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MEASURING VOLATILITY AND LEVERAGE EFFECT OF GLOBAL SUSTAINABLE AND CONVENTIONAL STOCK INDICES – EVIDENCE FROM SUSTAINABLE STOCK EXCHANGES IN INDIA, RUSSIA, AND LUXEMBOURG

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ABSTRACT

Demand for Sustainable, Climate, Social finance has gained momentum after the COP 21 agreement and paved the way by adopting United Nations Sustainable Development Goals for the sustainable development in all dimensions of the global society. The global corporate world working onenvironmental, social, and economic aspectsof business operational practices.The UN's sustainable stock exchange (SSE) initiative (2009)has adopted five (SDGs 5, 8, 10, 12 & 13) SDGs for global stock exchanges.The paper examines the sustainability practices and volatility nature and leverage effect of sustainability indices inIndia, Russia, and Luxembourg stock exchanges.For the analysisdata has taken from2015 to2021 and analysed by using unit root test, ARCH/GARCH family models,Johansen co-integration test.The results indicate that the sustainability indices perform well and investors can diversify their portfolios to minimizing risk through responsible investment. The study finds that the higher volatility prevalence in Luxembourg than Russia and India. The study also finds the leverage effect and indicates the negative news have more impact on volatility than the positive news.

***KEYWORDS**: UN SDGs, Sustainable Stock Exchanges, ARCH/GARCH, EGARCH.*

Introduction

In 2015, the United Nations general assembly formally adopted the 2030 agenda for sustainable development and formalized 17 sustainable development goals (SDGs) which includes 169 targets. The United Nations sustainable stock exchanges (UN SSE) initiative took birth in 2009 and working collaboratively with different stakeholders towards SDGs for stock exchanges. The UN SSE is a partnership initiative of UNCTAD, UN Global Compact, UNEP-FI and PRI (https://sseinitiative.org/). The UN SSE initiative is a global platform, where it works with stock exchanges, stock markets regulators, investors, policy makers, governments and companies to achieve the target of sustainable development by encouraging sustainable investment, environmental, social and economic practices.

Sustainability indices are stock market indices that evaluate the sustainability performance of companies. The world's first sustainability index is Domini 400 social index launched in 1990 (Mansi Jain,2019).Dow Jones Sustainability Index, S&P BSE CARBONEX (2012), S&P BSE GREENEX (2012), S&P 500 ESG, NYSE Arca Environmental Services Index, NASDAQ Clean Edge US Index (CLEN), MOEX-RSPP Sustainability vector index, Lux RI Fund index, developed markets ESG index and Emerging markets ESG index etc are some of the sustainable indices.

There are 97 stock Exchanges along with 51,943 companies from Americas, Europe, Asia, Africa and Australia (August, 2020) has collaborated with UN's SSE Initiative to work on Sustainable Development Goals for Stock Exchanges i.e.SDG-5: Board room diversity and Gender Equality, SDG-8: SME Growth and Sustainable Development, SDG-10: Security market Regulation, SDG-12: Reporting on Environment, social, Governance, SDG-13: Climate Action (Green Finance) and SDG-17: Partnerships for sustainable and transparent capital markets(Initiative, 2009).

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The present paper mainly focuses on volatility and leverage effect on sustainable indices and conventional indices from India, Russia and Luxembourg stock exchanges. And it also works on co-integration between sustainability indices and conventional indices.The study lastly concludes with empirical analysis.

