

Diversification Opportunities: Are Sustainability Indexes A New Option

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Abstract

The present study examines the interdependence among selected sustainable and conventional indices of the Indian economy. Econometric tools have been utilised to explore the connection between sustainability and conventional indices of India. Findings from the analysis show a correlation between sustainable indices and traditional indices in the Indian economy. Still, the two stock market indices have not been integrated over the extended period, and both operate autonomously. In addition, no causality exists, so the current trend of one index can't be predicted by the past trend of another stock market price series. Based on findings, this study suggests that investment managers use sustainability indices for portfolio diversification, which are also helpful for regulators and policymakers.

Keywords- Cointegration, Conventional indices, Sustainable Development, Sustainable Finance, Sustainability Indices.

Introduction

Market integration is essential in emerging financial markets and has been the most studied by researchers in recent decades. The removal of trade barriers and capital control at the end of the 1980s and early 1990s resulted in market openness for international trade. Many multinational companies have started to trade cross-border, which has resulted in the integration of commercial markets and the economies of countries. In addition, more globalised trading and investment lead to financial market integration. Thus, markets start to move together and narrow the price differentiation between the different stock markets (indexes). Increased economic integration can be seen as a mixed blessing.

Integration has potential benefits of improving Financial Market and lowering the cost that is paid for raising capital from various sources, foreign investment, etc. At the same time, it reduces the market diversification benefits due to integration among stock markets. Because highly interconnected markets propagate the risk of the portfolio. Much research focuses on integrating major stock indexes of

developed and developing nations. Research studies on market integration findings are significant for international portfolio investment decisions, diversification of portfolios, and stock market growth (Floros and Vougas, 2008; Vo and Daly, 2015; Menon and Sagar, 2009; Batareddy et al., 2012; Curto and Vital, 2014; Seth and Sharma, 2015; Jain et al., 2019).

Focus on sustainability in the financial market results in a new opportunity for diversification for stock investors. All increased sustainable investment leads toward the sustainability indexes. Sustainability indexes evaluate the company's performance working on Sustainable projects and incorporate environmental, social, and governance (ESG) factors as part of their aim. Sustainability indexes are getting popular, and investors are finding ways to diversify their portfolios through them. Many researchers considered the integration of sustainability and conventional indices, but previous studies only include developed countries and some leading sustainability indexes (Curto and vital, 2014; Bacillary et al., 2017; Rehman et al., 2021). Previous studies focused on developed countries' sustainability indexes. Non-consideration of an emerging market like India during the prior studies motivates me to examine the interdependence of sustainability and conventional indexes in the Indian economy. India's current status is evident as one of the most important emerging markets with high growth potential. BSE is the oldest stock exchange in India and the South Asian region. In May 2021, the combined market capitalization of all stocks listed on the BSE amounted to \$3.1 trillion USD. The long history of the Indian capital market is reflected in an organized, relatively integrated, and modernized market globally. India has always remained a part of the transformational journey of sustainable development, which includes the Montreal Protocol 1987, the Rio Summit 1992, the Kyoto Protocol 1997, and many others; now, India has also signed the 2015 agreement with 195 other Nations. India is growing as an emerging market for the issue of sustainability bonds.

According to the Economic Survey 2019-20, India secured the second position among major emerging markets for the green bond issue with USD 10.3 billion worth of

transactions. According to SSE, a U.N. Partnership program database, there are 103 SSE partner exchanges. Among them, 45 stock exchanges have an ESG index with 42,746 listed companies and USD 82,912,521 Million domestic market capitalization. India is one of the countries with two major stock exchanges, i.e., NSE and BSE, with ESG indices. The increasing number of sustainable indices also shows the importance of examining the interrelationship between sustainable and conventional indices in India. The integration and causality among sustainable and conventional indices of the Indian economy have been focused on in the present research. Further, investors, policymakers, portfolio managers, and regulators can use these findings to make decisions.

Review Of Literature

Researchers and academicians have disclosed the most topical patterns in ESG components and sustainable indices. Many researchers have discovered the relevance of ESG factors in finance in terms of performance, value, credit rating, and returns. Some believe that ESG has a robust and optimistic relationship with the organisation's economic indicators. Scholarly research has emphasised the need to explore the association between ESG components and monetary returns.

