

Does commitment to environment and society pays? Evidence from COVID-19 impact on stock volatility

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Abstract

Purpose – This study aims to analyse whether investment in green and sustainable stocks provide some cushion during current precarious time. To compare the impact of COVID-19 on the volatility of sustainable and market-capitalisation-based stocks, daily returns from Greenex, Carbonex, Large-Cap, Mid-Cap and Small-Cap index have been analysed over a period of six years from 2015 to 2021.

Design/methodology/approach – At the outset, logarithmic return of all selected indices has been tested for possible unit root and heteroscedastic. On confirmation of stationarity and heteroscedasticity of data, auto-regressive conditional heteroscedastic models have been applied. Thereafter, volatility is modelled through best suitable model as suggested by Akaike and Schwarz information criterions.

Findings – The findings indicate the positive impact of COVID-19 on the volatility of the indices. Asymmetric power ARCH model indicates highest significant impact of COVID-19 over the volatility of Large-Cap index, whereas exponential GARCH model detected highest significant impact of COVID-19 over the volatility of Mid-Cap Index.

Originality/value – To the best of the authors' knowledge, the present study is original in the sense that it aimed at comparing the possible impact of COVID-19 over sustainable and market-capitalisation-based indices.

Keywords ARCH-based models, COVID-19, Market-Capitalisation-based indices, Sustainable indices and volatility

Paper type Research paper



Introduction

According to efficient market hypothesis, the stock markets around the world are sensitive to news in the market. Almost all stock markets reacted to the occurrence of any bad news in the market, no matter whether these shocks are directly related with financial world or have any indirect influence over the same. Recent studies evidence that not just global financial crisis led to market oscillations but the outbreak of contagious diseases such as severe acute respiratory syndrome (SARS) and H1N1 also increased the stock market volatility (Mun and Brooks, 2012; Peckham, 2013; Jin and An, 2016).

In recent times, the entire world is brutally hit by a contagious and deadly virus COVID-19. The outbreak of the COVID-19 not only affected the health of the people but also devastated the financial markets and business houses. The imposition of curfews, lockdowns, travel restrictions and shutdown of workplaces, shopping malls, trade and businesses by the government have shuddered all economies (Şenol and Zeren, 2020). The financial markets also became highly volatile globally since December 2019 due to the outbreak of COVID-19 (Zhang *et al.*, 2020; Ozili and Arun, 2020; Estrada and Lee, 2020). Yousef (2020) found that COVID-19 had a significant impact on the conditional variance for all major indices of US stock market. In context of Indian financial market also, similar findings are expected. However, considering the state of mind of a risk-averse investor, the present study aims at exploring an investment avenue that may provide some cushion during this anxious time. During the turbulent phase of financial crisis, researchers (Tripathi and Bhandari, 2012; Aggarwal, 2014) observed that green and sustainable stocks were comparatively stable and outperformed in comparison to other portfolios.

The concept of sustainable stocks is getting wide acceptance as an alternative to the traditional profit maximising stocks because it recognises the need to pursue societal goals of environmental protection, social justice and economic development. This concept got formal acceptance when International Chamber of Commerce issued Business Charter for sustainable development in 1990 in response to the call of World Commission for Environment and Development in 1987, emphasising upon the need of industry participation for the sustainable development (Wilson, 2003). The sustainability performance dimensions are driven by Stakeholder and Stewardship theories and in contemporary times, companies are required to ensure environmental, social and governance (ESG) performance. Analysing ESG cores for China's CSI300 benchmark index, Broadstock *et al.* (2021) found that ESG performance is positively associated with the short-term cumulative returns of the stocks around the COVID-19 crisis. Further, agency/ shareholder theory, legitimacy theory, signalling theory and institutional theory also offer strong justifications for engaging in sustainability performance. In India, ESG investment is evolving very fast and current thrust over green energy clearly highlights the country's inclination towards promotion of ESG investments (Sarangi, 2021).

The present paper aims at investigating whether it is advantageous to invest in ESG stocks during the oscillation caused due to onset of coronavirus. The study analyses the impact over stock volatility, which is a matter of prime concern for all investors, traders, businessmen and regulators. The results are also expected to offer empirical evidence as to why a company should exhibit ESG commitment. The forthcoming section reviews the available literature followed by research methodology adopted for the purpose of analysis. The fourth section discuss the findings and last section provides conclusion of the study.

