Dynamic Interdependence: Analysing BSE SENSEX and its Relationship with Global Stock Indices from 2018 to 2022

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ABSTRACT

This comprehensive analysis delves into the intricate relationship between the Bombay Stock Exchange SENSEX (BSE SENSEX), India's leading stock market index, and popular international stock indices during three distinct research periods from 2018 to 2022. The study employs a combination of correlation analyses and multiple regression models to explore how SENSEX interacts with global counterparts, shedding light on the evolving dynamics of the Indian stock market. The five-year research period from 2018 to 2022 reveals that SENSEX displays a robust positive correlation with various international indices, including Nikkei 225, DAX, CAC40, S&P500, NASDAQ100, and DOW JONES. This suggests a substantial degree of co-movement with global markets, emphasizing the influence of external economic and financial factors on India's stock market. A multiple regression analysis further substantiates these relationships by indicating that international indices collectively have a significant impact on SENSEX's variations during this period.

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1. INTRODUCTION

In today's interconnected global economy, financial markets around the world are increasingly interdependent. Investors, policymakers, and financial institutions constantly monitor and analyze various indices to make informed decisions about investments, risk management, and economic policies. One of the key players in this global financial landscape is India, a rapidly growing economy with a burgeoning stock market. This study delves into the fascinating realm of Indian indices and their integration with global counterparts. India, known for its diverse and dynamic financial ecosystem, has witnessed significant changes and developments in recent years. The integration of Indian indices with global indices has become a pivotal aspect of global financial markets, influencing investment strategies, risk assessment, and capital flows.

The Indian stock market, represented by indices like the BSE Sensex and NSE Nifty, has evolved from being a regional player to a global contender. The rise of Indian companies on the international stage, coupled with the liberalization of the Indian economy, has attracted the attention of global investors. As a result, Indian indices have become a barometer of economic performance not only for domestic stakeholders but also for international investors seeking diversification and exposure to emerging markets. The integration of Indian indices with global indices involves a complex interplay of factors. It encompasses the impact of global events on Indian markets, the influence of Indian companies on global portfolios, and the evolving correlation between Indian indices and major global benchmarks like the Nikkei 225, SSE Composite Index, DAX, CAC 40, S&P 500, NASDAQ 100, Dow Jones.

Understanding these dynamics is crucial for investors, financial analysts, and policymakers, as it provides insights into the broader implications of economic and financial developments in India. In this study, we will explore the multifaceted aspects of Indian indices integration with global indices. We will examine the historical trends, drivers, and challenges associated with this integration, along with its implications for risk management and investment strategies. Furthermore, we will investigate the role of technological advancements, regulatory changes, and international capital flows in shaping this integration.

The study aims to shed light on how the convergence of Indian and global indices affects portfolio diversification, investment decision-making, and risk assessment. It will also analyze the potential benefits and risks associated with this integration and offer insights into strategies that investors can employ to navigate this evolving landscape successfully. In a world where financial markets are increasingly interconnected, understanding the integration of Indian indices with global indices is not just a matter of academic interest but a practical necessity for all stakeholders involved in the global financial ecosystem. This study seeks to contribute to this understanding, providing valuable insights into the ever-evolving relationship between India's dynamic economy and the global financial marketplace.

2. LITERATURE REVIEW

Subramanyam et al. [1] studied the integration between the Indian stock market and developed stock markets. Their research revealed increasing connectivity between the Indian market and developed counterparts. They observed that international events exerted considerable influence on the Indian market. While integration benefits diversification, it also heightened vulnerability to global shocks. Their findings underscored the need for investors to comprehend the evolving relationships between Indian and developed markets for informed decision-making. Jana [2] the study investigates the relationships between stock market integration and trade with India's key trading partners. By analysing these connections, the research sheds light on the interplay between stock market dynamics and international trade, contributing to a deeper understanding of India's economic interactions.

Ramana Rao, Marisetty and Lohith [3] there study underscores the critical role of stock indices co-movements in shaping portfolio diversification strategies. The modern portfolio theory's emphasis on risk management through diversification is validated, contingent on the degree of correlation among global indices. Utilizing multivariate analysis techniques, the research highlights that several indices exhibit strong co-movements, while others, like Sensex,

demonstrate weaker correlations with select counterparts. Geographical proximity seems to influence these relationships, with certain countries exhibiting higher correlations among their stock markets. Moreover, the study's consistency between principal component analysis (PCA) and correlation results reinforces the importance of employing statistical tools in portfolio construction. These findings offer valuable insights for both individual investors and portfolio managers seeking to optimize returns within specified risk parameters.