As a result, some recent literature explores the cointegration and causality between sustainable and conventional indices after initiating sustainability indices in the security market. Literature that explores the influence of the ESG components on business in a different context is collected to witness the importance of the ESG factor in research and its implications. These studies covered the period from 2013 to 2020. Further literature examining the cointegration and causality between various countries' stock indices, including sustainability indices, is collected to understand the tools and methods applied by different researchers. Literature has been collected from the best available resources, including Emerald Insights, Google Scholars, and MDPI. Keywords used to search this research paper are ESG factors, financial performance, integration, sustainability indexes, and conventional indexes.

Literature on ESG Factor Impact on Financial Performance Indicators

This review of literature sheds light on ESG and sustainability, and the relationship between them in the context of financial markets.

Tyagi and Sharma (2013) analysed the connection amongst social performance and company's financial performance. The study used secondary data of firms listed in the NSE and S&P's ESG India 500 Index as the base of investigation. The study found a negative relationship between both aspects using weighted least squares and panel regression techniques and the results focus on prioritising social performance to accelerate financial performance.

Muttakin et al. (2018) considered the corporate governance structure as an effecting aspect of CSR activities. To investigate this relationship, 282 corporations listed on the Dhaka Stock Exchange spanning 2005 to 2013 were considered. By employing regression analysis, a positive relationship between the board of directors' capital and CSR disclosure was found. On the contrary, there exists a negative influence of CEOs' power on CSR disclosure.

Chelawat and Trivedi (2016) examined the significance of ESG issues in enhancing the financial performance of organisations. Using the Levin-Lin-Chu (LLC) test, Variance Inflation Factor (VIF), and panel data regression on secondary data from 93 companies in the Nifty 100 index, this study demonstrated that ESG Factors have a beneficial effect on financial performance in the Indian context. These findings illuminate the importance of ESG considerations on the financial growth of firms.

In relation to existing research, the article by Atan et al. (2018) also examined the impression of ESG variables on business assessment and the cost of capital. The study examined secondary data from 52 Malaysian public limited firms, covering 2010 to 2013. The study, conducted using panel data regression analysis, demonstrated that ESG characteristics do not have a substantial impact on the cost of capital, profitability, and business value.

Laskar et al. (2017) elucidated the effect of sustainability on financial performance within non-financial businesses. The

Asian setting was examined using secondary data from 28 Indian and 35 Japanese enterprises, covering 2009 to 2014. The panel and Logit data regression analyses revealed a substantial and favourable influence of sustainability on financial performance, particularly within the Japanese corporate landscape. The results demonstrated the importance of sustainability performance concerning the expansion of economic performance.

The aim of the study by Velte (2017) is to check the influence of ESG performance on the financial performance of German firms listed on the Prime Standard (DAX30, TecDAX, MDAX) from 2010 to 2014. The discovery demonstrated that the performance of ESG factors has a valuable effect on the return on assets, but it does not substantially impact Tobin's Q.

Kim and Oh (2019) investigated CSR activities of a firm and their correlation with its financial performance. The enterprises listed on the NSE and BSE were considered as sample data from 2010 to 2015, with a specific focus on the Indian setting. The t-tests and panel regressions findings indicate that CSR efforts do not regularly influence financial performance. However, once the threshold limits are reached, CSR activities benefit the company's financial performance and value.

This study by Tyagi and Abilasha (2019), like the literature mentioned above, focuses on examining the effects of CSR on financial performance specifically in the Indian setting. The sample comprises the economic data of the 10 Indian corporations spanning from 2014 to 2017. Consistent with other research, this study also demonstrated the beneficial influence of CSR on financial success through regression modelling.

Maqbool and Bakr (2019) examined the correlation between CSR activities and financial success of Indian enterprises. This study utilised the panel regression model to explore the non-linear association between CSR and financial success. The analysis focuses on 43 publicly traded businesses that are part of the BSE 100 index, covering the period from 2008 to 2017. The study identified a substantial correlation between CSR initiatives and

economic performance. The findings of this study are in line with the preceding literature, indicating the considerable significance of CSR initiatives in driving financial performance and business value in the Indian setting.

