# SOCIALLY RESPONSIBLE INVESTING AND STOCK PERFORMANCE

## A STUDY ON COMPARISON OF SUSTAINABILITY INDICES IN INDIA (ARCH & GARCH APPROACH)

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*P*URPOSE
*THIS research paper intends to contrast the performance and volatility of Socially Responsible Indices i.e. BSE GREENEX and BSE CARBONEX viz a viz BSE SENSEX over a period of 2012-2020 in terms of its risk and return and to analyze whether these Socially responsible indices outperform general indices in Indian stock market.*

*Design/Methodology/Approach: To achieve the desired objectives, Daily Returns of BSE SENSEX, BSE GREENEX and BSE CARBONEX has been taken for a period starting from 1st May 2012 to 28th Feb 2020.Various statistical tools as well as financial tools are applied by the researcher including CAPM Model(using OLS Regression), Sharpe Ratio, Treynor Ratio, and Jenson Alpha. To check the volatility of the indices, GARCH model has been applied.*

*Findings: After analyzing all the sustainability indices viz a viz SENSEX, it has been observed that during the period of study, SENSEX generated highest returns as compared to other the two sustainability indices, GREENEX and CARBONEX. Conversely, comparing GREENEX & CARBONEX, it is found that CARBONEX performs much better than GREENEX. Talking about volatility, GREENEX tops the list. It has been concluded that Socially Responsible Investing is still at an infant stage in India. So, more awareness is required on the part of investors and Indian companies have to take more initiatives in the areas of environmental concerns and governance issues.*

*Research Limitations: As the study has been conducted only for S&P BSE Indices. It has limited implications for other stock exchange indices.*

*Practical Implications: The results of the study can be very helpful for the policy makers as it has been revealed through the study that Socially Responsible Investing is at a baby stage in India. Considering its relative importance for Corporate Behavior, Transparency, Environmental outlook and Social Change, there should be more awareness and information about responsible investor behavior.*

*Originality/Value: This study is probably the first to empirically compare Socially Responsible Indices viz a viz general market Index,*

*Key Words: BSE GREENEX, SENSEX, BSE CARBONEX, ARCH, GARCH, Socially Responsible Investing, Green Investing.*

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## Introduction

Traditionally, Investors and other stakeholders focused only on financially stable companies generating high returns as the investment avenues. This continued for a very long period. But, it was observed that crisis was become a normal phenomenon and due to global climate change, environment was degrading. On the other hand, there were floods of governance issues in various companies in India and abroad. In wake of this, companies and Indian investors became more aware and started looking towards ESG Investment. Indian Investors are looking on to financial stable returns and social good together. Also, the companies are aware and seeking to incorporate ESG factors into their business practices. ESG comprises the following themes: environmental (Inefficient use of resources, use of inexhaustible sources of energy, pollution, climate change, carbon emissions), Social (human rights, workplace conditions, gender disparity, societal relations, and governance (compliance, transparency sustainability reporting, corporate social responsibility, and independent board).

SRI has emerged as one of the powerful investment criteria globally. Looking on to American and European nations, they already have a family of SRI indices like Dow Jones Sustainability Index (DJSI), FTSE4GOOD index, and so on. But in India, it is at the infant stage. This started when BSE launched GREENEX in 2012 in collaboration with IIM Ahmedabad and launched an Environmental, Social, and Governance (ESG) index to measure the extent to which companies are following sustainability practices. A number of SRI funds and green bonds are now prevailing in Indian market. Till now, there is extensive research carried out by the researchers in India. Some of the studies reported that SRI funds outperform Non-SRI funds (Moskowitz, 1972; Luck, & Pilotte, 1993; Derwall, Guenster, Bauer, & Koedijk, 2005; Edmans, 2011).On the other hand, few researches revealed that there is no significant difference between SRI returns and conventional returns except if multi factor measures used (Roy, 2019).

Researches related to Socially Responsible Investing in India include performance contrast of ethical and responsible funds and general mutual funds, comparison of ethical portfolios and normal portfolios. Investor's returns and stock prices are always debated as investors may prefer green investing, but they are not ready to compromise on the returns. It may be a case that investors are not even aware of responsible investing. This paper focuses on comparing the performance of socially responsible impact Indices and general BSE INDICES in India.