Literature Review

The study of (Alshehhi, 2018), uses the content analysis to examine the literature related impact of corporate sustainability on the financial performance and concludes that the major studies shown empirical evidence on the positive relationship between the corporate sustainability practices and corporate financial performance.(Maraqa, 2020),The author employed DCC-MGARCH model and study the interrelationship & spill-over effect among sustainable stock indices, crude oil prices and stock returns of European oil importing countries and the results concludes that the dynamic interrelationship between sustainable stock indices and stock returns of oil importing countries. The further concludes that the significant spill-over among sustainable stock indices, stock returns, oil prices.(Balcilar, 2017), study the diversification benefits of socially responsible investments over conventional stock indices by examining the risk spill-over and dynamic correlation between sustainable and conventional indices and findings suggest that the sustainable investments provide diversification gains over conventional indices globally. (Sharma, 2015), the article is based on the analysis of volatility and spill-over effect between currency and stock market in India and the methodology of the study based on unit root test, ARCH model, Johansen co-integration test and VECM model and the empirical findings indicate bidirectional volatility spill-over between Indian stock market and currency market.(Ali, 2016), the paper examines the relationship between returns and volatility, volatility clustering and leverage effect of NSE and BSE, employed GARCH-M and EGARCH models and concludes that the volatility, volatility clustering and leverage effect persistent at significant level.(Jain, 2019), study a comparative analysis between ESG indices and MSCI indices by adopting the ARCH/GARCH model, Johansen co-integration and VECM model and the results concludes that sustainable indices and conventional indices were integrated and found a flow of information between two investment avenues and the study indicates that there is no significant difference in performance between them, and the study further suggests that portfolios should consider both the indices to diversifying the risk.(Mohapatra, 2020), study focusses on establishing portfolio-based momentum profits in the Indian market and on designing a model to identify portfolio-specific and macroeconomic factors generating abnormal returnsby using vector autoregressive methodology and concludes that the examined returns of long-term and short-term winners and losers'portfolios to establish the existence of extra-normal profits.(Sadorsky, 2014), used Multivariate GARCH models to study the volatilities and conditional correlation between stock prices, oil prices and gold prices and results shown that socially responsible investment exhibits similar results with the S&P 500.(Managi, 2012), In this study, using the socially responsible investment (SRI) indexes and conventional stock indexes in the US, the UK, and Japan, first and second moments of firm performance distributions are estimated based on the Markov switching model, no statistical difference in means and volatilities generated from the SRI indexes and conventional indexes in either region (bull/bear) was found. Furthermore, it concludes strong co-movements between the two indexes in both regimes.(Bianchi, 2010), study concludes that the sustainable investment is a potential solution to social and ecological issues. There is immense study on the U.S. Sustainability indices (Antonakakis, 2016), (Mensi, 2017), (De la Torre, 2016), Europe Sustainability indices (Charlo, 2017),(Stolowy, 2018). In developing countries few studies found on Sustainability indices (Jain, 2019). The present paper takes into three stock exchanges namely BSE, MOEX and Lux SE from India, Russia and Luxembourg respectively. Study focuses on sustainability practices as well as volatility behavior, leverage effect and co-integration among the indices of BSE, MOEX and Lux SE.

Objectives

The following objectives has drawn in line with the study:

- To analyses the sustainability practices and performance of stock exchanges in India (BSE), Russia (MOEX) and Luxembourg (Lux SE).
- To examine the volatility and leverage effectof sustainability stock indices and conventional indicesof BSE, MOSE and LuxSE.

Data and Methodology

The study examines sustainability practices of Bombay stock exchange (BSE), Moscow stock exchange (MOEX) and Luxembourg stock exchange (Lux SE), the parameters and data retrieves from UN's SSE Initiative database for analysis. And the study also focuses on volatility analysis, leverage effect and co-integration analysis of S&P BSE SENSEX (benchmark index), S&P BSE CARBONEX (sustainability index) from India and MOEX Russia index (benchmark index), MOEX – RSPP sustainability vector index (sustainability index) from Russia and Lux X index (benchmark index) and Lux RI Fund Index (sustainability index) from Luxembourg.