Kim et al. (2009) explored the correlation between CSR activities and financial success, specifically focusing on the impact of external assurance of CSR reports. Using the least square model and regression analysis on secondary data from 5,040 US enterprises between 2006 and 2016, this study demonstrated that a reliable CSR report enhanced the connection between CSR activities and financial performance.

Bodhanwala&Bodhanwala (2020) investigated the performance of Sustainable and Responsible Investment (SRI) indexes compared to traditional indexes on a worldwide scale. A sample of secondary data on financial performance and risk of companies from seven nations has been considered. The investigation utilised Jensen's alpha within the Capital Asset Pricing Model (CAPM) and the Fama and French three-factor model. The study demonstrated the worse performance of SRI in impoverished countries; however, in developed countries, SRI surpassed conventional measures. The findings of this study revealed the variations in the performance of SRI across different regions, as compared to major indexes. Additionally, these findings highlight the potential for portfolio diversification for investors globally.

Bhattacharya and Sharma (2019) examined the influence of ESG reporting on the credit ratings of corporations within the Indian environment. The sample comprises the secondary data of 122 enterprises that are registered on the BSE, which were chosen from a pool of 500 listed companies. The regression model results indicate a favourable impact of ESG reporting on credit ratings in Indian companies. The results of this study offered valuable understanding regarding the significance of the reporting system in bolstering the credibility of organisations in the Indian financial industry.

Javeed &Lefen (2019) inspected the correlation between CSR performance and financial performance, considering

the impact of CEO authority and ownership structure. The dataset encompassed the eight industrial industries that occurred during the years 2008 and 2017 in Pakistan. The study demonstrated that CSR performance has a significant and beneficial effect on financial performance, using a fixed effects model with the generalised method of moment (GMM). Nevertheless, the relationship between CEO authority and ownership structure does not have a significant impact.

Jouber (2019) examined the CEO's remuneration level and its correlation with CSR efforts in enterprises based in the United States, Canada, Spain, and France. The Durbin-Wu-Hausman test revealed a significant correlation between the proportion of CEO remuneration and CSR. These results demonstrated the significance of decision-makers accurately determining the pay level for the financial performance of firms.

Velte (2020) examined the correlation between ESG aspects and financial success, taking into account the influence of CEO authority as a moderating element. The study examined 775 German-listed companies from 2010 to 2018. The Panel regression analysis revealed a positive correlation between ESG variables and financial performance. The findings emphasized on the significance of CEO authority in leveraging the ESG element to enhance the financial performance of firms.

Kaur & Singh (2020) examined the association between CSR and financial performance of the Indian steel sector. An analysis is conducted on the financial secondary data of 40 steel businesses spanning 14 years using Panel regression analysis, ANOVA, and MANOVA. The study discovered a direct correlation between CSR and financial performance. These findings indicate a need for greater attention to CSR initiatives in India's steel sectors.

Alareeniand Hamdan (2020) investigated how disclosing ESG elements in financial statements impacts financial performance. The study examined companies listed on stock exchanges in USA, with a particular emphasis on the S&P 500 index from 2009 to 2018. The panel regression model revealed a favourable influence of ESG aspects on financial performance. The findings underscore the need to

disclose the reporting methods related to the ESG element in attaining elevated financial objectives.

P and K.B. (2020) examined the attributes of a company as a metric for CSR disclosure and ESG factors. In order to examine this correlation, the dataset includes information from 386 companies, listed on the Indian stock exchange, specifically the BSE 500 index, during the years 2007 to 2016. By utilising the regression model on this panel data, the study demonstrated diverse outcomes based on the characteristics of the firms. This study enhances our comprehension of this novel correlation and allows additional research to establish a well-defined link between both characteristics.

Cherian et al. (2020) examined the correlation between the level of influence a CEO holds and the initiatives undertaken by a business concerning CSR. By utilising the Ordinary Least Squares (OLS) regression, this study conducted an analysis of the companies that are traded on the Shanghai Stock Exchange in China. The results demonstrate an unforeseen inverse correlation between both variables, contributing to the comprehension of the influence of CEOs on Chinese enterprises, particularly concerning their implementation of CSR activities.

Jha and Rangarajan (2020) observed the correlation between the sustainability performance and financial performance of organisations. The study examined the Indian setting by utilising data from the top 500 Indian enterprises spanning from 2008 to 2018. The study utilised Granger causality tests, multiple regression, and trend analysis. The study's findings revealed a surprising outcome, indicating that an augmentation in investment towards sustainable initiatives did not impact a company's financial outcomes.