## Socially Responsible Investing – How it grew?

While Socially Responsible Investing might seem like new or at an infant stage due to its growing popularity, but its origin dates to centuries ago. It provides us a set of criteria to gain financially stable returns ethically. Prominence of SRI grew in 1980s and 1990s due to climate change, non-transparent practices, and disclosures of companies, and lack of corporate governance. By the early 1970s, North America had its first of kind of mutual funds reflecting its faith based values and concerns towards environment. There were questions around the impact investing including civil rights movements. Between 1970s and 1990s there was an unspoken pressure on the fund managers to avoid investing in 'irresponsible companies'. In 1990s and beyond there was an awakening threat from prolonged environmental changes and global climate change.

Global climate was changing on its full swing and then Global Financial Crisis 2008 came up and led the entire world to its toes. This crisis gave us an important relationship between societies and economies. Socially Responsible Investing ignited by the increased regulation, pressure from millennial generations, and growing attitude towards increased transparency standards. (Puaschunder, 2016) in his research highlighted that in the aftermath of world crisis, the demand for ethicality has gained its momentum.

## Stock Market Indices Used for Current Study

S&P BSE CARBONEX: This index is introduced in India as first of its kind by BSE. CARBONEX tracks the operation of the companies within S&P BSE 100 according to their capability of minimizing risks due to climatic changes. This index tries to record the performance of the companies within the

S&P BSE 100 to the extent they are able to reduce risks arising from climatic change. The top five constituents of the BSE CARBONEX index are HDFC Bank Ltd, ITC Ltd, Housing Development Finance Corp., Reliance Industries Ltd and Larsen and Toubro Ltd (L&T)

S&P BSE GREENEX: GREENEX index was launched by BSE in 2012, owing to the need of lower carbon path across Indian companies. The need for low carbon emission can be traced to the climate change affecting countries worldwide. It is called as country's first carbon tracking index. This index will comprise of 25 stocks according to the carbon emission, market cap and turnover value. These 20 (now 25) companies are the subset of BSE 100.Categorization of companies is based on carbon footprint and energy efficiency. Investors who are interested to pay the premium for green initiatives opt for these stocks. Some of the major constituents of the Index include Tata Steel, ICICI Bank, SBI, HDFC, Sun Pharma and BHEL.

S&P BSE SENSEX: The S&P BSE SENSEX a free float market weighted stock market index. This index is to track the accomplishment of the 30 largest, most liquid, established and financially stable organizations. These companies are also called blue chip stocks. All the companies together represent all varied sectors of economy.

## Literature Review and Research Gap

Socially Responsible Investing also called as green investing is the talk of town at present in finance domain. Extensive research process is underway regarding the comparison of SRI funds and conventional funds, Green and Non-green portfolios and related green investing. Although Socially Responsible Indices is the sub-division of broader general indices, a comparison of their performance is also a matter to study.

The empirical academic literature based on SRI possesses questions on whether Socially Responsible companies perform better than 'irresponsible' companies. (Sudha, 2014, p. 1339) in her study based on the comparison between socially responsible indices viz a viz conventional indices in India mentioned that "annualized returns are better for SRI indices and it is a favorable game for retail and institutional investors, organization, and society as a whole". (Murthy, Bhandari, & Pandey, 2014, p. 1) said "Paradigm shift has taken place over time which has led to the emergence of conceptual framework of Corporate Responsibility which provides holistic approach towards Governance, Corporate Social Responsibility, and Environmental Accountability. We expect that social responsibility has a distinct and positive effect on the security prices in the stock market". (Managi, Okimoto, & Matsuda, 2012, p. 1520) revealed that "there is no statistical difference between in means and volatilities generated from the SRI indexes and conventional indexes in US, UK, and Japan". Vasal (2009) viewed about socially responsible returns. Author explained his research through taking daily compounded returns of the indexes and took its conditional volatility too.

Globally, research on socially responsible aspects have paved its way long back including the comparison of SRI mutual funds with conventional funds, analyzing the performance of Ethical indices, and general indices. For instance, Torre, Galeana, & Aguilasocho (2016) discussed about mean variance efficiency of SRI and general market using daily standard deviation measure and Sharpe ratio for the duration of November 2008 to August 2013 and found that the results were similar for both the indices. Benson, Gupta, & Mateti (2010) also studied his research on Dow Jones Sustainability Index (DJSI) and found that socially responsible investment does not outperform general investment. This is the case of most of the studies. Since, there always remains a debate whether Sustainability indices perform better than general broad indices, so this research will add to the existing body of knowledge.

