is an extension of GARCH (Generalised Autoregressive Conditional Heteroskedasticity) model to accurately depict the volatility of the selected ESG portfolios. The chosen model accounts for asymmetric effect in volatility of financial time series. Asymmetric effect is the tendency of volatility of financial time series to be impacted more by the negative shock than a positive shock of the same magnitude.

ARCH models are used to model the conditional variances in time series data. Financial data often exhibit fluctuating levels of volatility, which is described by the non-constant variance of the error term across time. ARCH models are effective in capturing the dynamic nature of volatility which is referred to as volatility clustering, by including the conditional variance as a function of past squared errors. The suggested model can be expressed mathematically in the following manner:

$$\text{ARCH}(p) : \sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{\{t-1\}}^2 + \alpha_2 \varepsilon_{\{t-2\}}^2 + \cdots + \alpha_p \varepsilon_{\{t-p\}}^2$$

where $\sigma^2{}_t$ represents the conditional variance at time 't', $\varepsilon^2{}_{\{t\text{-}i\}}$ refers to the squared error terms from previous time points '$t-i$' and α_0, α_1, α_2, …, α_p are model parameters.

GARCH is an extension of the ARCH model that includes lagged conditional variances and squared error terms. This model enables the comprehension and depiction of the persistent characteristics of sudden and significant changes in volatility over a specific timeframe. The GARCH model can be expressed mathematically in the following manner:

$$\text{GARCH}(p, q) : \sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{\{t-1\}}^2 + \alpha_2 \varepsilon_{\{t-2\}}^2 + \cdots + \alpha_p \varepsilon_{\{t-p\}}^2 + \beta_1 \sigma_{\{t-1\}}^2 + \beta_2 \sigma_{\{t-2\}}^2 + \ldots + \beta_q \sigma_{\{t-q\}}^2$$

where $\sigma^2{}_t$ represents the conditional variance at time 't', $\varepsilon^2{}_{\{t\text{-}i\}}$ denotes the squared error terms and α_0, α_1, α_2, …, α_p and β_1, β_2, …, β_q are the parameters of the model.

The GJR model is a modification of GARCH that includes an extra component to accommodate for asymmetries. Now, the conditional variance is expressed as

$$\begin{aligned}\sigma_t^2 = {} & \alpha_0 + \alpha_1 \varepsilon_{\{t-1\}}^2 + \alpha_2 \varepsilon_{\{t-2\}}^2 + \cdots \\ & + \alpha_p \varepsilon_{\{t-p\}}^2 + \gamma_i \varepsilon_{\{t-1\}}^2 I_{\{\varepsilon_{t-1>0\}}} \\ & + \beta_1 \sigma_{\{t-1\}}^2 + \beta_2 \sigma_{\{t-2\}}^2 + \cdots + \beta_q \sigma_{\{t-q\}}^2\end{aligned}$$

where γ_i is the coefficient of the lagged squared error term multiplied by an indicator variable $I_{\{\varepsilon_{t-1>0\}}}$, which equals 1 when $\varepsilon_{t-1}<0$ and 0 otherwise (Brooks 2019). Positive value of γ_i indicates that negative news has greater impact than the positive ones on conditional variance and nonzero value of γ_i signifies the presence of asymmetricity (Narula 2016).

GARCH models are widely used in finance to describe volatility due to their effectiveness in capturing the properties of financial time series data such as leptokurtosis, volatility clustering and leverage effect. The reason for choosing these models is rooted in the need to obtain a deeper understanding of the time-dependent fluctuations in volatility within ESG portfolios. By using these models, our goal is to provide a thorough analysis of the risk dynamics in the selected indices. This will ultimately supplement our ability to assist well-informed investment decision-making.

Results

The descriptive statistics for the ESG Indices-MSCI China ESG Leaders Index Standard, MSCI India ESG Leaders Index Standard, Japan ESG Leaders Index Standard and USA ESG Leaders Index Standard during and post-Covid is provided in Table 1. It presents details regarding the central tendency, variability, skewness, kurtosis and other attributes of the return distributions of selected indices.