Literature on Cointegration of Stock Indices in Respect of Different Countries

This part of the literature review provides insights into tools used to examine the interrelationship among different stock markets and indices.

Floros and Vougas (2008) utilised daily data from the FTSE/ASE-20 and FTSE/ASE mid-40 Stock Index futures

traded on ADEX. The objective was to examine the correlation between the Greek spot market and the futures market throughout the crises that occurred between 1999 and 2001. The study established a durable correlation between Greek future and spot prices through the application of cointegration tests and vector error correction methods. Additionally, it illustrated that forthcoming markets would exhibit significantly higher efficiency levels than Greece's securities market. The results emphasise the importance of the futures market in determining prices and managing risks and contribute to our knowledge of how prices behave during crises.

Menon et al. (2009) investigated the correlation between the Indian stock exchange and other prominent stock markets, including China, the US, Hong Kong, and Singapore. The study analysed the daily closing prices of various indices for ten days and concluded no evidence of cointegration between the Indian, American, and Hong Kong markets. Conversely, there is a robust integration between the Shanghai and Singapore markets. The results offer valuable insights on diversifying investments across several countries.

Siddiqui and Seth (2010) examined the short-term interdependence between Indian and Japanese stock markets using the dataset of five years and by applying Granger's causality test and concluded that Indian and Japanese stock markets were not connected with each other in the short run.

Batareddy et al. (2012) investigated the enduring correlation between emerging and developed stock markets by analysing ten years of index data from six distinct nations: India, the USA, South Korea, Taiwan, China, and Japan. The findings demonstrated a sustained cointegration between India's emerging and developed markets, highlighting the interconnectedness of global financial markets.

Rajwani and Mukherjee (2013) studied the enduring correlation between the Indian market and other Asian markets. The Lagrange Multiplier and Gregory and Hansen cointegration tests indicated no enduring connection with other markets, particularly Asia. The study determined that

the Indian market does not actively participate in the region. Curto and Vital (2014) utilised data from four conventional and ten sustainable indices, primarily sourced from the United States and Europe, to examine the correlation between sustainability and stock market index performance. It suggests that, in the long term, there is no reliable connection between traditional and sustainability-related measurements. The research concludes that market performance connected to sustainability operates autonomously from conventional market trends, based on unit root tests, cointegration tests, and Granger's Test for Causality. The findings demonstrate the contrasting behaviour of investment indices associated with sustainability compared to those not.

Seth and Sharma (2015) analysed the correlation between the American and Asian stock exchanges and their ability to process information effectively. The analysis involves the utilisation of the Pearson correlation coefficient, unit root tests, Granger causality test, and Johansen's cointegration test on a dataset comprising ten years of daily closing stock prices from thirteen different nations. Although the variables have a long-term relationship, the statistics indicate temporary inefficiencies in the market. The financial crisis has had a limited effect despite its influence on market integration.

This research inspected the relationship between USA and numerous Southeast Asian stock markets in relation to the Asian Financial Crisis of 1997, both before and after the crisis. The study examined the daily closing prices of the indexes and gathered data from the DataStream. The survey conducted by Vinh Vo and James Daly (2005) revealed that before the crisis, there was a state of mixed integration among various Asian markets. However, during the crisis, clear evidence of integration was observed among these markets.

This study examined the potential for diversification provided by various sustainable and conventional indexes. The study focuses on the daily closing prices of the stock market from January 2004 to September 2015. It utilises the MS-DCC-GARCH model, Volatility Spillover Tests, and Dynamic Correlations analysis. The study conducted by

Balcilar et al. (2017) discovered that sustainable indices provide diversification options and contribute to the development of a robust portfolio, after analysing risk spillover and dynamic correlations.

Jain et al. (2019) examined the superior performance of sustainable indices compared to traditional indices. The study examined the association by analysing the stock return. The dataset includes the daily closing prices of ESG and MSCI indices for both developed and developing nations. The employed methodologies include unit root tests, ARCH-GARCH models, Granger's causality test, Johansen's cointegration analysis, and VECM (Vector Error Correction Model). The findings suggest that there is no discernible disparity in the performance of sustainable investing indexes and traditional indices.