The study uses daily closing prices of indices under reference from2015 to 2021 and log returns have been calculated. The total observations were taken as 7368of all indices i.e., SENSEX, CARBONEX, MOEX-Russia, MOEX-RSPP Sustainability vector index, Lux X index and Lux RI Fund index of the study. The paper takes the log returns to arrive at their respective daily returns. The stock return of the series is calculated by

$$r_t = \ln\left(c_t / c_{t-1}\right) * 100 \quad (1)$$

Where; r_t = stock return

c_t = Closing index value at time period t

c_{t-1} = Closing index value at time period t-1

ln = natural logarithm

Data analysis begins with computation of the descriptive statistics, including mean return, median return, standard deviation, skewness, kurtosis and Jarque-Bera (JB) statistic with the help of E-Views statistical package version 8.0. The article proceeds with the econometric analysis with line graphs of the series. Augmented Dickey-Fuller (ADF) unit root test applied to examine the stationary of the series. Augmented-Dickey-Fuller (ADF) unit root test is applied to examine whether or not the series are stationary. The following equation explains the basic concept of the unit root testing:

$$y_t = p y_{t-1} + x_t' + \varepsilon_t \quad (2)$$

where x_t' are optional exogenous repressors, which consist of a constant, *r* and *d* are the parameters to be estimated, and ε_t is assumed to be white noise.

The standard Dicky-Fuller test is carried out by estimating the following equation.

$$\Delta y_t = \alpha y_{t-1} + x_t' + \varepsilon_t \quad (3)$$

The study undertakes Heteroskedasticity test to examine the ARCH effect of the series under reference. Further, in order to check the volatility, the author adopted ARCH/GARCH family model. The relevant ARCH/GARCH family model is selected based on the Akaike information criterion (AIC), Schwarz information criterion (SIC). As per the AIC and SIC structure, the lower the values of SIC and AIC, the better is the model.

The ARCH/GARCH family model, GARCH (1,1) has employed to test the volatility of all the indices of BSE, MOEX and Lux SE.

$$Y_t = X_t' \theta + \varepsilon_t \quad (4)$$

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (5)$$

Where, ω = constant term, $\alpha \varepsilon_{t-1}^2$ = ARCH Term, $\beta \sigma_{t-1}^2$ = GARCH Term

To examine the leverage effect EGARCH model has applied. The Exponential GARCH model developed by Nelson (1991) to capture the leverage effects of shocks on financial market. The Equation of EGARCH model is

$$\ln(h_t) = \alpha_0 + \alpha_1 \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \lambda_1 \left(\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right) + \beta_1 \ln(h_t\text{-}1) \quad (6)$$

Where, α_1 is ARCH term, λ_1 Asymmetric term and β_1 is GARCH term.

H_0: No leverage effect (H0 > 0.05)

H_1: Leverage effect exists (H1 < 0.05)

The paper applies Johansen co-integration test to check the long-term relationship among the series under study. The Johansen co-integration test is tested by trace statistic value and maximum eigen value. The Null hypothesis can be written as

H_0: No Co-integration Equation (H0 > 0.05)

H_1: H0 is not true (H1 < 0.05)

Results and Empirical Analysis

Table 1: Results of Sustainability Practices of sample Stock Exchanges

S.no	Sustainability Parameter	BSE (India)	MOEX (Russia)	LuxSE (Luxembourg)
1.	SSE Partner Exchange	Yes	Yes	Yes
2.	Annual Sustainability report	Yes	Yes	No
3.	ESG reporting listing rule	Yes	No	Yes
4.	Guidance on ESG reporting	Yes	No	Yes
5.	ESG related training	Yes	No	Yes
6.	Sustainability related Indices	Yes	Yes	Yes
7.	Sustainability bond listing segment	Yes	Yes	Yes
8.	SME listing platform	Yes	Yes	Yes
	Sustainability practices**(Score)**	**100 %**(8/8)	**62.5 %** (5/8)	**87.5 %** (7/8)

Source: Data analyzed by author and collected from UN SSE initiative database

From Table 1., On the line with UN SDGs (2015), the SSE initiative started working (2009) with global stock exchanges in collaboration with different stakeholders to transform into sustainable stock exchanges. There are 97 stock exchanges (2020) globally partnered with SSE initiative, working on ESG disclosure, Green finance, Gender Equality, SME growth and Securities Regulation. The BSE joined with SSE in 2012, Lux SE in 2016 and MOEX in 2019.For measuring sustainability performance of sample stock exchanges, SSE initiative methodology has adopted and assigned score accordingly their practices. Based on the above methodology the Bombay stock exchange(100%) is in first line than Moscow stock exchange (62.5%) and Luxembourg stock exchange (87.5%). The MOEX is lack behind in ESG reporting listing rule, ESG reporting guidance and ESG training with sample stock exchanges.