Notably, during the Covid period, India exhibited a substantial mean return of 0.092274, while the USA also performed well with a mean return of 0.092593. Japan and China, however, had lower mean return of 0.033668 and 0.025696, respectively. Post-Covid, the average return decreased significantly across all indices, with India's mean return dropping to 0.003898 and China experiencing a notable decline

Table 1 Statistical summary of returns for ESG indices. *Source*: Analysis output

	During Covid				Post-Covid			
	India	China	Japan	USA	India	China	Japan	USA
Mean	0.092274	0.025696	0.033668	0.092593	0.003898	−0.06442	−0.00614	0.006545
Median	0.142657	0.009845	0.021023	0.104898	0.000891	−0.16032	−0.03251	0
Maximum	10.28026	5.945843	7.232319	9.921401	3.573107	16.93975	4.789351	5.699862
Minimum	−13.7017	−7.3816	−6.21985	−12.1245	−5.87929	−9.17687	−3.7558	−4.26819
Std. Dev.	1.651282	1.810456	1.200388	1.657432	1.038665	2.27169	1.175874	1.237406
Skewness	−1.27596	−0.25652	0.171639	−0.63199	−0.33804	1.136792	0.073714	−0.00833
Kurtosis	18.89371	4.204494	7.768366	16.74125	5.684429	10.49536	3.621207	4.193018
Jarque–Bera	5419.976*	35.85126*	478.0536*	3982.941*	165.7177*	1326.684*	8.815068*	30.78468*

*Significant at 5% level

to −0.06442. Japan and the USA also saw decline in mean return to −0.00614 and 0.006545, respectively.

The standard deviation (a measure of volatility) varied widely among the indices, reflecting differing levels of risk. During Covid, China exhibited the highest volatility with a standard deviation of 1.810456, followed closely by the USA at 1.657432. Post-Covid, China's volatility surged to 2.27169, indicating increased market instability. Skewness and kurtosis metrics further elucidate the distribution of returns. During Covid, India has highly negatively skewed returns (−1.27596) followed by moderate negative skewness by USA (−0.63199). Post-Covid only China has highly positive skewness of 1.136792 suggesting a right-skewed distribution, meaning more frequent occurrences of positive returns. Value of kurtosis greater than 2 is considered as leptokurtic and has been observed in all the series during both periods. The Jarque–Bera test results also confirm the same. Significant values (*) of the test highlight that the returns distribution for all indices deviate significantly from normality, emphasising the nonlinear nature of market performance during and after the pandemic. These findings underscore the importance of robust risk management strategies and tailored investment approaches to navigate the complexities of ESG investments in global markets during distinct regimes.

Unit root test

Next, we analysed the stationarity of our dataset. Ensuring that the variables are stationary is crucial since non-stationary time series might lead to misleading and inaccurate findings in the study. Figures 1 and 2 clearly demonstrate that all the indices display non-stationary behaviour when analysing the closing price. The findings of the augmented Dickey–Fuller (ADF) test also show that the data lack stationarity. Additionally, the data display asymmetric patterns in relation to both the intercept and trend components. Figures 3 and 4 demonstrate a significant change as the series achieved stationarity when we transformed the closing price series into returns series. Furthermore, the ADF test confirms (as shown in Table 2) that the returns of all four series demonstrate the essential characteristic of stationarity.

Volatility models

We utilised the GJR-GARCH model (Table 3) to assess and evaluate the volatility of the financial indices. The model is pivotal since all four returns series of ESG indices exhibit volatility clustering, as depicted in Figs. 3 and 4. This model offers significant insights into the short-run and long-run volatility patterns, while also considering the asymmetric impact on the financial returns. The crucial factors to take into account are the coefficients of lagged squared residual or ARCH term (alpha 1), the coefficients of lagged conditional variance GARCH term (beta 1) and the term that represents the asymmetric effect (gamma 1) as shown in Table 3. All the GJR-GARCH models were robust when we tested for heteroskedasticity and autocorrelation using ARCH-LM test and Durbin–Watson test, respectively.