This literature by Rehman et al. (2021) examines the long-term relationship between ESG and conventional metrics within the BRICS countries. The data encompasses the performance of MSCI ESG and Composite Indices and utilises similar tools as used by Jain et al. (2019). The findings indicate a significant long-term integration between both indices. However, the causal links are inconclusive. This study offers valuable insights into the exploration of potential research prospects in developing countries.

After analyzing the existing literature, we found, however, several studies have been done on the importance of ESG factors in financial performance. Still, more research needs to be done on the sustainability indices, which are indicators of the economic performance of companies working on the ESG factor model. Some studies evaluate sustainable indices worldwide, such as Dow Jones Sustainability and MSCI indexes. Major studies covered developed market indices, including U.S. sustainability indices, Europe's, Australia's, Hong Kong's, and other conventional indices as research data and ignored the emerging markets. No study exists on the Indian sustainability indices of BSE. Additionally, current research has not explored the integration and causality among Indian sustainability indices on the BSE and major conventional indices.

Understanding the integration of sustainable and conventional indices within the Indian economy is crucial. Thus, the proposed study stands out for investigating this integration among indices in India, representing one of the emerging sustainable financial markets.

The research objectives lead to the formulation of the following assumptions essential for conducting the research and obtaining relevant findings:

H01= There is no correlation between sustainable and conventional stock indices of India.

H02= There is no long-term integration between sustainable and conventional stock indices of India.

H03= There is no short-term association between sustainable and conventional indices of India.

Research Methodology

Data Description and Collection

The present study focused on sustainability and conventional indices. As stated in an earlier chapter, we look at integration in the domestic border indices—the two essential stock exchanges in India are BSE and NSE. We consider major sustainability indices and conventional indices from these stock exchanges for the study, as mentioned in Table 1. The SNX and NIFTY, India's leading

stock indices, represent the conventional indices. The CBX and GNX indices are considered to represent the sustainability indices.

S&PBSE SENSEX

India's most followed Index is SNX. It is introduced to evaluate the performance and working of India's 30 most reliable and liquid stocks. That covers the critical sector of the economy.

NSE NIFTY50

NSE has the 4th rank globally; the Nifty 50 index covers 13 significant sectors of the Indian economy. Nifty 50 is the standard Index that considers the 50 companies among the most prominent Indian companies.

S&PBSE CARBONEX

The S&PBSE CARBONEX, the unprecedented index, was introduced to evaluate the performance of companies that work on mitigating the risk due to climate change and is listed in the S&PBSE 100 Index.

S&PBSE GREENEX

The GNX assesses the leading 25 “green companies” by considering their greenhouse gas (GHG) emissions, market liquidity, and capitalization.

Table 1: Nature and stock exchanges of stock indices analysed

Stock Indexes	Nature of Indexes		Stock Exchanges	Abbr.	Source
	Conventional Indices	Sustainable Indices			
NSE NIFTY 50	✓	-	National stock exchange	NFT	www.nseindia.com
S&P BSE SENSEX	✓	-	Bombay stock exchange	SNX	www.bseindia.com
S&P BSE CARBONEX	-	✓	Bombay stock exchange	CBX	
S&P BSE GREENEX	-	?	Bombay stock exchange	GNX	

Data For The Study

The study uses high-frequency data (daily and tick-by-tick data) to analyse cointegration and interlinkages between stock indices. Daily or high-frequency data over low-frequency data (weekly or monthly data) work to better

model short/long-term price movements and potential interactions among indices of the Indian stock market. For the reasons mentioned above, this study utilised the daily closing prices of the stock market.

Period Covered in the Study:-

This research considers the time period starting from 30 November 2012 to 30 November 2022 to collect daily closing prices. The non-trading days and other holidays on which stock exchanges were closed, are not considered as part of the data set for this study.

Method To Measure Financial Market Interdependence:-

Based on what we studied in the literature compiled, some of the most used methodologies are used for measuring financial market interdependence. The proposed research is an empirical study in which methods have been used that include:

- 1 The correlation test
- 2 Unit root test (Augmented dickey fuller test)
- 3 Johansen's cointegration test
- 4 Granger's causality test

Pearson's Correlation Test

The correlation test is perhaps a well-known measure for examining comovement between two markets. The more positive correlation coefficient indicates that both index (market) prices move in the same direction, and it will reduce the benefit of a diversified portfolio. If an investor wants to decrease the risk of investment, then there is a need to search for indexes (markets) that do not correlate, i.e., negative correlation coefficients. The coefficient r measures the dependence level among two variables between -1 and +1.