Table 2: Descriptive Statistics

Variables	S&P BSE SENSEX	S&P BSE CARBONEX	MOEX-RUSSIA	MOEX-RSPP-SUS	Lux-X Index	Lux-RI Fund
Mean	0.000306	0.000258	0.000493	0.000592	-0.000368	0.000216
Median	0.000591	0.000617	0.00076	0.001023	-0.000287	0.000693
Maximum	0.085947	0.083121	0.074349	0.075214	0.075382	0.031934
Minimum	-0.141017	-0.13961	-0.08713	-0.097702	-0.09744	-0.058517
Std. Dev.	0.011735	0.011629	0.011361	0.010402	0.015721	0.007311
Skewness	-1.779195	-1.830128	-0.943995	-1.355112	-0.360624	-1.424065
Kurtosis	29.67552	28.74352	14.74955	19.09558	6.961809	13.19478
Jarque-Bera	37147.77	34679.65	7263.745	13664.76	831.7524	5746.989
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	0.376344	0.317552	0.607285	0.728294	-0.453114	0.265508
Sum Sq. Dev.	0.169391	0.166333	0.15876	0.133089	0.303991	0.065744
Observations	1231	1231	1231	1231	1231	1231

Source: Calculated by author

Table 2, shows that the average daily returns of S&P BSE SENSEX, S&P BSE CARBONEX MOEX- Russia index, MOEX- RSPP Sustainability vector index, Lux X index and Lux RI Fund index are 0.000306%, 0.000258%, 0.000493%, 0.000592%, -0.000368% and 0.000216% respectively.MOEX-RSPP Sustainability vector index gives the highest average daily return than other sample indices. The table also depicts median return, minimum return, maximum return, standard deviation, skewness and kurtosis of all indices under study. The Lux RI fund shows least variations, followed by MOEX- RSPP

Sustainability vector index and the Lux X index exhibits highest variation. The Jarque-Bera probability value is 0.0000 for all indices, that indicates the null hypothesis of normality can be rejected for all indices and concluding that the series under study are non-normal in nature. Based on the above results author can suggest that the FII's can choose the MOEX- RSPP Sustainability vector index in their responsible investment portfolio and followed by S&P BSE CARBONEX, Lux RI Fund index.

The following are line graphs of the S&P BSE SENSEX, S&P BSE CARBONEX, MOEX- Russia index, MOEX- RSPP Sustainability vector index, Lux X index and Lux RI Fund index representing the volatility clustering and stationarity under study.