The ARCH term coefficient (alpha1) in the GJR-GARCH (1,1) model captures the impact of past

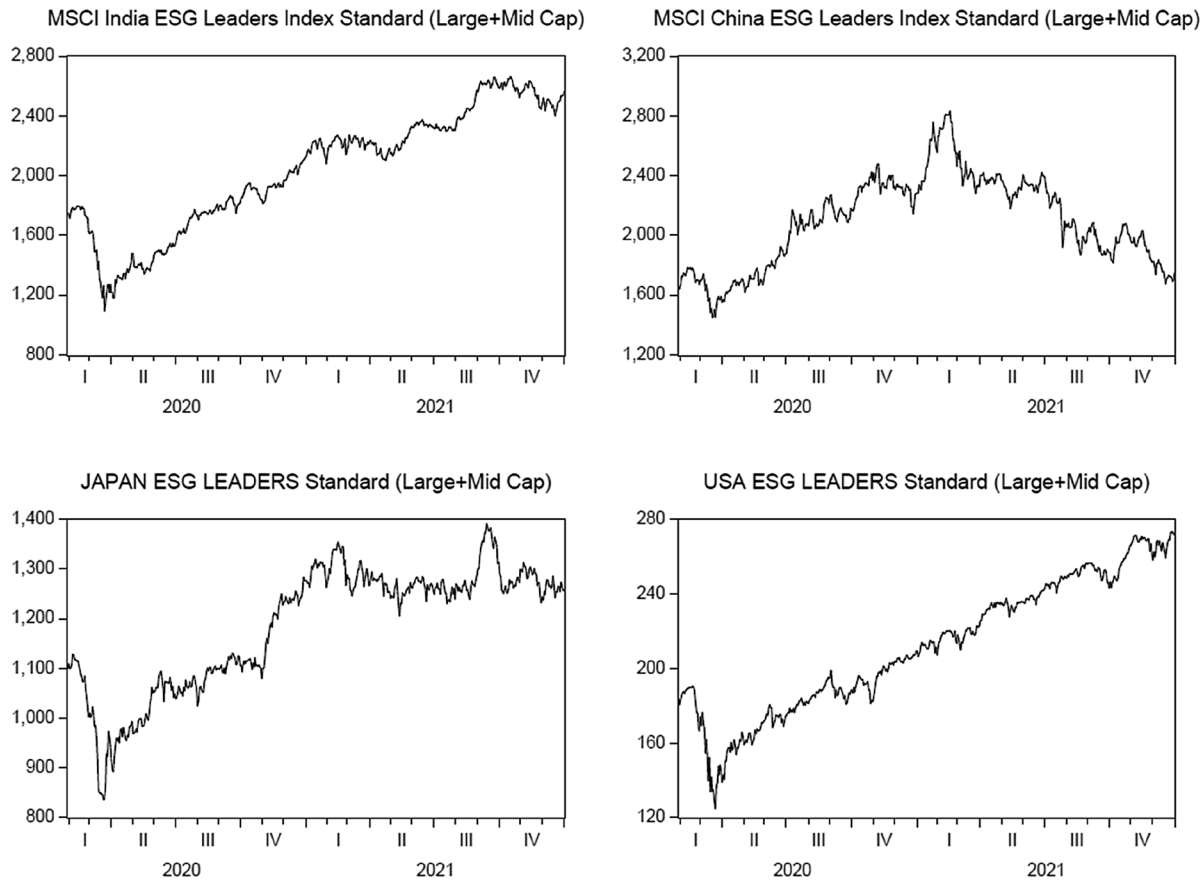

Fig. 1 Closing price of ESG indices during Covid. *Source*: Analysis output

shocks on current volatility of returns (short run). Or we can infer that it captures any new information available in the market (If the value is significant). The ARCH term is significant only for Japan during Covid regime whereas it is not significant for any index post-Covid. This means conditional volatility is not affected by news for any index (except for Japan in the pre-Covid regime).

The coefficient of GARCH term (beta1), representing the persistence of conditional volatility (long run), also exhibits notable differences between countries and time periods. During Covid, India showed high beta1 value close to 1, indicating strong autocorrelation in conditional volatility. Surprisingly beta1 value is lowest for China (0.003636). Post-Covid, these beta1 values elevated, highlighting ongoing market sensitivity to past volatility across all indices. For all the indices, it is evident that the long-term shocks are more perceived than short-term shocks.