Review of literature

During the past decade, the concept of "socially responsible investment", i.e. an investment based on ESG criterion got mass popularity. The concept calls for development of

innovative and environment friendly products. The ascending traction towards such investment is quite apparent from the fact that the amount of new money in ESG funds reached \$51bn in 2020, more than double the figure of the previous year (Lacurci, 2021). Huge investment in such funds is promoting launch of green and sustainable stocks in the market. The number of sustainable funds available to US investors increased nearly fourfold over a decade (Hale, 2021). The approbation of sustainable funds has motivated researchers to investigate and compare the performance of sustainable funds with the performance of traditional funds in contemporary precarious conditions. Ortas *et al.* (2010) evaluated the conditional volatility in the sustainability and traditional stock exchanges in Spain with the use of univariate and multivariate GARCH models. The results indicate that investment in socially responsible investment reduce the volatility, as social and environmental screening decreases the possibility of incurring high costs during corporate social crises. Bhattacharya (2013) compared the performance of one of the green stock index, i.e. BSE Greenex with two other prominent indices of India, i.e. BSE Sensex and BSE 500. The study observed that investment in green stocks gives superior financial performance over the investment in rest two indices, i.e. BSE Sensex and BSE 500. Sadorsky (2014) estimated volatilities and conditional correlations among socially responsible investments, oil prices and gold prices. The study applied multivariate GARCH models. Sudha (2015) compared the volatility of Environmental Social and Governance (ESG) index with one of the leading index of India, i.e. Nifty. Both of the indices reported to be heteroscedastic, and therefore, ARCH-based models have been applied. The findings revealed ESG has low volatility over the study period. Tripathi and Bhandari (2015) and Kaur (2018) examined the performance of socially responsible indices such as ESG index and Greenex index. The study compared the performance of these indices with two conventional indices of India, i.e. Nifty and Sensex. The findings revealed that in comparison to conventional indices the sustainability indices have positive returns during crisis period. Malik and Yadav (2020) also analysed the returns and volatility of the returns of the sustainability indexes such as Greenex, Carbonex and ESG index. The results of GARCH model found that variance of these indices is a function of its past behavior.

As financial markets have always been a subject to market shocks, many researchers made an attempt to identify any possible impact of such shocks on the stock market. In recent past, few studies have explored the impact of contagious diseases on stock market (Wang *et al.*, 2013; Peckham, 2013; Ozili and Arun, 2020; Nguyen *et al.*, 2020; Baker *et al.*, 2020). Some of the studies probing the possible impact of COVID-19, which has been proven as the deadliest disease that entire world experienced in the past decade. Zhang *et al.* (2020) and Morales and Andreosso-O'Callaghan (2020) reported that due to the outbreak of COVID-19, the volatility of global financial markets has shown substantial increase. He *et al.* (2020) observed that COVID-19 has spill-over consequences on the stock markets of Asian, European and American countries. Similarly, Yousef (2020) investigated the impact of the COVID-19 on the US stock market by taking a dummy variable COVID-19. The results of ARCH-based models proclaimed that the volatility of stock market has been significantly and positively affected by the number and growth rate of new cases on a daily basis. However, Onali (2020) observed that returns of US stock markets have not got influenced by the cases and deaths of COVID-19. Few studies found that the outbreak of infectious diseases affected the major stock markets and their returns at global level (Estrada and Lee, 2020; Liu *et al.*, 2020; Ramelli and Wagner, 2020; Şenol and Zeren, 2020). However, the investments in sustainable indexes provide satisfactory financial returns during COVID-19 (Sharma *et al.*, 2021; Omura *et al.*, 2021). Similarly, Chiappini *et al.* (2021) concluded that

sustainable indexes were not affected by lockdown orders during COVID-19 and showed better performance as compared to traditional indexes.