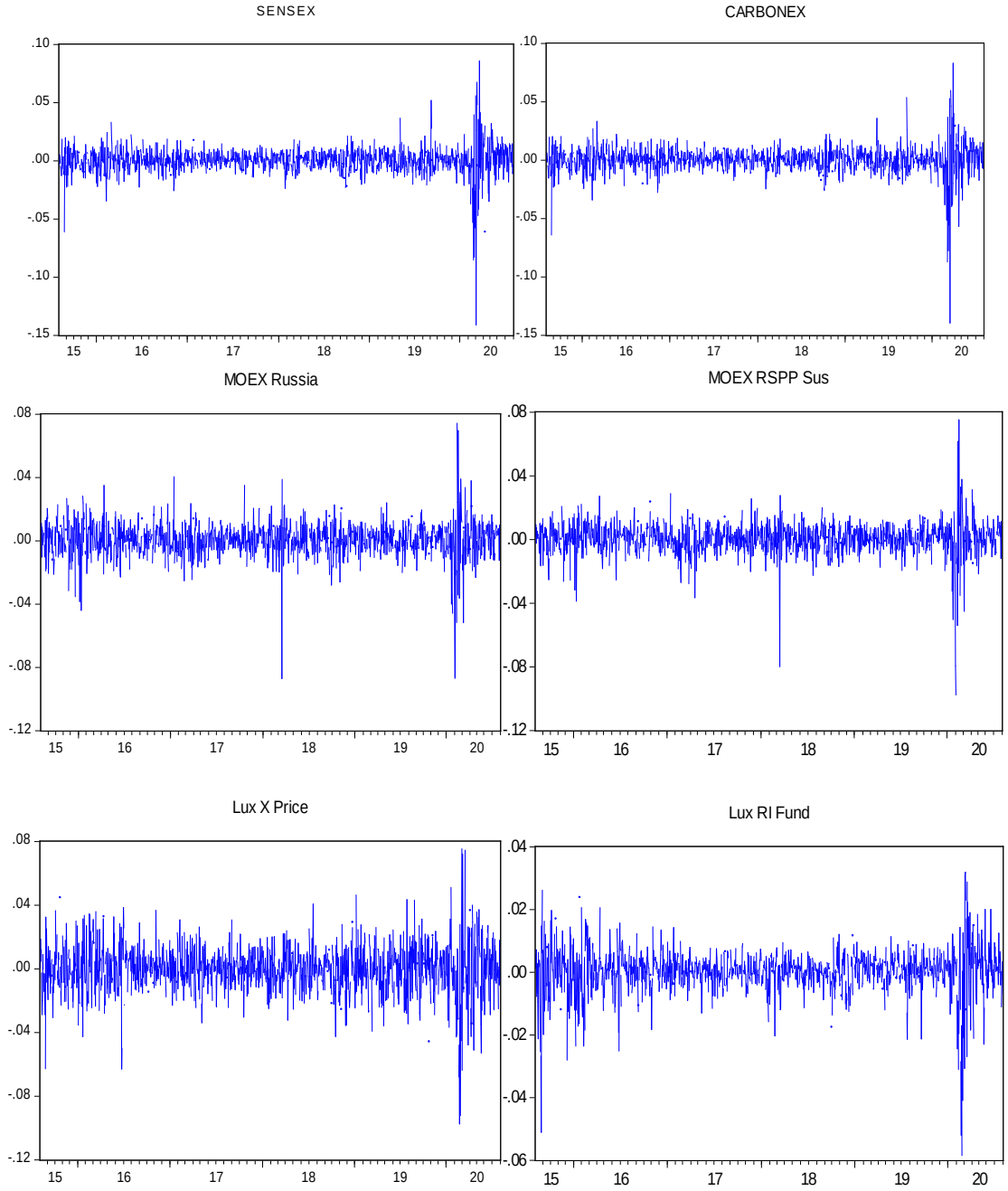

Table 3: Augmented Dicky Fuller Test – Unit Root

Variable	Coefficient	Standard Error	t- Statistic	Probability
S&P BSE SENSEX	-0.814858	0.091150	-8.939773	0.0000
S&P BSE CARBONEX	-0.800976	0.085408	-9.378262	0.0000
MOEX- Russia	-0.924789	0.071564	-12.92263	0.0000
MOEX- RSPP-Sus	-0.807060	0.065784	-12.26833	0.0000
Lux-X Price Index	-0.908494	0.076447	-11.88393	0.0000
Lux RI Fund	-0.708470	0.066252	-10.69360	0.0000

Source: Calculated by Author

In Table 3, the study employs the Augmented Dickey Fuller Unit Root Test for testing the series under reference are stationary or non-stationary. The results of ADF unit root test on all the series i.e., S&P BSE SENSEX, S&P BSE CARBONEX, MOEX-Russia, MOEX-RSPP Sustainability vector index, Lux-X index and Lux RI Fund index are indicating that the rejection of the null hypothesis and concluding that series under reference are stationary.

