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BSE Greenex: A Pre & Post Covid-19 Empirical Study

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Abstract

BSE GREENEX is one of its kind indices that assesses the listed stocks on their “carbon performance” to quantify the energy efficiency of those listed stocks based on publicly available data. Past studies have analyzed the performance of listed stock of the index but not the performance of index itself. The present study analyzes the BSE GREENEX performance. The performance has also been analyzed for pre and post covid era. The result suggests that there is consistency in return over the period of time, whereas post covid performance of index is better than that of pre covid. As post covid return outperform the pre covid return, the study concludes that including sustainable finance not only attract more profit but also brings stability to the financial market and economy as well.

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Keywords: Carbon Performance; Covid-19; ESG investing, Green Practices; Sustainability; Value at Risk.

1. Introduction

The outbreak of pandemic has turned the financial market and world economy to look for options other than the traditional way of running business. The terms like ESG investment, sustainability development goals, sustainable finance, green stocks etc. are being used widely in recent time. Though before the covid 19 pandemic, sustainability was quite a popular term, but more serious effort has been made and still is being made to ensure sustainability practice in business after the pandemic only. Including sustainability goals into business practices are inevitable as number of studies have suggested that companies practicing such sustainability goals are more profitable and can survive the different turmoil in comparison to the companies which are not doing any such business practice. Green

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transition, green policies, green parties are going to be business practice for all the firms. According to report of World Economic Forum 2022 [1], India has pledged that it will reach net zero emissions by 2070 and has also announced that 50% of energy will be renewable energy by 2030. Primarily, investment in clean energy is going to be priority for world economy. In such scenario the performance of index which are based on sustainability practices of companies is of interest area for many research studies. This leads to the reason of conducting an empirical study based on such sustainability index of Indian financial market i.e., BSE Greenex. BSE Greenex index is launched by Bombay Stock Exchange (BSE). This index includes companies which are found to be energy efficient with parameter like emission intensity (ratio of total emission and total revenue). A number of studies has been conducted to check the performance of the listed stock on BSE Greenex though very few studies talk about performance of index itself. Therefore, the present study aims to analyze the BSE Greenex index performance and also to do return forecasting by the value at risk (VaR) method for the same index. Value at risk calculation enables the present study to have better understanding of index's return forecasting because ultimately minimization of risk is used to be primary goal of investment. Finally, by aligning the index performance and VaR calculation for BSE Greenex, the study summarizes the impact of sustainable investment in financial market.

This study is presented in seven sections. The section on introduction is followed by literature review on BSE Greenex. Literature review section is followed by Objective of the study. After that research methodology is explained which is followed by data analysis and result of the study. Data analysis section leads to section on scope of the study. Lastly conclusion of the study is discussed.

2. Literature Review

The present study reviews the existing literature on BSE Greenex thoroughly. Though there are only few studies which has explored the BSE Greenex performance, there are many studies which has explored the performance of stock listed on BSE Greenex. The existing literature suggests mixed results i.e., positive, negative and neutral impact of sustainability activities on firm's market performance. Raja [2] compares performance of three indices i.e., BSE Greenex, BSE Sensex, and BSE – 100 for time period of March 2012 to March 2018 and finds Greenex and its constituent companies does not have better performance than that of other indices. Kadam [3] measures the performance of BSE-GREENEX Index and compares it with two other indices i.e., BSE -SENSEX & BSE-SENSEX 500 index to check which index is more profitable to the investors. Bammi [4] employs event study method to investigate investors 'reaction to the announcement of stock being included in BSE Greenex and finds that there are negative returns during that event study window, which means investors do not welcome inclusion of stock in green indices. The study by Swahil *et al.* [5] calculates Altman Z- score to measure the financial performance and financial distress of stocks listed on BSE GREENEX. Their study concludes that almost half of the listed stocks are at risk of financial failure zone. Rahul [6] compares volatility and return of SRI companies and traditional investments companies in India and Asia. His study reports lack of difference between these two kinds of investments companies with a single energy index exception having higher risk in comparison to others. Sanjay and Priyanka [7] explores the behavioral anomaly of India ESG indices towards market indices. Their study includes two sustainability indices i.e., BSE Carbonex and BSE Greenex and two market indices i.e., BSE Sensex and BSE 500 to examine its performance. The performance of these four indices is compared and the result indicates that the Carbonex index performance imitates the performance of both market indices whereas Greenex index underperformance than both market indices.