If the sum of ARCH and GARCH term (alpha1 + Beta1) > 1, the model is mean reverting. 1-(alpha1 + Beta1) represents volatility decay. For the ESG indices, volatility decay is fastest in China and slowest in India during Covid whereas post-Covid, it is faster for China and India than Japan and USA. Overall, for all the indices, the volatility is decaying faster during Covid than the post-Covid period.

The gamma1 parameter, capturing asymmetric effects in volatility, is particularly insightful. It is positive and significant for all the ESG indices and sub-periods, confirming the presence of asymmetricity in returns of ESG indices. During Covid, Japan exhibited the highest gamma1 value (0.505307), and post-Covid, China has the highest gamma 1 value (0.127551) indicating high asymmetric response to negative shocks. Post-Covid the asymmetricity has reduced for all the ESG indices.

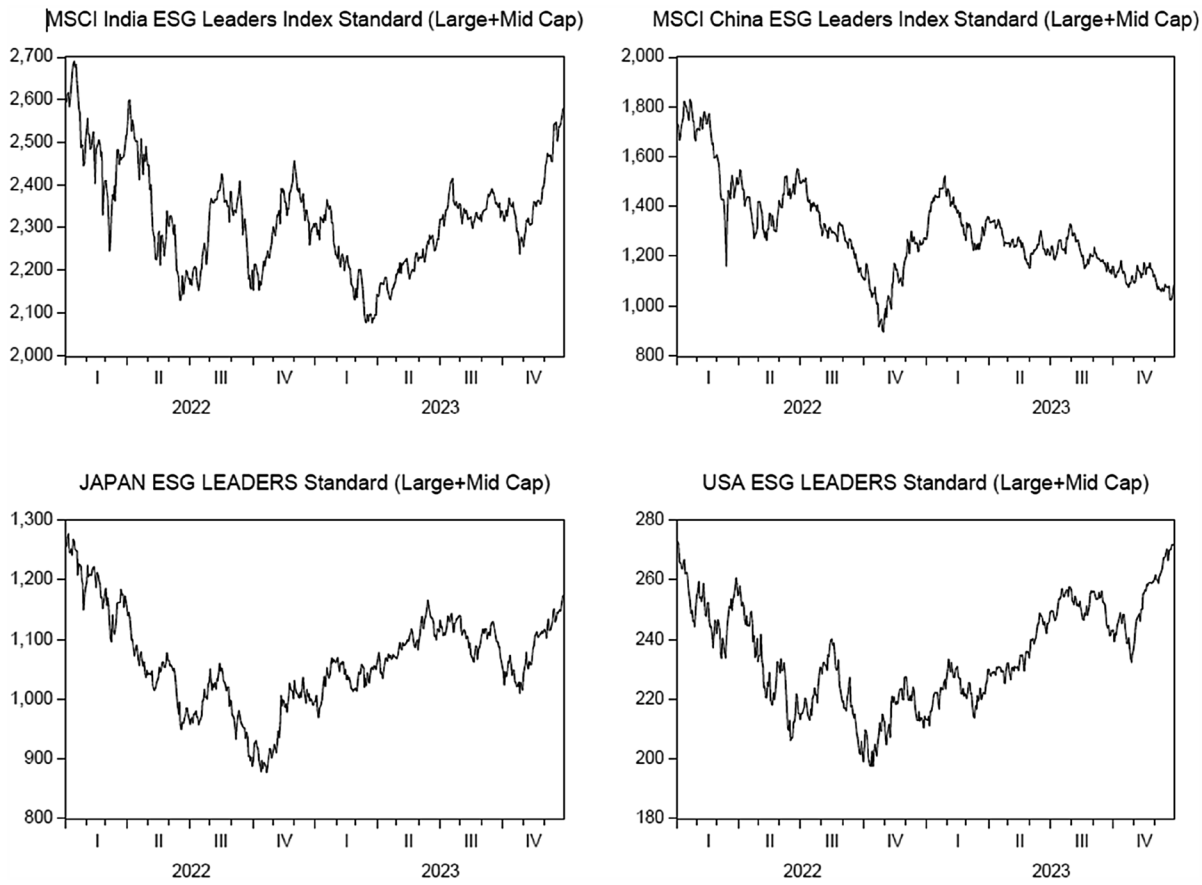

Fig. 2 Closing price of ESG indices post-Covid. *Source*: Analysis output

Findings and discussion

The findings of the study make a valuable contribution to the continuing academic discussion around ESG investing. Specifically, they provide insights into the intricate volatility associated with ESG portfolios in global financial markets during and post-Covid pandemic. The study observes that ESG portfolios of India and USA have higher and positive returns in both the regimes. The mean return of the all the ESG portfolios has declined post-Covid regime with Japan and China depicting negative returns. Country wise, the volatility decay (the rate at which volatility is diminishing) is fastest in China followed by Japan, USA and India during the Covid. Post-Covid also, China has fastest volatility decay followed by India, Japan and USA. On the other hand, during Covid, Japan exhibited the highest asymmetric effect followed by China, USA and India, and post-Covid, China indicates the higher asymmetric response to negative shocks relative to other markets.

Furthermore, both long-run and short-run volatility has been significantly lower during Covid than post-Covid period for all the ESG portfolios. Empirical studies have reported that ESG investments have performed better than the traditional investments during the crises period (Ouchen 2022; Zhou and Zhou 2022; Taera et al. 2023). But our analysis shows that they have outperformed (in terms of both return and risk) even themselves during crises than that in post-crises. Possible explanation could be that ESG indices consist of companies that perform better in ESG aspects and hence, investors prefer to invest in such stocks during unfavourable conditions. Moreover, the asymmetric effect has seen reduction post-Covid for all the ESG portfolios. This finding is also in line with the findings of previous studies such as Sabbaghi (2023). During crises, due to the factors such as