## Objectives of the Study

1. To study the general trend of GREENEX, CARBONEX with respect to broad market index SENSEX.

2. To measure the market performance of socially responsible indices in contrast with SENSEX.

3. To compare the volatility of sustainability index with general index.

### Hypotheses of the Study

H01: There is no significant difference between the average return of BSE SENSEX and BSE GREENEX.

H02: There is no significant difference between the average return of BSE SENSEX and BSE CARBONEX.

H03: There is no significant difference between the average volatility of BSE SENSEX and BSE GREENEX.

H04: There is no significant difference between the average volatility of BSE SENSEX and BSE CARBONEX.

## Research Methodology

### Sample Selection

The significant driving factor of current research study is to collate the performance and volatility of BSE sustainability indices with broad BSE SENSEX. To achieve this objective daily data of return of BSE SENSEX, BSE GREENEX and BSE CARBONEX has been taken.

### Source and Duration of Data

Current study uses secondary data of daily closing prices of taken indices for a period starting from 1st May 2012 to 28th February 2020. The data related to every day's closing values was collected from the official websites of respective stock exchanges. For return involving no risk, daily return on Govt. Bond has been taken. The matching dates for all the four indices have been taken. Software R-studio has been used for study.

### Tools used for Analysis

The statistical and financial techniques used in current study are as under:

### Capital Asset Pricing Model

CAPM model has been incorporated to estimate Risk Premium on BSE GREENEX and BSE CARBONEX (Separately) for which Govt. Bonds have been used to find out risk free rate of return while BSE SENSEX has been used to find out market return. CAPM in the current study has been applied through ordinary least square (OLS) model of regression. The belief high risk high return has been considered, thus the magnitude of Jensen's measure of alpha also has been incorporated in applying CAPM model. Under CAPM model only the systematic risk will be considered. The formula to calculate Jensen's alpha is as under:

$$\alpha = (R_{it} - R_{ft}) - \beta (R_{mt} - R_{ft})$$

Thus, keeping Jensen's alpha into consideration the CAPM equation used to predict Risk Premium is as under:

$$(R_{it} - R_{ft}) = \alpha + \beta (R_{mt} - R_{ft}) + \Sigma_{it}$$

Where: (While esttimating Risk Premium on BSE GREENEX)

$R_{it}$ = Daily Return on BSE GREENEX

$R_{ft}$ = Daily Return on Govt. Bonds

$\alpha$ = Abnormal return on BSE GREENEX

$\beta$ = Systematic Risk

$R_{mt}$ = Return on BSE SENSEX

$\Sigma_{it}$ = the stochastic disturbance term that takes into account the inherent representative risk

Where: (While estimating Risk Premium on BSE CARBONEX)

$R_{it}$ = Daily Return on BSE CARBONEX

$R_{ft}$ = Daily Return on Govt. Bonds

$\alpha$ = Abnormal return on BSE CARBONEX

$\beta$ = Systematic Risk

$R_{mt}$ = Return on BSE SENSEX

$\Sigma_{it}$ = the stochastic disturbance term that takes into account the inherent representative risk

**Tools used for Contrast Establishment**
In order to compare the performance of sustainability indices (BSE GREENEX and BSE CARBONEX) with BSE SENSEX following components are compared:

The daily mean return performance: The average daily returns have been compared using t-test.

Jensen's measure of alpha: Jensen's alpha is based on the concept of non-diversifiable risk. It is the abnormal return on security. The daily returns of the BSE GREENEX and BSE CARBONEX have been regressed in contrast to the daily return values of the general market index (BSE SENSEX) for computation of a measure of systematic ie non-diversifiable risk as calculated by CAPM . The differential change between the actual return value of the indices and the modeled risk-adjusted return values is the magnitude of performance in relation to the market. (Formula already discussed above).