Table 4: Volatility Analysis- GARCH (1,1) Model

- **Volatility Analysis of S&P BSE SENSEX**

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000788	0.000221	3.559845	0.0004
SENSEX(-1)	0.039466	0.034407	1.147030	0.2514
Variance Equation				
C	2.89E-06	7.89E-07	3.661380	0.0003
RESID(-1)^2	0.134733	0.015134	8.902896	0.0000
GARCH(-1)	0.841494	0.020660	40.72999	0.0000

Source: Calculated by Author

The Mean coefficient (0.000788) indicates that the average stock return.The past value of the series under study predicts the current value of the series by 0.039466.The probability value mean equation is 0.0004, which indicates significant for return under series. In Variance equation the Coefficient values of constant, ARCH term (0.134733) and GARCH term (0.841494) are positive and statistically significant at 5% level. The probability value in variance equation of S&P BSE SENSEX is 0.0000.The total volatility (ARCH term volatility is 0.134733 and GARCH term volatility is 0.841494) of the S&P BSE SENSEX series is 0.976227 ($\alpha + \beta < 1$), which is closer to one and indicates that the volatility is high.

õ **Volatility Analysis of S&P BSE CARBONEX**

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000729	0.000225	3.237399	0.0012
CARBONEX(-1)	0.051431	0.034593	1.486764	0.1371
Variance Equation				
C	3.58E-06	9.18E-07	3.903411	0.0001
RESID(-1)^2	0.144308	0.016507	8.742406	0.0000
GARCH(-1)	0.825756	0.022976	35.94045	0.0000

Source: Calculated by Author

The Mean coefficient (0.000729) indicates that the average stock return. The past value of the series under study predicts the current value of the series by 0.051431. The probability value of the mean equation is 0.0012, which indicates significant for the return. In Variance equation the Coefficient values of constant, ARCH term and GARCH term are positive and statistically significant at 5% level. The probability value in variance equation of S&P BSE CARBONEX is 0.0000.The total volatility (ARCH term volatility is 0.144308 and GARCH term volatility is 0.825756) of the S&P BSE CARBONEX series is 0.970064 (α + β < 1), which is closer to one and indicates that the volatility is high.

õ **Volatility Analysis of MOEX – Russia Index**

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000677	0.000267	2.538071	0.0111
MOEX_RUSSIA(-1)	0.070605	0.030557	2.310632	0.0209
Variance Equation				
C	5.28E-06	1.06E-06	4.985598	0.0000
RESID(-1)^2	0.112219	0.014671	7.649062	0.0000
GARCH(-1)	0.845341	0.018513	45.66157	0.0000

Source: Calculated by Author

The Mean coefficient (0.000677) indicates that the average stock return. The past value of the series predicts the current value of the series by 0.070605. The probability value of the mean equation is 0.0111, which is significant to return. In Variance equation the Coefficient values of constant, ARCH term and GARCH term are positive and statistically significant at 5% level. The probability value in variance equation of MOEX – Russia Index is 0.0000.The total volatility (ARCH term volatility is 0.112219 and GARCH term volatility is 0.845341) of the MOEX – Russia Index series is 0.95756 (α + β < 1), which is closer to one and indicates that the volatility ishigh.

õ **Volatility Analysis of MOEX – RSPP- Sustainability Vector Index**

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000696	0.000243	2.868994	0.0041
MOEX_RSPP_SUS(-1)	0.104776	0.032232	3.250663	0.0012
Variance Equation				
C	6.25E-06	1.24E-06	5.036803	0.0000
RESID(-1)^2	0.127793	0.017010	7.512649	0.0000
GARCH(-1)	0.806522	0.025499	31.62999	0.0000

Source: Calculated by Author

The Mean coefficient (0.000696) indicates that the average stock return. The past value of the series predicts the current value of the series by 0.104776. The probability value of the mean equation is 0.0041, which is significant to return. In Variance equation the Coefficient values of constant, ARCH term and GARCH term are positive and statistically significant at 5% level. The probability value in variance equation of MOEX – RSPP Sustainability Vector Index is 0.0000.The total volatility (ARCH term volatility is 0.127793 and GARCH term volatility is 0.806522) of the MOEX – RSPP Sustainability Vector Index series is 0.934315 (α + β < 1), which is closer to one and indicates that the volatility is high.