Thus, different researchers have anatomised different facets of individual stock market. Some researchers analysed the volatility and risk and return characteristics of sustainable companies and some have conducted a study to analyse the impact of different shocks. But the studies comparing the impact of COVID-19 over sustainable vis-a-vis market-capitalisation-based indices are in a dearth. In this context, the present study aims at bridging this research gap. The study aims at testing a null hypothesis that there is no significant impact of COVID-19 on the volatility of returns of selected index (i.e. BSE Greenex, Carbonex, Large-Cap, Mid-Cap and Small-Cap). To capture the impact of COVID-19 on the volatility, a dummy variable has been created that carries 1 value from the date of reporting of first case of COVID-19 in India, i.e. 30 January 2020. All the values of prior dates have been taken as zero. This variable has been included as regressor to test the null hypothesis.

Research methodology

Bombay Stock Exchange of India (BSE) has launched three sustainable indices, namely, BSE Greenex (22 February 2012), BSE Carbonex (30 November 2012), BSE 100 ESG Index (26 October 2017) and three market-capitalisation-based indices, namely, BSE Large-Cap Index (15 April 2015), BSE Mid-Cap Index (11 April 2005) and BSE Small-Cap Index (11 April 2005). As the BSE 100 ESG Index has been launched very recently during late 2017, the same has not been included for analysis to avoid data limitation. Daily observations for all remaining indices have been taken from most recent date, i.e. since 15 April 2015 till 30 June 2021 from the official website of BSE.

At the outset, logarithmic daily returns have been calculated by the following formula:

$$R_t = \ln \frac{P_t}{P_{t-1}}$$

where R is the return during ' t ' time period; P_t is the stock price at the end of time period;

P_{t-1} is the stock price in the beginning of the time period and \ln stands for natural log.

The possibility of unit root and heteroskedasticity of return have been examined through augmented Dickey–Fuller (ADF) and Lagrange multiplier (LM) test, respectively. The LM test statistics is $(T \cdot q) R^2$ where $(T - q)$ is the number of complete observations and R^2 is coefficient of determination. The test examines the null hypothesis (H_0) of no ARCH effect through Chi-square test. If the probability is less than 5%, the H_0 will be rejected and vice-versa. As results indicate heteroscedasticity of returns, volatility has been measured through four prominent auto-regressive conditional Heteroscedastic (ARCH) models, which can be briefly stated as under (Karmakar, 2006; Srivastava, 2008; Joshi, 2010; Ortas *et al.*, 2010; Bhattacharya, 2013; Yousef, 2020):

1. Generalised auto-regressive conditional heteroscedasticity (GARCH) model: It is proposed by Bollerslev (1986) and applies both an autoregressive and moving average structure to the variance:

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i \epsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2$$

The model restricts the negativity of the coefficients, i.e. asserts that $\alpha_1 > 0, \beta_1 > 0$.

2. Exponential GARCH (EGARCH) model: It was proposed by [Nelson \(1991\)](#) considers log of variance. To capture the asymmetric relationship between shocks and volatility, it allows weights declining exponentially. If $\gamma = 0$, the impact is assumed to be symmetric. But if $\gamma < 0$, the asymmetric impact is considered:

$$\ln \sigma_t^2 = \omega + \alpha \left(\left| \frac{\epsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} \right| - \sqrt{\frac{2}{\pi}} \right) + \gamma \frac{\epsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \beta \ln(\sigma_{t-1}^2)$$

3. Threshold ARCH (TARCH): It was model proposed by [Zakoian \(1991\)](#) to handle leverage effects. The model uses zero as its threshold to separate the impacts of past shocks:

$$\sigma_t^2 = \omega + \alpha_1 \epsilon_{t-1}^2 + \gamma \epsilon_{t-1}^2 d_{t-1} + \beta_1 \sigma_{t-1}^2$$

The impact of good news ($\epsilon_t > 0$) and bad news ($\epsilon_t < 0$) has different effect on conditional variance. If $\gamma = 0$ the volatility is symmetric, and if it is not zero, the impact is asymmetric.