The Sharpe Ratio: The sharpe ratio was developed by William Sharpe in 1966. The ratio is based on the measure extra return received for additional volatility. The formula for calculating sharpe ratio is as under:

Sharpe Ratio (x) $= \dfrac{r_x - R_F}{Std\ dev\ r_x}$

Where

X = The security (Index in our study)

$r_x$ = The average return on security x

$R_F$ = The best available return on risk free security

Std dev $r_x$ = Standard Deviation of average return on security x

In current study the sharpe ratio for all the indices BSE SENSEX, BSE GREENEX and BSE CARBONEX has been calculated.

Treynor Ratio: Treynor ratio is also similar to sharpe ratio. Both the ratios are used to calculate risk adjusted measure of rate of return. The Sharpe ratio is based on the concept of return of a security in relation to its risk while the Treynor ratio generates the excess return received for each unit of risk undertaken. Treynor ratio used Beta (against standard deviation in sharpe ratio) as a measure of risk. The forumula for calculating Treynor ratio is as under:

Treynor Ratio (x) $= \dfrac{R_x - R_F}{Beta_x}$

Where

X = The security (Index in our study)

$R_x$ = Return on security (index in our study)

$R_F$ = Risk free rate of return

$Beta_X$ = volatility of security (index in our study)

The higher is the treynor ratio the better is the performance. In current study the treynor ratio for all the indices has been calculated individually.

## Analysis of Risk in case of Heteroscedasticity and Model used

There are various assumptions about error term in the model of OLS regression; one of them is that the variance of error term is unknown but similar. This property of constant variances is known as Homoscedasticity. This is the necessary assumption; if it is not in place the problem is called as heteroscedasticity. Heteroscedasticity is termed as systematic change in the spread of the residuals over the range of measured values. "A stochastic process is said to be stationary if its mean and variance are constant over time, and the value of the covariance between the two time periods depends only on the lag between the two time periods and not the actual time at which the covariance is computed" (Gujarati, & Sangeetha, 2007, p. 816).

To check the problem of heteroscedasticity Augumented Dickey Fuller test and Phillips Perron test have been used in the study. The eqution for Augumented Dickey Fuller test is as under:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{t-1}^{m} \alpha i \ \Delta Y_{t-1} + \varepsilon_t$$

Wherein

$Y_{t-1}$ = lag 1 of time series

$\delta Y_{t-1}$ = first differential of the time series at time (t-1)

where $\Sigma_t$ is a pure white noise error term.

While the equation for Phillips Perron test is as under:

$Y_t = \alpha + \beta \ Y_{t-1}$

Both the tests ADF and PP confirm about heteroscedasticity in the indices so Engle's (1982) "autoregressive conditional heteroscedasticity (ARCH) model has been used to estimate such a varying variance (volatility)".
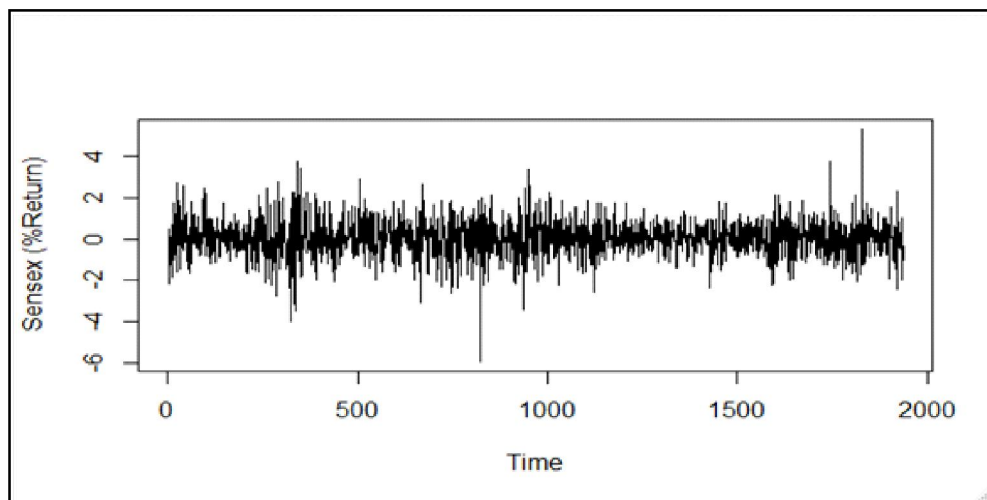