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

A correlation coefficient measures the degree of association and gives an idea about portfolio diversification to reduce risk. However, it does not provide any information regarding the trend of the indices (market).

Unit Root Test:-

The essential characteristic of time series data is that it should be stationary. Stationery in time series occurs when there is a constant means of constant variance over time. Forecasting the trend of stationary time series is straightforward since the consistent statistical parameters observed in the past are expected to remain unchanged. Analysing the non-stationary stock index data may mislead the predictions and show an unreal relationship between variables. We have used an augmented dickey–fuller model.

It is as follows:

$$Y_t = c + \beta_t + \alpha Y_{t-1} + \Phi \Delta Y_{t-1} + e_t$$

Where α is a constant, ΔY_1 is the differenced level of Y . ADF test considers the null hypothesis that has been formulated that indicates the existence of unit root. If the coefficient of the lagged independent variable (P-1) equals zero, then the null hypothesis is accepted, indicating stationarity. Subsequently, the first difference of the price series is observed for a second level. If the coefficient of the lagged independent variable (P-1) is greater than zero, the null hypothesis is not accepted, implying that the stock price data exhibits a non-stationary characteristic.

Johansen's Cointegration Model

Cointegration is used to assess the long-term interrelationship between variables using time series data. The existence of cointegration among time series shows that two or more stock markets move together through time 't' in some underlying fact. Cointegration analysis is an econometric test for testing the long-run interdependence between variables based on the non-stationary time series data if their stationary linear combination exists. Johansen's cointegration model forms a vector autoregressive model. This dependent variable is a function of its independent variable. In other words, the dependent variable appears as an independent variable in the form of lags. Johansen cointegration test can be applied with the condition that time series are integrated at order one.

The following statistics are used:

The trace test statistic is specified as:

$$\lambda_{max}(rr + 1) = -T \ln(1 - \lambda r + 1)$$

The maximum eigenvalue test statistic is specified as:

$$\lambda_{trace}(r) = -T \sum t = r + \ln(1 - \lambda r + 1)$$

Granger Causality Test

Granger's causality test is widely used to analyse short-term relationships between time series data. The Granger causality test ascertains if predicting one time series is possible with the past movement of another. This test provides the forecast of change in one series as the cause of change in another. Still, it cannot give a quantitative degree of relationship among stock market series. The null hypothesis that Y does not explain the variation in X and X

does not explain the variation in Y will be rejected if the $p > 0.5$ in the first and second equations. This rejection will result in a short-term relationship among stationary stock market price time series.

Empirical Analysis

Correlation

Highly correlated stock markets have characteristics of comovements. Logarithmic daily returns of the sustainable and conventional indices are the basis for applying correlation analysis. The result of the correlation test of all four indices of the Indian economy's stock exchanges from 30 November 2012 to 30 November 2022 is shown in Table 2.

Table 2: Result of Correlation Test

INDICES	CBX	GNX	NFT	SNX
CBX	1	0.987197	0.999352	0.997160
GNX	0.987197	1	0.985210	0.979973
NFT	0.999352	0.985210	1	0.999078
SNX	0.997160	0.979973	0.999078	1

It showed that all four indices of the Indian stock market are strongly correlated. First, let's see the correlation coefficient of sustainability indices; sustainability indices CBX is correlated with other sustainability indices GNX with 98.71% correlation, and CBX shows the highest correlation with NFT, i.e., 99.93%; it is also the highest among all correlations analysed and followed by CBX correlation with SNX with 99.71%. GNX also shows more correlation with NFT, with 98.52% correlation, compared to SNX, with 97.99% correlation. Secondly, both conventional indices, i.e., SNX and NFT, are highly correlated with 99.90% correlation.

So, overall, above 97%, a positive correlation was seen between all sustainable and conventional indices. So, the null hypothesis is not accepted, proving that the Indian economy is sustainable and conventional indices have shown strong cooperation. So, in the short run, the

movement of one index can be predicted in the direction of other indexes.