Sharma et al. [4] the study investigates forecast accuracy using various models. By examining SENSEX's dynamics and comparing them with global indices and individual firms, the research contributes to our comprehension of the factors influencing SENSEX fluctuations and forecasting methods for investors and financial practitioners. Marisetty [5] Their study focused on Indian index correlation and integration with international indexes. The findings highlighted varying degrees of correlation between Indian indexes and global counterparts. The methodology involved analysing historical data and employing statistical tools to measure correlations. The study suggested that Indian investors diversify their portfolios by including international assets to mitigate risks associated with domestic market fluctuations. Additionally, it recommended policymakers consider these correlations when making decisions about economic policies.

Sachita Yadav's [6] explored the interplay between exchange rates and the Indian stock market. The research discovered a dynamic relationship between these two variables. Exchange rate fluctuations influenced stock market movements, with a bidirectional influence observed. The findings highlighted the intricate connections between currency values and stock market performance, providing insights for investors and policymakers navigating India's financial landscape. Panda, [7] investigates stock market integration and their methodology involves analysing daily stock index returns using correlation and cointegration techniques. Findings indicate varying degrees of integration across markets, with the US exhibiting higher integration with India compared to other markets. The study suggests considering diversification benefits and potential market interdependencies when making investment decisions. The research contributes to understanding cross-border market dynamics and offers insights for

global investors seeking to manage risks and optimize portfolios.

Heikki Lehkonen's [8] The study found that the crisis intensified integration among stock markets, signifying heightened cross-market linkages during periods of economic turmoil. The research emphasized the importance of considering global financial events in understanding market interdependencies and underscored the need for comprehensive analyses of market integration dynamics. Das Gupta [9] the research investigates the relationships and interdependencies between the Indian stock market and those of BRIC nations. The study's findings contribute to understanding cross-border market dynamics and potential contagion effects. Kumar and Deo [10] analyses connections using network analysis techniques. By investigating these relationships, the research sheds light on the intricate interdependencies within global financial systems, contributing to our understanding of market dynamics and potential contagion effects.

Srikanth [11] study delved into the connection between the Indian stock market and its counterparts in the Asia Pacific region. Through the application of the ADF Unit root test, the study revealed the presence of stationarity, indicating stability in the time series data. Furthermore, the utilization of the Johansen and Juselius co-integration approach provided evidence of integration between the Indian stock market and other Asian Pacific markets. This insightful investigation, encompassing monthly data from January 2000 to December 2010, sheds light on the dynamic interplay and potential cross-border influences among these markets, offering valuable insights for investors, policymakers, and researchers alike. Yash Pal Taneja's [12] explored integration among major global stock exchanges, focusing on India. The research examined linkages between Indian markets and world exchanges, revealing that India's markets have progressively integrated with global counterparts. The study's findings underscored the significance of understanding cross-border market relationships and indicated India's growing role in the interconnected global financial landscape.

Tripathi and Shruti Sethi's [13] investigated the integration of the Indian stock market with major global stock markets. The authors found that there was evidence of increasing integration between the Indian stock market and

international markets over the years. They employed econometric models to analyze data and measure the extent of integration. The study recommended that investors consider global market trends when making investment decisions in the Indian stock market. It also emphasized the importance of understanding the interdependence between domestic and international markets to manage investment risks effectively. Raj and Dhal [14] analysed the daily returns using correlation and cointegration techniques. Results indicate varied integration, stronger with developed markets like the US, and weaker with regional counterparts. The study recommends diversification for Indian investors across global markets and underscores the importance of considering international market dynamics in economic and financial policy decisions. It contributes valuable insights into India's standing within the global financial framework.

Siddiqui's [15] study assessed stock market integration across global markets. The literature review emphasized linkages between selected world markets. Findings highlighted that increased globalization leads to stronger interdependencies among stock markets. Integration often heightened during periods of market turbulence, emphasizing the importance of studying cross-market relationships. The study underscored the significance of interconnectedness in modern financial systems and the need to comprehend global market dynamics for effective investment strategies. Surbhi Jain and N. R. Bhanu Murthy [16] The research explored the degree of integration among various financial markets in India. Findings indicated that integration varied across markets, with some sectors showing higher integration levels. The study emphasized the importance of understanding these integration dynamics for policymakers and investors to make informed decisions in the Indian financial landscape.