**Figure No. 1: Trend line of Return of Sensex**
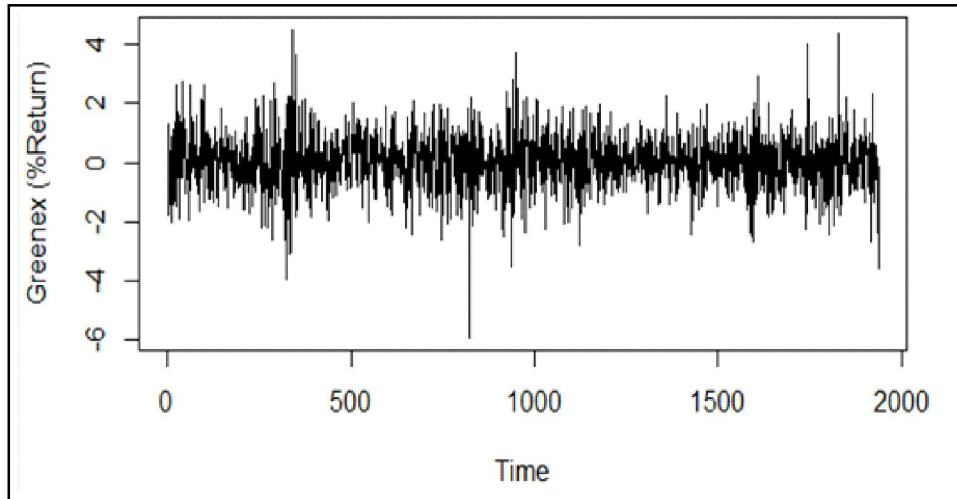
*Source: Author's own work*

**Figure No. 2: Trend line of Returns of Greenex**
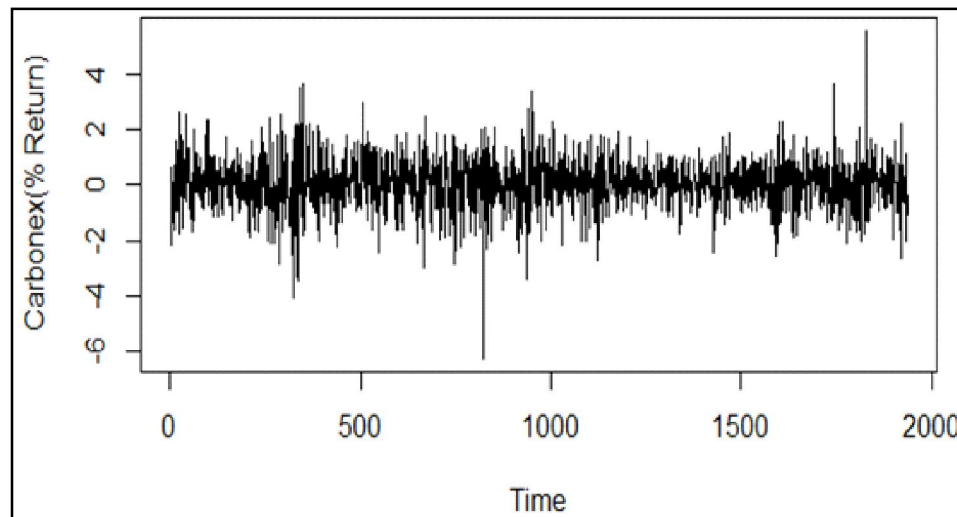
*Source: Author's own work*



**Figure No. 3: Trend line of Returns of CARBONEX**

*Source: Author's own work*

**The ARCH and GARCH Models**

The ARCH also called as Autoregressive Conditional Heteroskedasticity model suggests a route to model a change in variance in a time series values depending on the time constraint, such as increasing or decreasing the volatility measure. It has an extended version which is also called as GARCH or "Generalized Autoregressive Conditional Heteroskedasticity" is meant to support changes in the volatility dependent on time, such as increasing and decreasing volatility in the similar time series.

The ARCH process by Engle (1982) specifically "recognizes the difference between the unconditional and the conditional variance allowing the latter to change over time as a function of past errors."

As per ARCH the conditional variance of the error ut is dependent on the lagged squared error terms. The equation can be shown as under:

$$Var\ u_t = \sigma^2 = \alpha_0 + \alpha_1\ \varepsilon_{t-1}^2 + \alpha_2\ \varepsilon_{t-2}^2 + \ldots\ldots\ldots \ldots + \alpha_p\ \varepsilon_{t-p}^2$$

If null hypothesis of constant á is rejected than we assume that there is an ARCH effect.