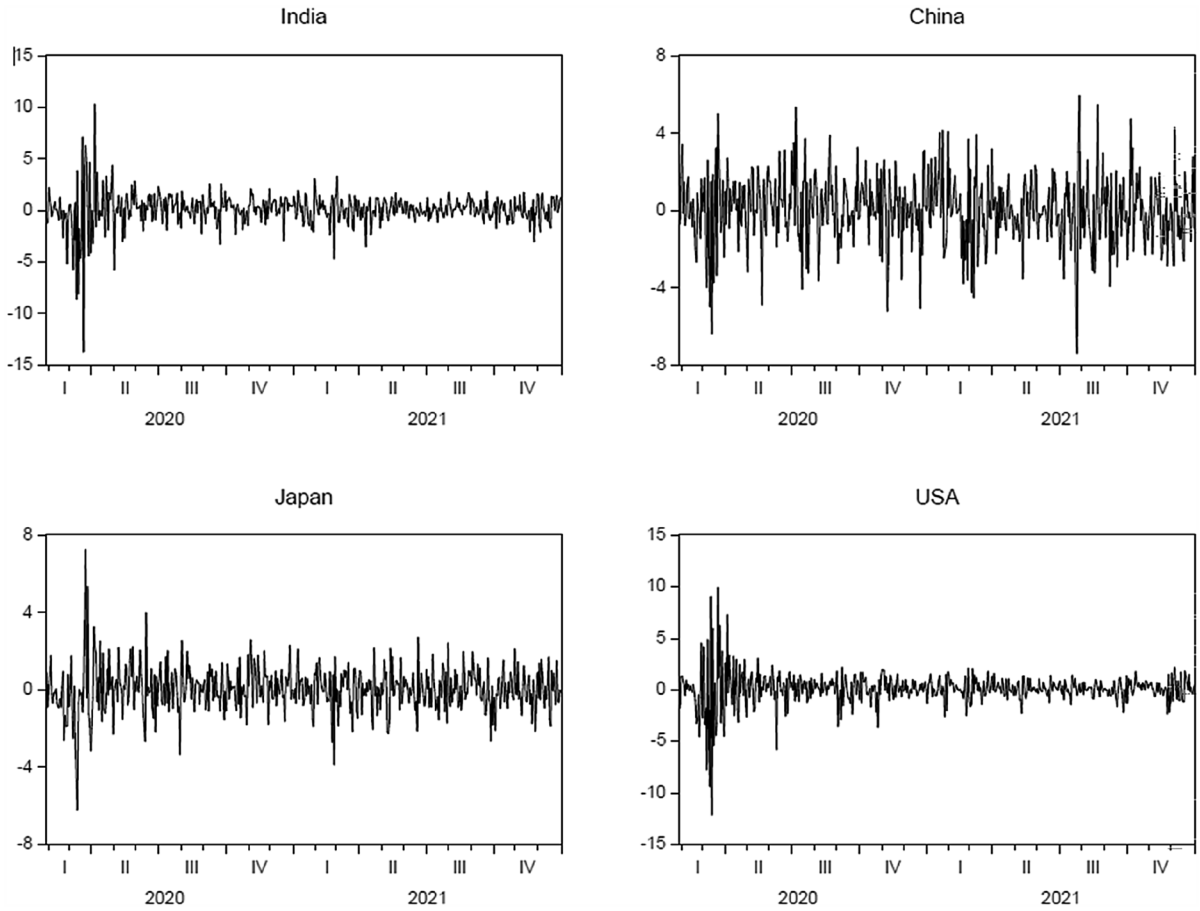

Fig. 3 Returns of ESG indices during Covid. *Source*: Analysis output

liquidity constraints, risk aversion, behavioural biases and policy uncertainty, investors have a stronger response to negative news compared to positive ones.

Practical implications

The study has important practical implications for several groups involved, including investors, asset managers and policymakers. To make informed investment decisions, investors and asset managers need to have a thorough grasp of the risk profiles associated with ESG portfolios under different market conditions. Firstly, the varying degrees of sensitivity to past shocks and the persistence of conditional volatility across countries and time periods underscore the need for robust risk management frameworks. Asset managers must incorporate these complex volatility patterns into their risk models to effectively manage portfolio risk during both crisis and post-crisis periods. Additionally, the confirmed presence of asymmetry in the returns of ESG portfolios, particularly during crisis periods, highlights the importance of accounting for asymmetric risk in investment decision-making processes. Asset managers should consider implementing strategies that mitigate the heightened impact of negative shocks on portfolio performance during crisis times.

The findings suggesting that ESG portfolio performed better during the crisis, with lower volatility and faster volatility decay, may encourage investors to consider increasing their exposure to ESG investments during crisis periods. However, this should be balanced against the potential for increased asymmetric risk during such times. These conclusions could also inform policymakers and regulators in developing appropriate frameworks and guidelines to