4. Asymmetric Power ARCH (APARCH) model: It was proposed by [Ding et al. \(1993\)](#). The asymmetry term (γ) of model allows positive and negative shocks of equal magnitude to elicit an unequal response from the market:

$$\sigma_t^\delta = \omega + \sum_{i=1}^p (\alpha_i |\epsilon_{t-i}| - \gamma_i \epsilon_{t-i})^\delta + \sum_{j=1}^q \beta_j \sigma_{t-j}^\delta$$

where $\omega > 0$, $\delta > 0$, $\alpha_i \geq 0$, $-1 < \gamma_i < 1$, $i = 1, p$, $\beta_j \geq 0$, $j = 1, \dots, q$

The model specifications are σ_t^2 is the conditional variance, ϵ_{t-1}^2 is the previous day's squared error and σ_{t-j}^2 is the previous time period volatility, $d_{t-1} = \begin{cases} 1, & \text{if } \epsilon_t < 0 \\ 0, & \text{otherwise} \end{cases}$

These models have been compared on the basis of selection criterions so that most suitable one may be selected. The selection criterions are:

A. Akaike information criterion (AIC): [Akaike \(1973\)](#) suggested a method to evaluate best suitable model in terms of Kullback–Leibler information, which is based on the concept of closeness between true distribution and the generic distribution developed by the model. B. Schwarz information criterion (SIC). This criterion was developed by [Schwarz \(1978\)](#) using the maximum likelihood method with a condition of large sample.

These two criterions provide a measure of information that strikes a balance between the measure of goodness of fit and parsimonious specification of the model. The model that minimises the value of the information criterion needs to be selected so that a model with larger number of lags would only be selected if the minimised value of log-likelihood outweighed the value of the penalty term ([Javed and Mantalos, 2013](#)).

To check robustness, heteroscedasticity of error terms and autocorrelation between the error terms will be checked through Lagrange multiplier test and Durbin–Watson (D/W) statistics respectively. The ideal value of D/W is 2 for data having no autocorrelation.

Analysis and discussion

[Table 1](#) depicts average annual returns, and it can be observed that during 2015, there were negative returns in all indices (except Mid-Cap stocks) due to strong selling by foreign institutional investors, behavioural response of investors towards the statement by RBI

Table 1.

Average annual
return

Year	Greenex	Carbonex	Large-Cap	Mid-Cap	Small-Cap
2015	−0.00052	−0.00053	−0.00057	0.00004	−0.00003
2016	0.00014	0.00018	0.00013	0.00031	0.00007
2017	0.00084	0.00110	0.00105	0.00158	0.00189
2018	−0.00023	0.00006	0.00009	−0.00058	−0.00109
2019	0.00016	0.00034	0.00042	−0.00013	−0.00029
2020	0.00075	0.00056	0.00054	0.00072	0.00110
2021*	0.00136	0.00109	0.00103	0.00187	0.00272
Mean	0.00032	0.00039	0.00038	0.00046	0.00049
Median	0.0009	0.00089	0.00083	0.00172	0.0019
SD	0.01128	0.01139	0.01133	0.01186	0.01202

Note: *Till 30 June 2021

Source: Author's Calculation

governor and state electoral results (Economic Times, June 2015). Thereafter, during 2018 Small-Cap followed by Mid-Cap depicted a massive fall, respectively, from 0.00189 to −0.00109 (157.67%) and from 0.00158 to −0.00058 (136.71%), which can be attributed to changed guidelines that restricts investment by Large-Cap in Mid-Cap and Small-Cap. Further, early debt maturity period betting on a sustained rebound in Small-Caps and declining valuation gap between Large-Caps and Mid-Caps pushed Large-Cap funds to register an improvement from 0.00009 to 0.00042 (366.67%) during 2019.

The year 2019 witnessed the rise in all stocks but highest improvement was observed in Carbonex, i.e. 466.67% (from 0.00006 to 0.00034) followed by Large-Cap (366.67%) and Greenex (169.57%). The initial phase of the year 2020 exposed a fall but later by the fag-end of the year, the stock moved to recovery zone. The period till 30 June 2021 registers a steady recovery and improvement in financial results.