Though literature on BSE Greenex performance is limited, ample studies have been conducted on performance of other sustainability index like Lopez *et al.* [8] concludes that negative correlation exists between sustainability and financial performance of firms. Mallet and Michelson [9] examine green funds, socially responsible funds (SRI), and index funds performance. Though their study reports marginal performance differences between index funds and SRI funds as the index funds outperformance the SRI funds, the results of this study does not find significant performance difference between green funds and SRI funds and between index funds and green funds.

Since the global pandemic outbreak number of studies has explored pre and post covid 19 microstructures of financial market. Kumar *et al.* [10] comments on market capitalization of Indian financial market for pre and post covid time. Their study finds positive and significance effect of global pandemic on the market's performance and the market capitalization. Sharma *et al.* [11] explores if clean energy indexes follow the same trend as conventional

indexes or the reverse. Their study uses econometric models to comment on causality and spillover effect of NASDAQ clean energy index with other NASDAQ indices. They find that both sustainable and green indexes have bi-directional causality in the long-run and the global pandemic time exhibits strong relationship between these two indices.

The extant literature on sustainability indices suggests different results owing to different market microstructures. No generalized result is found which explains the performance of such sustainability indices. Hence, it is of interest to examine the performance of Indian sustainability index i.e., BSE Greenex.

3. Objectives of the study

Based on literature review following research gaps are identified

1. There is no study which analyze the BSE Greenex performance for pre and post covid era.
2. No study do Value at Risk forecasting for the BSE Greenex.

These gaps in literature bring us to explore following research questions:

Research Objective 1: To analyze the index performance as a single time series and pre and post covid time series

Research Objective 2: To calculate value at risk for further forecasting and analysis

4. Research Methodology

The study has taken Greenex daily closing prices from October 2008 to July 2022 for analysis. These closing price series is converted into return series by taking log difference of two days consecutive closing price. Further, this time series has been divided into two parts i.e., pre covid and post covid. Thus, the study analyses the performance of three time-series t_1 , t_2 and t_3 . t_1 denotes daily return from October 2008 to July 2022, t_2 denotes daily return from October 2008 to January 2020 (pre covid) and t_3 contains daily return from February 2020 to July 2022 (post covid).

For analyzing the index performance to achieve first research objective i.e., RO1, we run different statistical test on all three time-series. These statistical tests include Jarque-Bera test to check normality, Ljung-Box test to check serial correlation and ADF test to check stationarity of data. The study also calculates descriptive statistics to describe the nature of undertaken data. Combined result of all employed statistical tests present an overall picture of BSE-Greenex index performance for all three time-series.

For second research question i.e., RO2, Value at Risk (VaR). is calculated. There are different methods to calculate VaR based on the characteristics of employed time-series. The statistical results indicating performance of the BSE-Greenex index confirms that data is non-normally distributed hence VaR calculations based on normal data distribution is excluded. We employ Historical simulation method to calculate VaR for given data. Time series t_2 is employed to run historical simulation for value at risk calculation. For checking the robustness of Historical simulation method, back-testing is performed on time series t_3 as t_3 is considered as out-of-sample data for back-testing.

5. Data Analysis & Results

This section explains the statistical tests for normality, serial correlation, stationarity, descriptive statistics, value at risk calculation and back-testing employed in the present study.