Bollerslev (1986) proposed that "The GARCH processes are generalized ARCH processes in the sense that the squared volatility $\sigma_t^2$ is allowed to depend on previous squared volatilities, as well as previous squared values of the process". The GARCH (p,q) model is a model representation where there are 'p' lagged squared residual terms and 'q' terms of the lagged conditional variances. The GARCH (1,1) can be represented as under:

Mean Equation : $R_t = \mu + \varepsilon_t$

Variance Equation: $\sigma_t^2 = \omega + \alpha\ \varepsilon_{t-1}^2 + \beta\ \sigma_{t-1}^2$

The necessary condition to ensure stictly positive conditional variance is "ω>0, α ≥ 0, β ≥ 0". The ARCH (α) and GARCH (β) capture short and long run persistence of shocks respectively. To fulfill the secondary necessary condition of GARCH is α + β < 1. The sum of the coefficients (α + β) closer to unity shows high persistence in volatility clustering.

## Emperical Results

Table no. 1 indicates the basic descriptive of return of all four indices. It can be observed that the average return of BSE SENSEX is highest while variance is highest in case of BSE GREENEX. If we compare both the sustainability indices the average return of BSE CARBONEX is higher than BSE GREENEX while its variance is lesser than BSE GREENEX.

**Table No. 1: Index Returns: Descriptive Statistics**

| Particulars | BSE SENSEX | BSE GREENEX | BSE CARBONEX | Govt Bond Yield |
|---|---|---|---|---|
| Mean | 0.04674388 | 0.03497171 | 0.04483253 | -0.0001479608 |
| Max | 5.32271 | 4.495641 | 5.523754 | 0.0686 |
| Min | -5.93622 | -5.916781 | -6.222118 | -0.0556 |
| Standard Deviation | 0.8774441 | 0.924726 | 0.8950028 | 0.006908768 |
| Variance | 0.76990815 | 0.8551181 | 0.80103001 | 4.4431075E |
| Skewness | -0.08174895 | -0.1332507 | -0.1717501 | 0.8402065 |
| Kurtosis | 2.837838 | 2.097559 | 2.886943 | 15.15878 |
| N | 1937 | 1937 | 1937 | 1937 |

*Source: Author's own calculation*

The result of table no. 2 and the trend line of returns of indices confirm that all the three series are stationary. Further analysis is performed on these series.

**Table No. 2: Results of Augmented Dickey–Fuller Unit Root Test**

| Index Series | Test Statistic | 5% Critical Value | P value |
|---|---|---|---|
| BSE SENSEX | -12.883 | -2.860 | 0.01 |
| BSE GREENEX | -12.517 | -2.860 | 0.01 |
| BSE CARBONEX | -12.53 | -2.860 | 0.01 |

Alternative hypothesis: stationary

*Source: Author's own calculation*

**Table No. 3: Two-Sample Mean Comparison Test of Risk Premium
(Welch Two Sample t-test)**

| | BSE GREENEX and BSE SENSEX | BSE CARBONEX and BSE SENSEX |
|---|---|---|
| Difference of Means | -0.11772172 | -0.001911350 |
| Probability | 0.6845 | 0.9465 |
| t-value | -0.40641 | -0.067111 |
| 95% confidence interval | - 0.06856245 to 0.04501811 | - 0.05774975 to 0.05392705 |

Alternative hypothesis: true difference in means is not equal to 0

*Source: Author's own calculation*

Table no. 3 depicts the comparison of the mean difference between BSE GREENEX and BSE SENSEX. t-value falls in acceptance region which means null hypothesis that mean difference is equal to 0 holds true **(H01 accepted)**. On comparing BSE CARBONEX and BSE SENSEX, t-value doesn't fall in acceptance region which means that the difference between means is not equal to 0. Thus our **H02 is rejected**. The Means in case of BSE CARBONEX and BSE SENSEX differ significantly. But the mean difference is on negative side which means average of BSE SENSEX is more than the average of BSE CARBONEX.

Table no. 4 presents the high degree of correlation in the risk premium in all three types of series.