The average return measured in terms of mean of returns observed to be highest for Small-Cap stocks, and the same has been followed by Mid-Cap and Carbonex stocks. The standard deviation in the returns of Small-Cap followed by Mid-Cap stocks found to be highest. Table 2 depicts that all returns are negatively skewed and have high value of kurtosis. Jarque–Bera test revealed that none of the return series is normally distributed. The results of ADF test witness the absence of unit root in the data cannot be accepted, and we may conclude that all returns are stationary at level. The results of LM test confirm the heteroskedasticity of returns and suggest the use of ARCH models to capture the time varying and leverage effect.

Particulars	Skewness	Kurtosis	Jarque-Bera	ADF	LM
Greenex	−1.32	19.67	18245.42**	−39.93218**	18.48958**
Carbonex	−1.66	25.74	33836.25**	−13.61378**	40.44390**
Carbonex	−1.64	25.73	33803.92**	−13.76208**	48.66430**
BSE Mid-Cap	−1.80	19.30	17856.92**	−12.96817**	15.22987**
Large-Cap	−2.05	18.36	16198.13**	−12.50198**	10.99065**

Note: **Significant at 1% level of significance

Source: Author's Calculation

Table 2.
Test statistics

As discussed in research methodology, GARCH, EGARCH, TARCH and APARCH models have been applied, and their respective AIC and SIC values have been observed, and the lowest values have been italicised to select the most suitable model for respective index (cf. Table 3).

AIC recommends APARCH model for all indices for further analyses. However, SIC recommends EGARCH model for three indices, namely, Greenex, Carbonex and Mid-cap. Following the recommendation of these criteria, we probe into the results of APARCH model for all five indices and EGARCH model for the three indices, i.e. Greenex, Carbonex and Mid-cap. Further, as the aim of this study is to examine the possible impact of COVID-19 on the volatility of the returns of selected index, i.e. either to accept or reject the null hypotheses, a dummy variable to proxy COVID-19 has been included. The results of the two selected models reveal the following information:

- impact of past shocks over current volatility (α);
- volatility clustering, i.e. the reaction of market towards any shock (β);
- Asymmetric effect of shocks, i.e. leverage effect (γ); APARCH model provides information about the δ also which is a power term parameter; and
- impact of COVID-19 on index proxied by dummy variable.

The coefficients of all of the above variables have been depicted in Table 4. The significance of the variable has been tested by comparing the p -value of all coefficients with 1% level as well as 5% level of significance. All the significant values have been shown by * marks.

In the financial market whenever any shock is infused, it dictates the demand and supply pattern of stock. But the memory of such shock fades away soon due to short memory. The α coefficient attempts to capture the impact of past shocks over the present volatility of the returns. As evident from the figures, the volatility of Small-Cap stocks has the highest influence of previous shocks, and Greenex stocks have least of such impact. Difference in the risk-bearing capacity of the investors of both stocks is the main cause responsible to bring out the difference in the impact of shocks. As individual investor sentiment has a significant impact on returns of Small-Cap stock (Yong, 2015), the effect of past shocks is higher for these stocks. The Greenex has been followed by Carbonex and Large-Cap in terms of bearing lesser impact of shocks. The β term represents the persistence of market reaction, which is the highest for Carbonex stocks followed by Large-Cap and Greenex. Small-Cap stocks have the least persistence of market reaction.

Index	Criterion	GARCH	EGARCH	APARCH	TARCH
Greenex	AIC	-6.434100	-6.482426	-6.484254	-6.475841
	SIC	-6.416746	-6.461601	-6.459958	-6.455016
Carbonex	AIC	-6.531836	-6.598045	-6.600936	-6.580708
	SIC	-6.514481	-6.577219	-6.576640	-6.559882
Large-Cap	AIC	-6.554108	-6.621336	-6.625703	-6.603397
	SIC	-6.536753	-6.600510	-6.601406	-6.582571
Mid-Cap	AIC	-6.281648	-6.328805	-6.331593	-6.321649
	SIC	-6.264294	-6.307979	-6.307296	-6.300824
Small-Cap	AIC	-6.273857	-6.307427	-6.315872	-6.308541
	SIC	-6.256502	-6.286602	-6.291576	-6.287716