5.1 Stationarity of data

The analysis starts with checking the stationarity of data in order to ensure the reliability of results. The study employs ADF Test (Augmented Dickey Fuller test) which is a popular statistical test to check if a data is stationary or not. Table 1 summarizes the results of stationarity test at 99% confidence level. Evidently the results confirm the stationarity of data for t_2 (pre-covid) and t_1 (whole time series) whereas post covid time series found to be non-stationary. With such result one can assume that instability of financial market due to pandemic may have led to the instability in post covid time series and thus series found to be non-stationary.

Table 1. ADF Test

	Time-series		
	t_1	t_2	t_3
P Value	0.01	0.0089	0.491
Null Hypothesis	Non-Stationary	Non-Stationary	Non-Stationary
Decision	Reject	Reject	Do not reject

5.2 Serial correlation

To explore the undertaken time series characteristics the study applies the **Ljung Box test** to detect serial autocorrelation at 99% confidence level. This test analyses the time series to know whether or not errors are independently and identically distributed (i.e. white noise) or does serial autocorrelations exist in the errors or whether residuals of time series are non-zero. Table 2 summarizes the results of auto correlation test. It is found that all three time-series is serially auto correlated (the test has been run for different lags). Auto-correlation of data can be explained as there in market inefficiency and past information can still leads to generate profit and trading strategies can be formed accordingly. Also, auto correlation of data can lead to the use of financial models in which residuals and errors can be accommodated.

Table 2. Ljung Box Test

	Time series		
	t_1	t_2	t_3
P Value	0.002169	5.99E-05	0.009
Null Hypothesis	No autocorrelation	No autocorrelation	No autocorrelation
Decision	Reject	Reject	Reject

5.3 Descriptive Statistics

Table 3 summarizes the descriptive statistics for three time periods. It is evident that post covid return has highest daily average return i.e., 0.0829% which will be 20.56% (0.0829% *252 working days) annually in comparison to daily pre-covid return i.e., 0.0371% which will be 9.34% annually (0.0371%*252). Table 3 also shows that post covid return has highest standard deviation owing to risks arises due to uncertain nature of pandemic. Mean, Median and mode found to be inequal and non-zero, and kurtosis found to be quite higher than 3 for all data. Hence, the results presented in table 3 concludes that all three data set are not normally distributed which is further confirmed by Jarque-Bera test.

Table 3. Descriptive Statistics

	Time series		
	t_1	t_2	t_3
Mean	0.000446	0.000371	0.000829
Standard Error	0.000226	0.000242	0.000595
Median	0.000817	0.000649	0.001889
Standard Deviation	0.013197	0.012807	0.014805
Sample Variance	0.000174	0.000164	0.000219

Kurtosis	14.48026	14.86293	13.01715
Skewness	-0.29229	0.123449	-1.52582
Range	0.27963	0.276956	0.206438
Minimum	-0.12587	-0.1232	-0.12587
Maximum	0.153755	0.153755	0.080564
Sum	1.527384	1.040803	0.513719
Count	3423	2802	620

Jarque-Bera test is used to check normality of data. It checks whether the kurtosis is higher than 3 and mean, median and mode is 0 for data or not which ultimately a test for checking whether time series is normally distributed or not. Table 4 summarizes the results of this test that confirms that at 0.01 significance level all three time-series are found to be not normally distributed. Therefore, any statistical test which assume data to be normally distributed can't be employed for this time series. It also excludes the possibility of using parametric VaR to be used for forecasting.

Table 4. Jarque-Bera Test

	Time series		
	t_1	t_2	t_3
P Value	2.20e-01	2.20e-16	2.20e-16
Null Hypothesis	Normal distribution	Normal distribution	Normal distribution
Decision	Reject	Reject	Reject

5.4 Value at Risk

Value at risk (VaR) calculates the maximum losses with given probability which can occur over a certain time period. Hence, VaR can be seen as the value loss that should not be exceeded for that certain time period given the confidence level. VaR also consider the magnitude of loss if actual losses exceed the expected loss. Therefore, VaR can be seen as a parameter which helps investors to take investment decision and also signifies the health of given stock or index.