**Table No. 4: Correlation in Risk premium of BSE SENSEX,
BSE GREENEX and BSE CARBONEX**

| Correlations | | | |
|---|---|---|---|
| | RiskPremium_SENSEX | RiskPremium_GREENEX | RiskPremium_CARBONEX |
| RiskPremium_SENSEX | 1 | 0.909** | 0.987** |
| RiskPremium_GREENEX | 0.909** | 1 | 0.922** |
| RiskPremium_CARBONEX | 0.987** | 0.922** | 1 |

*** Correlation coefficient is significant at the 0.01 level of significance (2-tailed).*

*Source : Author's own calculation*

The result of OLS model of regression estimates of CAPM equation (mentioned above) have been shown in table no. 5 (a) and 5(b). Table no. 5(a) presents the results of regression equation of BSE GREENEX on BSE SENSEX while table no. 5(b) presents the results of regression equation of BSE CARBONEX on BSE SENSEX. Table no. 5 (a) depicts the value of beta which indicates the volatility of BSE GREENEX is 0.958 (1% level of significance) when regressed on BSE SENSEX. Since the beta is less than one, it can be noted that BSE GREENEX is not riskier than BSE SENSEX. Jensen's alpha in this case is negative and not statistically significant. This means that for a unit increase risk premium of BSE SENSEX the risk premium of BSE GREENEX will increase by 0.958 units.

Table no. 5 (b) shows the value of beta (1.006) indicating the volatility of BSE CARBONEX (significant at 1% level) when regressed on BSE SENSEX. Since the beta is more than 1, it can be noted that BSE CARBONEX is riskier than BSE SENSEX. Jensen's alpha in this case is negative and not statistically significant. This means that for a unit increase risk premium of BSE SENSEX the risk premium of BSE GREENEX will increase by 1.006 units. A higher beta and higher adjusted $R^2$ indicate that [BSE] CARBONEX is better explained by BSE SENSEX.

**Table No. 5(a): Results of OLS Regression using CAPM**

| Market Proxy | Alpha | Beta | Adjusted $R^2$ (%) | Pro> F | N |
|---|---|---|---|---|---|
| Dependent Variable: Risk Premium BSE GREENEX | | | | | |
| Risk Premium BSE SENSEX | -0.009820 (-1.122) | 0.958375 ***(96.155) | 0.8268 | 0 | 1935 |

*** P d"0.01, ** P d" 0.05, * P d" 0.1 (t values in parentheses)

*Source : Author's own calculation*

**Table No. 5(b): Results of OLS Regression using CAPM**

| Market Proxy | Alpha | Beta | Adjusted $R^2$ (%) | Pro> F | N |
|---|---|---|---|---|---|
| Dependent Variable: Risk Premium BSE CARBONEX | | | | | |
| Risk Premium BSE SENSEX | -0.002212 (-0.666) | 1.006416 ***(266.117) | 0.9734 | 0 | 1935 |

*** P d"0.01, ** P d" 0.05, * P d" 0.1 (t values in parentheses)

*Source: Author's own calculation*

Table no. 6 presents the performance of BSE GREENEX and BSE CARBONEX in comparison to BSE SENSEX. For the three performance evaluation ratios i.e. Sharpe ratio, Treynor ratio, and Jensen's Alpha have been used. From the table, It can be noticed that the Sharpe ratio is highest in case of BSE SENSEX (4.7%) followed by BSE CARBONEX (4.5%) and then BSE GREENEX (3.5%). In case of Treynor ratio, again BSE SENSEX is highest (4.7%), BSE CARBONEX (4.5%) and BSE GREENEX (3.5%). The annualized Jensen's alpha (abnormal return) is negative in both BSE GREENEX and BSE CARBONEX. But in comparison it is comparatively better in case of BSE CARBONEX. All these measure of performance ratios indicate that the performance of BSE SENSEX is superior to both the indices. When we compare the two sustainability indices taken for the study, we can conclude that the performance of BSE CARBONEX is better than the BSE GREENEX.