Table 3.
AIC and SIC values
in different models

Source: Author’s calculation

									COVID-19 impact on stock volatility
Coefficients	APARCH					EGARCH			
	Greenex	Carbonex	Large-Cap	Mid-Cap	Small-Cap	Greenex	Carbonex	Mid-Cap	
ω	0.09	0.20	0.23	0.15	0.11	−63.09**	−51.48**	−97.99**	309
α	8.22**	8.41**	8.41**	10.01**	12.48**	9.63**	8.37**	10.54**	
β	87.42**	89.70**	89.67**	81.80**	76.73**	94.17**	95.36**	90.42**	
γ	99.99**	99.98**	99.99**	99.99**	87.84**	−15.40**	−16.81**	−18.96**	
Dummy	0.05	0.10*	0.12*	0.07	0.06	6.57**	5.47**	8.83**	
δ	91.40**	67.80**	64.45**	92.18**	103.43**				
Durbin – Watson statistics	2.000	1.9998	1.9998	1.9996	1.9998	1.9999	1.9998	2.000	
R^2	0.4583	0.2134	0.1854	0.0378	0.0029	0.1041	0.0052	0.5800	
Chi-square probability	0.4984	0.6441	0.6668	0.8457	0.9564	0.7470	0.9423	0.4463	
Note: **Significant at 1 and * at 5% significance level Source: Author's Calculation									Table 4. Volatility estimates* (%)

Table 4.
Volatility estimates*
(%)

As COVID-19 was included as dummy variable in the model, to test the null hypothesis, the dummy variable statistics has to be checked. The null hypothesis will be accepted if probability of dummy variable is more than 0.01/0.05, respectively, at 1 and 5% level of significance. Null hypothesis has been rejected for Carbonex and Large-Cap index under APARCH model, and it can be concluded that there is a significant impact of Covid-19 on these two stock indices. The higher impact was observed on Large-Cap index and lower on Carbonex. However, for Greenex, Mid-cap and Small-cap the null hypothesis could not be rejected, and it can be concluded that COVID-19 has not any significant impact over these three indices. The results of EGARCH model pronounced rejection of null hypothesis for three indices, i.e. Mid-Cap, Greenex and Carbonex, and they have got significant impact of COVID-19. For robustness check, autocorrelation and heteroscedasticity of error terms have been checked. As D/W statistics is near to two for all indices, error terms are not autocorrelated. Further, LM test reveals R^2 is pretty low and chi-square probability $> 5\%$, so possibility of heteroscedasticity is rejected. Therefore, it can be concluded that models are statistically fit and appropriate.

Conclusion

Financial markets are highly sensitive to market shock, no matter whether these shocks are directly related with financial world (e.g. financial crisis) or have any indirect influence over the same (e.g., outbreak of contagious diseases). Realising the importance of sustainable stocks, the present paper aims at examining how far these stocks immune to current pandemic. The study compares the impact of COVID-19 over the volatility of returns from sustainable indices (i.e. Greenex and Carbonex) with the impact over volatility of returns from market-capitalisation based indices (i.e. Large-Cap, Mid-Cap and Small-Cap) of India. As the indices found to be heteroscedastic, the analysis has been done with the help of ARCH models. APARCH and EGARCH observed as the most suitable on the basis of information criterions. Similar to other studies (Loh, 2006; Estrada and Lee, 2020), study found significant impact of COVID-19 on stock market. APARCH model reported Greenex was not affected from COVID-19; however, Carbonex got affected by 0.10%. Among market-capitalisation-based indices, large-cap indices found to be worst affected. EGARCH model detected the impact of COVID-19 over Mid-Cap, Greenex and Carbonex. But the impact over

Carbonex was the least, and on Mid-cap, it was found to be highest. Thus, as suggested by [Leite and Cortez \(2015\)](#), investors may alternatively choose sustainable or traditional investments when a bear market occurs because they may have not to pay the price for sustainability.

The findings of the present study may help the investors in exploring the risk exposure of their investment in different indices. The results can be implemented by investors for framing their investment strategy and in better management of their portfolio. Further, it offers an empirical justification towards the need of committing to environment and society. As the results are focused on Indian capital market, an orientation to international capital market may be conducted in future studies. The impact of COVID-19 on the risk and return characteristics of sustainable vis-à-vis non-sustainable indices may be analysed. Further, it would be interesting to analyse any volatility spill-over effects of these indices.

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