õ **Volatility Analysis of Lux X Price Index**

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-5.85E-05	0.000365	-0.160011	0.8729
LUXXPRICE(-1)	-0.032484	0.030115	-1.078674	0.2807
Variance Equation				
C	6.78E-06	2.05E-06	3.311338	0.0009
RESID(-1)^2	0.088809	0.013859	6.408223	0.0000
GARCH(-1)	0.881238	0.019548	45.07982	0.0000

Source: Calculated by Author

The Mean coefficient (-0.0000585) indicates that the average stock return. The past value of the series predicts the current value of the series by -0.032484. The probability value of the mean equation is 0.8729, which is not significant to return. In Variance equation the Coefficient values of constant, ARCH term and GARCH term are positive and statistically significant at 5% level. The probability value in variance equation of Lux X Price Index is 0.0000.The total volatility (ARCH term volatility is 0.088809 and GARCH term volatility is 0.881238) of the Lux X Price Index series is 0.970047 ($\alpha + \beta < 1$), which is closer to one and indicates that the volatility is high.

õ **Volatility Analysis of Lux RI Fund Index**

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000334	0.000145	2.298766	0.0215
LUX_RI_FUND(-1)	0.256795	0.031096	8.257998	0.0000
Variance Equation				
C	8.58E-07	1.53E-07	5.596996	0.0000
RESID(-1)^2	0.089080	0.008528	10.44509	0.0000
GARCH(-1)	0.888282	0.008937	99.39159	0.0000

Source: Calculated by Author

The Mean coefficient (0.000334) indicates that the average stock return. The past value of the series predicts the current value of the series by 0.256795. The probability value of the mean equation is 0.0215, which is significant to return. In Variance equation the Coefficient values of constant, ARCH term and GARCH term are positive and statistically significant at 5% level. The probability value in variance equation of Lux RI Fund Index is 0.0000.The total volatility (ARCH term volatility is 0.089080 and GARCH term volatility is 0.888282) of the Lux RI Fund Index series is 0.977362 ($\alpha + \beta < 1$), which is closer to one and indicates that the volatility is high. The volatility analysis of the series under reference leads to the interpretation that all the series are highly volatile and the Lux RI Fund Index is showed high volatility with 0.977362 than other series in the study and followed by S&P BSE SENSEX (0.976227), S&P BSE CARBONEX (0.970064), Lux-X Price index (0.970047), MOEX – Russia index (0.95756) and MOEX-RSPP Sustainability Vector index (0.934315).

The E-GARCH Model results from Table 5, exhibits the leverage effect or asymmetric information, which is a negative correlation between the past return and future volatility of the return. The presence of leverage effect implies that every price change is responding asymmetrically to the positive and negative shocks in the market. The ARCH coefficient (α_1) and GARCH coefficient (β_1) are statistically significant for all of the indices in the study implying a greater impact of shocks on volatility. The leverage/asymmetric term (λ_1) is negative and statistically significant and indicating that the volatility is high when there are negative shocks in the market than the positive shocks for all the indices under reference. From the table 6, it is evident that the leverage effect is higher in S&P BSE CARBONEX (-0.162864) and followed by Lux RI Fund (-0.142368), S&P BSE SENSEX (-0.138180), MOEX-Russia (-0.081425), MOEX-RSPP Sustainability Vector index (-0.079798), Lux-X Price index (-0.067903).