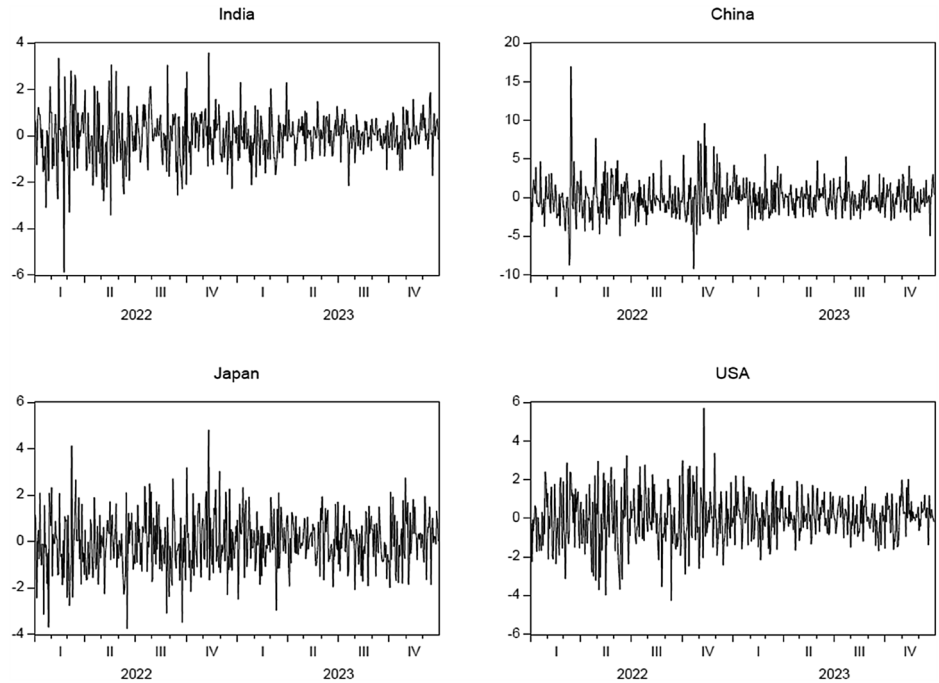

Fig. 4 Returns of ESG indices post-Covid. *Source*: Analysis output

Table 2 Unit root test on returns of the series. *Source*: Analysis output

	During Covid				Post-Covid			
	India	China	Japan	USA	India	China	Japan	USA
ADF test at level	−8.8849*	−22.0307*	−20.6865*	−6.1635*	−22.2246*	−21.5035*	−23.8975*	−22.3493*
PP test at level	−25.0542*	−22.037*	−20.6886*	−31.1506*	−22.2188*	−21.4719*	−23.9177*	−22.3493*

*Significant at 5% level

promote sustainable and responsible investing practices, particularly in the context of crisis management and post-crisis recovery efforts.

Moreover, the divergence of volatility patterns across developed and emerging markets during crisis periods may present opportunities for cross-border investments and strategic asset allocation decisions, enabling investors to capitalise on diversification benefits during challenging times. By incorporating these practical implications into their investment strategies and risk management practices, asset managers and investors can better navigate the complexities of ESG investing in global financial markets ensuring responsible and sustainable investment decisions across diverse market conditions and geographical regions.

Limitations and suggestions for future research

This study offers imperative insights into the comparative risk assessment of ESG portfolios during and post-pandemic. However, it is essential to recognise that there are certain limitations. The study is based on the use of historical data and the inclusion of specific model assumptions. Market conditions are always changing, which can cause swings. The research has a relatively shorter period, which may not capture wider and more long-lasting patterns in ESG portfolio risk. However, these patterns could be included in future research. To enhance the generalizability of the findings, it is possible to include other markets. Despite these limitations, the current study improves the understanding of the risk linked to ESG