Testing For Stationary for Indices

Time series should have characteristics of stationarity for further analysis. Stationary time series exhibit consistent mean and variance, crucial for obtaining accurate results.

Firstly, the ADF test was performed on the base level of the stock market. After finding the non-stationary characteristics at the level, the ADF test was performed on the first difference of the stock price's time series from 30 November 2012 to 30 November 2022. The optimal lag length has automatically been based on Schwartz Criterion info (SCI), and the maximum lag has been put to 26. Analysis of different variables, i.e., stock market indices on the base level, has been done as follows:

Table 3: Unit Root Test

Indices	At level		At First Difference	
	t-Statistic	Prob*	t-Statistic	Prob*
CBX	0.377458	0.9820	-48.63053	0.0001
GNX	0.428740	0.9842	-48.08338	0.0001
SNX	0.386833	0.9824	-49.04818	0.0001
NFT	0.357157	0.9811	-48.85460	0.0001

*MacKinnon (1996) one-sided p-values

Table 3 represents the ADF test results for unit root. It indicates that at level, all Indices have characteristics of unit root. This means that all Indices have non-stationarity at a level, so further ADF tests are applied to the first difference in closing prices. As it rejects the null hypothesis strongly, this indicates that the variables have no characteristics of unit root at first difference. It can be concluded that variables show integration in order one.

Hence, all four sustainability and conventional indices have stationary characteristics at the first deference level. This indicates that the series has a consistent average and variability over its duration. Now, we can use other tools to

check long-term integration and causality among stock indices in further sections.

Johansen's Cointegration Test

In our previous section, using the ADF test to check unit root, results conclude that stock price time series were stationary at first difference. That is the prerequisite for testing cointegration. We can, therefore, further analyse the long-run interdependence among indices. The result of the cointegration test of all four indices of the stock market understudy for the period of 30 November 2012 to 30November 2022 is shown in table 4:

Table 4:Johansen's Cointegration Test

Hypothesized No. of CE(s)	Trace Test			Maximum Eigenvalue		
	Statistic	0.05 Critical Value	Prob**	Statistics	0.05 Critical Value	Prob**
None	29.66714	47.85613	0.7358	14.81591	27.58434	0.7627
At most 1	14.85123	29.79707	0.7896	8.471659	21.13162	0.8726
At most 2	6.379573	15.49471	0.6507	6.222496	14.26460	0.5848
At most 3	0.157077	3.841466	0.6919	0.157077	3.841466	0.6919

Trace test and Maximum Eigenvalue indicate no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Johansen's cointegration test result using the trace value and maximum eigenvalue has shown that the criticalvalue at 0.05 is greater than the value of the statistic. Therefore, based on the trace value test and maximum eigenvalue, there is no evidence of integration among the stock indices analysed in the study.

The result showed that the stock price's time series has no cointegration from 30 November 2012 to 30November 2022. This indicates the long-term interdependence among the series. After the analysis, it is concluded that the Indian

economy's selected sustainability indices and convention indices, i.e., SNX, CBX, GNX, and NFT, do not have any long-term correlation or comovement.

Analyses needing more cointegration dismiss the presence of a long-term correlation between time series of stock market prices. However, it does not deny any short-run causal relationship among indices. This prompts an exploration of short-term causal relationships among stock indices. In the next section, the analysis of the short-term course quality with Eagle Granger's causality test is presented.

Granger's Causality Test

The test was used to identify causality relationships among different indices over the short run in the Indian economy. The test shows whether any Indices can cause other indices or be caused by any other index. That test is applied to the return series, which is calculated by taking the log of closing prices of the stock market price series. The most favourable

lag length was automated and generated through Schwartz Criterion info (SCI), and it was put to lag 5 in the case of all indices. After analysis, we can explain whether the present return of one Index is influenced by the previous day's return of another. It will be used to interpret the short-run trend of any indices with the help of the causal relationship of other indices.