Table 5: Testing Leverage Effect: E-GARCH Model

Index	Variable	Coefficient	Std. Error	z-Statistic	Prob.
S&P BSE SENSEX	α_1	0.160302	0.023599	6.792790	0.0000
	λ_1	-0.138180	0.011692	-11.81843	0.0000
	β_1	0.972994	0.003944	243.7006	0.0000
S&P BSE CARBONEX	α_1	0.147447	0.026951	5.470912	0.0000
	λ_1	-0.162864	0.012510	-13.01846	0.0000
	β_1	0.970775	0.003830	253.4837	0.0000
MOEX- Russia	α_1	0.173325	0.022947	7.553201	0.0000
	λ_1	-0.081425	0.015386	-5.292121	0.0000
	β_1	0.963869	0.007493	128.6309	0.0000
MOEX- RSPP Sus	α_1	0.187517	0.023931	7.835828	0.0000
	λ_1	-0.079798	0.015601	-5.115100	0.0000
	β_1	0.953992	0.009425	101.2239	0.0000
Lux-X price	α_1	0.126556	0.021843	5.793799	0.0000
	λ_1	-0.067903	0.012693	-5.349567	0.0000
	β_1	0.978254	0.006217	157.3629	0.0000
LuxRI Fund	α_1	0.130132	0.016334	7.966798	0.0000
	λ_1	-0.142368	0.013053	-10.90682	0.0000
	β_1	0.969589	0.004298	225.5964	0.0000

Source: Calculated by Author

Table, 7 tests the co-integration among sustainability and conventional stock indices. The trace statistic value of 1460.166 is greater than the corresponding critical value of 95.75366. Therefore, the H0 of the co-integrating equation is rejected, which means that there is at least one co-integrating equation among the series under study. From table 7, The maximum eigen value statistic value of 352.6216 is greater than the corresponding critical value of 40.07757. Therefore, the H0 of the co-integrating equation is rejected, which means that there is at least one co-integrating equation among the series under study. Finally, we can conclude from the Johansen's co-integration analysis (trace statistic and maximum eigen value statistic), that there is at most 6 co-integrating equations and the co-integration results exhibit a long-run relationship.

Table 6: Johansen Co-integration Test Results

Unrestricted Co-integration Rank Test **(Trace)**

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.249953	1460.166	95.75366	1.0000
At most 1 *	0.207163	1107.545	69.81889	1.0000
At most 2 *	0.204630	822.9443	47.85613	0.0001
At most 3 *	0.157309	542.2545	29.79707	0.0001
At most 4 *	0.135306	332.4188	15.49471	0.0001
At most 5 *	0.118174	154.1830	3.841466	0.0000

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Unrestricted Co-integration Rank Test **(Maximum Eigenvalue)**

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.249953	352.6216	40.07757	0.0001
At most 1 *	0.207163	284.6005	33.87687	0.0001
At most 2 *	0.204630	280.6898	27.58434	0.0001
At most 3 *	0.157309	209.8357	21.13162	0.0001
At most 4 *	0.135306	178.2359	14.26460	0.0001
At most 5 *	0.118174	154.1830	3.841466	0.0000

Source: Calculated by Author
Max-eigenvalue test indicates 6 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Conclusion

The study concludes that the Bombay stock exchange is ahead in sustainability performance than the Moscow stock exchange and Luxembourg stock exchange and the MOEX it lacks behind in ESG reporting listing rule, ESG reporting guidance, and ESG training with sample stock exchanges. The findings show that MOEX- RSPP Sustainability vector index gives the highest average daily return than other sample indices.

The volatility analysis of the series under reference leads to the interpretation that all the series are highly volatile and the Lux RI Fund Index is showed high volatility than other series in the study and followed by S&P BSE SENSEX, S&P BSE CARBONEX, Lux-X Price index, MOEX – Russia index and MOEX-RSPP Sustainability Vector index. TheMOEX- RSPP Sustainability Vector index exhibits high average return, low risk and low volatility hence investors can include the index in an investment portfolio.

It is evident from findings that the leverage effect is higher in S&P BSE CARBONEX and followed by Lux RI Fund, S&P BSE SENSEX, MOEX-Russia, MOEX-RSPP Sustainability Vector index, Lux-X Price index. We can conclude from the Johansen co-integration analysis test that there is at most six co-integrating equations and the co-integration results exhibits a long-run relationship.

Finally, it can conclude that investors can diversify their portfolio by adopting socially responsible investments globally and it also leads to sustainable development in line with UN SDGs. The findings of the study will be useful to the international and domestic investors, corporations, and policymakers for decision making.

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