Table 3 GJR-GARCH (1,1) model results

	During Covid				Post-Covid			
	India	China	Japan	USA	India	China	Japan	USA
Mu	0.088846 (0.076619)	0.028073 (0.712217)	0.068658 (0.151065)	0.019966 (0.665030)	0.020537 (0.594059)	−0.162771 (0.053641)	0.03117 (0.475770)	−0.003318 (0.944586)
Omega	0.041461 (0.001088)	0.906468 (0.000799)	0.107596 (0.000037)	0.111789 (0.007680)	0.011738 (0.197598)	0.053910 (0.264671)	0.003784 (0.405828)	0.003638 (0.484120)
Alpha1	0.000000 (1.000000)	0.003636 (0.923267)	0.120714 (0.021319)	0.018304 (0.592040)	0.006090 (0.722018)	0.000000 (1.000000)	0.000001 (0.999999)	0.000000 (1.000000)
Beta1	0.901959 (0.000000)	0.593371 (0.000000)	0.616506 (0.000000)	0.795703 (0.000000)	0.947268 (0.000000)	0.935224 (0.000000)	0.960769 (0.000000)	0.979466 (0.000000)
Gamma1	0.129597 (0.000116)	0.234257 (0.009000)	0.505307 (0.003501)	0.215809 (0.000563)	0.062207 (0.071728)	0.127551 (0.000001)	0.069735 (0.004828)	0.034235 (0.026816)
Alpha1 + Beta1	0.901959	0.597007	0.73722	0.814007	0.953358	0.935224	0.96077	0.979466
Volatility decay	0.098041	0.402993	0.26278	0.185993	0.046642	0.064776	0.03923	0.020534

portfolios during different market conditions and creates a foundational framework for future research and practical applications in the field of sustainable finance.

Subsequent research should consider an extended timeframe to ascertain enduring patterns of risk in ESG portfolios. More countries could be included in the future studies to better capture the influence of different markets on ESG investing. Furthermore, MGARCH models can be used to better capture the complex nature of ESG portfolio risk as it incorporates other factors that can affect the performance of ESG portfolios.

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Declarations

Conflict of interest The authors have no conflict of interest to declare.

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