**Table No. 6: Performance Comparison of Indices through Ratios**

| Ratio | BSE SENSEX | BSE GREENEX | BSE CARBONEX |
|---|---|---|---|
| Sharpe Ratio | 0.047060501 | 0.035279703 | 0.045145832 |
| Treynor Ratio | 0.0470398 | 0.035274054 | 0.045127506 |
| Jensen's Alpha | 0.0000 | -0.009820 | -0.002212 |

*Source: Author's own calculation*

Table no. 7 presents the result of conditional volatility analysis of the indices taken for the study. Volatility clustering can be noticed from the trends plots of return of the indices. Lagrange Multiplier (LM test) or ARCH test explains the arch effects in the taken indices. Ljung–Box test (White noise test) statistic for the taken indices also show that the null hypothesis of no arch effect in the indices is rejected. L-jung-Box has been applied to check autocorrelation in squared terms of return. So finally the LM test statistic and the probabilities indicate that in all the three indexes there is ARCH effect and that the respective residuals are white noise.

**Table No. 7: Result of Conditional Volatility Analysis**

| Indices | Lagrange Multipler Test | | | Portmanteau Tests | | |
|---|---|---|---|---|---|---|
| | Chi-squared | df | P-value | X-squared | df | p-value |
| BSE SENSEX | 85.514 | 12 | 3.624e-1 | 11.983 | 1 | 0.0005369 |
| BSE GREENEX | 92.015 | 12 | 2.008e-14 | 11.137 | 1 | 0.0008462 |
| BSE CARBONEX | 85.356 | 12 | 3.888e-13 | 15.478 | 1 | 8.349e-05 |

*Source: Author's own calculation*

As per results obtained from table no. 8, It can be noticed that the coefficients of Alpha and Beta are statistically significant in all the three indices (as per the p value) at 1% significance level. The measure for $\alpha+\beta$ are are about 0.97, 0.95, 0.96 for BSE Sensex, BSE Greenex and BSE Carbonex .Thus, the measures of $\alpha+\beta$ are very close to unity. Thus, it can be concluded that there is short-run as well as long-run persistence of volatility in all the three indices taken for study. Since the measures of volatility are different in the three series so our null hypotheses (H03 and H04) regarding equal average volatility are rejected.

## Findings of the Study
This study based on comparison of socially responsible indices (GREENEX & CARBONEX) with the general broad index SENSEX is conducted using daily returns data of all the three indices from 1st May 2012 to 28th Feb 2020. Along with the comaprison of returns of market indices, conditional volatility is also modelled using GARCH, ARCH models. Firstly, comparing the annualized mean returns, it has been observed that SENSEX has the highest mean return as compared to sustainability indices. Secondly, Sharpe ratio is highest in case of BSE SENSEX (4.7%) followed by BSE CARBONEX (4.5%) and then BSE GREENEX (3.5%).This also indicates that broad market index performance is superior in all cases.

## Conclusion of the Study
After conducting this research study, it can be concluded that Socially Responsible Investing is still at nascent stage in India. In spite of sustainable Indices in place, the performance in comparison to the

**Table No. 8: Result of GARCH (1,1) Estimation**

| Indices | Measure | Estimate | t value | Pr(>|t|) |
|---|---|---|---|---|
| BSE Sensex | Mu | 0.066725 | 3.6558 | 0.000256 |
| | omega | 0.017111 | 2.7978 | 0.005145 |
| | Alpha 1 | 0.057664 | 5.2244 | 0.00000 |
| | Beta 1 | 0.921121 | 59.0239 | 0.00000 |
| BSE Greenex | Mu | 0.049678 | 2.5442 | 0.010954 |
| | Omega | 0.031465 | 5.0500 | 0.000000 |
| | Alpha 1 | 0.067785 | 5.0500 | 0.000000 |
| | Beta 1 | 0.896688 | 42.7509 | 0.000000 |
| BSE Carbonex | Mu | 0.064614 | 3.4564 | 0.000548 |
| | Omega | 0.024719 | 3.0984 | 0.001946 |
| | Alpha 1 | 0.065666 | 5.3616 | 0.000000 |
| | Beta 1 | 0.904652 | 49.9624 | 0.000000 |

*Source: Author's own calculation*

general broad indices is not appealing. Socially responsible investing carries a cost of low returns with it. Investors, particularly retail investors may incorporate ESG criteria in their financial decision making process.

## Scope for Further Research

Since the results indicate that Socially Responsible Investing is still not prevalent in Indian stock market in spite of its great relevance. So, the probable reasons or determinants of Investors behavior towards responsible investing could be the area of future research. Further scope of this research can also be extended to comparison of Indian stock market sustainability indices with other foreign responsible indices like US Dow Jones sustainability index.

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