5.4.1 Historical Simulation

There are different types of method for value at risk calculation. Each of such method has sets of assumptions also. As none of the three time-series has been tested as normally distributed, the study employs the historical simulation method for VaR calculation which does not assume data to be normally distributed. The simulation is run for different confidence intervals i.e., 90%, 95% and 99%. The study uses return time for calculation. As historical simulation VaR method calculates the worst expected loss, the study sorts return series values from the lowest to the highest. Then for different confidence interval, we take corresponding values e.g., the VaR at 99% confidence level is the mean of the return minus the 1% lowest value in the return time series.

5.4.2 Back-testing

To check the accuracy of employed historical simulation VaR method, the study conducts the Percentage Absolute Relative Error (PARE) for back testing. PARE is calculated with following equation:

$$PARE = \frac{|N_{expected} - N_{calculated}|}{N_{expected}} \quad (1)$$

$N_{expected}$ is number of violations expected at certain level of confidence and $N_{calculated}$ is actual number of

violations. For example, out of sample time series has 620 days return, hence at 10% $N_{expected}$ will be 62 days as shown in Table 5.

The study also employs the properties of binomial distribution to calculate probability of VaR exceptions for given time series. Table 5 Summarizes the PARE and probability result. It can be observed that with PARE method historical simulations predict the value at risk for out of sample time series precisely therefore this model can be used for further prediction. Except for 90% confidence level, error is found to be high. Therefore, comparison with other VaR method is inevitable to comment on the comparative accuracy given that data is not normally distributed. Whereas the probability calculation with binomial distribution finds this model to statistically significant at all confidence level except at 90%.

Table 5. Percentage Absolute Relative Error (PARE) back-testing & Binomial Distribution Probability results

α (%)	$N_{expected}$	$N_{calculated}$	PARE	Binomial Distribution Probability
10	62	69	0.112903226	0.157602034
5	31	44	0.419354839	0.008944151
1	7	15	1.142857143	0.000665016

6. Scope of the study

The employed methodology can be used for performance analysis of other sustainability indices like Dow Jones Sustainability Index and NASDAQ OMX etc. A comparative study of other indices and other sustainability indices can also be explored for further research. As time series are found to be not normally distributed, one can employ other methods for value at risk calculation including GARCH, EGARCH as model specification. Other advance method for return calculations and forecasting method can also be employed for in-depth analysis

7. Conclusion

Studies based on performance analysis of green equities, green funds, SRI in comparison to market indices do not have unilateral results. Few studies have indicated negative or underperformance of these green funds [12, 13] whereas other studies has reported positive performance of sustainability indices compared to market indices [14]. The data analysis for first research objective of the present study concludes that post covid return time series outperforms in comparison to pre covid time. Intuitively risk was also found high for post covid time series while second research objective analysis suggests the efficiency of employed VaR method and accuracy of out of sample forecast. Historical simulation VaR method is found to be more precise at higher confidence level in return forecasting. The result of present study also confirms that the need of including sustainable finance as common business practice for enhanced performance of index and stocks is a must.

BSE Greenex performance can also be seen as evidence of incentive to include ESG investing practices by companies. Pre and post covid-19 time has changed the microstructure of the financial market. Hence, performance analysis of indices is found to be significantly different in pre-post crisis period [15]. Though a comparative studies and further exploration of data will provide more insight on such index performance. Most of the included stocks of BSE Greenex are also part of BSE SENSEX and other indices so the studies can be conducted on such co-listed stocks. This study results also advocates the better and clear public policy for ESG investing in India because only handful of stock are being added to BSE Greenex owing to their energy efficiency whereas other indices have large number of companies' stocks. For generalization of this study result, it is necessary to have more companies to practice sustainable finance.

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