Table 5: Granger's Causality Test

Null Hypothesis	Obs	F-Statistic	Prob.
GNX does not explain the variation in CBX CBX does not explain the variation in GNX	2470	0.38903 0.29558	0.8566 0.9156
NFT does not explain the variation in CBX CBX does not explain the variation in NFT	2470	0.94251 0.64662	0.4522 0.6641
SNX does not explain the variation in CBX CBX does not explain the variation in SNX	2470	0.46293 0.40706	0.8041 0.8442
NFT does not explain the variation in GNX GNX does not explain the variation in NFT	2470	0.42974 0.44396	0.8282 0.8179
SNX does not explain the variation in GNX GNX does not explain the variation in SNX	2470	0.44617 0.28886	0.8163 0.9194
SNX does not explain the variation in NFT NFT does not explain the variation in SNX	2470	0.63612 0.51693	0.6722 0.7637

Table 5 deploys the analysis of the detailed Granger's causality test for sustainable and conventional indices of the Indian stock market, i.e., CBX, GNX, SNX, and NFT.

The Granger causality test indicates three different perspectives of the causal relationship. The first one explains the possibility of sustainable indices. It was found that the present return of the sustainable Index cannot be influenced or predicted by the past return of other sustainable indices. The second relationship examines the conventional Index of the Indian market. SNX and NFT, two conventional Indices, do not show any short-run causal relationship.

Further, more than 0.05 P-value SNX and an NFT do not show any causal relationship with GNX and CBX, which sports the diversification opportunity between conventional and sustainable indices of the Indian stock market. Overall, it was found that the selected sustainability and conventional industries in the Indian stock market did not have a short-term causality relationship. The other sustainability or conventional indices can not predict all

sustainability indices like the other sustainability and conventional indices can not predict all traditional indices. So, the null hypothesis is not accepted in this case as well.

Conclusion

The present research analyses the cointegration and causal connections between sustainable and conventional indices across the Indian stock market. This paper found a strong correlation between sustainable and conventional indices from 2012 to 2022. Pearson's correlation coefficient, Johansen's cointegration, and Granger's causality test have been used to test three hypotheses. The H01 has not been accepted because the stock indices show a strong relationship in the Indian market. It leads us in the direction of further study of interdependence between stock indices. H02 is accepted through integration analysis, and no long-run integration exists among indices from 2012 to

2021. The H03 is also rejected, and it was concluded that there exists short-term causality among the indices under consideration.

On the contrary, Other major stock markets show cointegration with conventional indices of the Indian market. Such as HongKong, America, China, USA, Japan, and Singapore (Menon and Sagar, 2009; Batareddy et al., 2012). This research shows that both stock indices work independently, and one stock index's information will not influence another stock index's performance. One stock indicator's news and information prevailing in the market did not affect the other stock Indices' performance. Granger's Causality test indicates acceptance of the null hypothesis H03 and evidence of no short-run causal relationship between sustainability and conventional indices. The results showed that no causality exists among any Indices. It found that the past trend of another stock price series can not predict the present trend of the Indian sustainable and conventional stock price series. According to the results, the suggested study concludes that there is no long-term integration or linkage between Indian sustainability and conventional indices.

Further, neither indices reflect any causal relationship. Our finding is an addition to the existing literature and in line with the research done by researchers in this area with different indices or tools. The study conducted on ten sustainability and four conventional indices interlinkage of USA and Europe also found no cointegration between sustainability and convention indices (Curto and Vital, 2014). Research conducted on Dow Jones sustainability indices and conventional indices found that there are diversification exits (Bacillary et al., 2017). The causality relationship is also shown in mixed evidence in the study conducted considering MSCI ESG and composite indices of BRICS (Rehman et al., 2021). The empirical research conducted in this study sheds light on the diversification of the stock market within the Indian economy. Individual investors, agents, brokers, and portfolio managers can consider this study to draw meaningful interpretations while operating the stock market. A positive correlation was found between sustainability and conventional indices so investors can predict the movement of indexes. Integration

is necessary to diversify the investment portfolio by including sustainable indices in the index portfolio. The inclusion of sustainable indices will provide risk management benefits so the effect of market volatility can be managed, and it facilitates decisions regarding the diversification of investment to ensure higher returns. Solid regulations and policies are needed to enhance sustainability reporting and investment so these benefits can be available in a better way. Policymakers and regulators like RBI, SEBI, and the Government can also take reference of findings to make decisions regarding financial stability framework and improvement of regulation. Future studies may include more markets, panel data, and more advanced tools to analyse data to add more literature to explain risk diversification through sustainable Indices.

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