Mukherjee and Mishra [17] examine interconnections between Indian and global equity markets. The methodology involves correlation analysis and Granger causality tests. Findings suggest a significant relationship between Indian and global markets, particularly with developed markets. They highlight the importance of global factors in influencing Indian markets. The study suggests that investors should consider international market movements while making investment decisions in India.

These insights contribute to a better understanding of market interdependencies and guide investors in managing risks associated with global market fluctuations. Nath and Samanta [18] their study investigates the relationships and interdependencies between foreign exchange and capital markets. By analysing these connections, the research provides insights into the integration dynamics of these markets, contributing to a broader understanding of India's financial landscape.

3. METHODOLOGY

3.1 Objectives of the Study

➢ To analyse the correlation between Indian BSE indices and selected global indices.
➢ To determine the impact of global market movements on the performance of Indian BSE indices.

3.2 Hypotheses

3.2.1 Correlation

- Null Hypothesis (H_0): There is no significant correlation between the monthly returns of the Indian stock index (BSE SENSEX) and the selected global stock indices.
- Alternative Hypothesis (H_1): There is a significant correlation between the monthly returns of the Indian stock index (BSE SENSEX) and the selected global stock indices.

3.2.2 Regression

- Null Hypothesis (H_0): There is no significant impact on the monthly returns of the Indian stock index (BSE SENSEX) by the selected global stock indices.
- Alternative Hypothesis (H_1): There is a significant impact on the monthly returns of the Indian stock index (BSE SENSEX) by the selected global stock indices.

3.3 Statement of Problem

The research aims to investigate the level of integration between Indian stock indices and global stock indices. The problem addressed is the extent of interconnections, dependencies, and correlations between Indian stock indices and key global stock indices. This study seeks to

determine whether Indian stock markets move in tandem with or are influenced by international stock markets. To achieve this, the research will employ quantitative methods, such as correlation analysis to assess the strength and nature of relationships between Indian and global indices.

3.4 Need for the Study

The study is needed to understand how Indian stock indices and global stock indices are connected, which can provide insights into how changes in global markets might impact India's financial markets and help investors make informed decisions. The scope of this study encompasses the analysis of the integration between Indian stock indices (SENSEX) and a selection of prominent global stock indices (Nikkei 225, SSECI, DAX, CAC40, S&P500, NASDAQ100, DOW JONES, HANG SENG) using historical data spanning five years (2018-2023). The primary focus is on quantifying the correlation between these indices to determine the extent of their interdependence. The research aims to reveal the patterns of correlation over time and explore whether and how the Indian indices are influenced by global market movements. The study will provide valuable insights into the degree of synchronization between Indian and global markets and potentially uncover significant cross-market relationships.

3.5 Limitation of The Research Study

The limitations of this research study include its focus on correlation-based analysis, which might not capture complex causal relationships between Indian and global stock indices, potentially limiting a comprehensive understanding of integration dynamics. Additionally, only using historical data may not take into consideration quick market changes or unique events that could have an impact on the results.

3.6 Tools of Data Collection

The data collection methodology involves using returns from selected global stock indices (SENSEX, Nikkei 225, SSECI, DAX, CAC40, S&P500, NASDAQ100, DOW JONES, HANG SENG) between 2018 and 2022. These indices' historical returns will be gathered and analysed to assess their performance and relationships over the specified time frame by statistical techniques correlation and multiple regression.

3.7 Framework of Analysis

3.7.1 Data collection

Gather historical daily stock index values for the chosen Indian and global indices (SENSEX, Nikkei 225, SSECI, DAX, CAC40, S&P500, NASDAQ100, DOW JONES, HANG SENG) over the five-year period (2018-2023).

3.7.2 Correlation and regression analysis

Calculate correlation coefficients and regression between Indian and each global index pair to quantify the strength and direction of their relationships. This step involves assessing the level of correlation, regression and identifying any patterns or trends over time.

3.7.3 Interpretation and conclusion

Analyse the correlation and regression results to determine the degree of integration between Indian and global indices. Interpret the findings in the context of global economic events and market dynamics, drawing conclusions about the synchronization and potential influences between the two sets of indices.

3.8 Data Collection Methods

Secondary data, on the other hand, refers to information that has been collected and compiled by others for purposes other than the current research. In this study, secondary data will be sourced from scholarly articles, financial reports, economic analyses, and market research related to the selected indices and global financial markets. This data will provide context, historical trends, and insights that can support the interpretation of the primary data's findings, helping to enrich the analysis and conclusions of the research.

3.9 Sample Design

The sampling frame defines the complete list or source from which the sample will be drawn. In this study, the sampling frame will consist of the entire dataset of daily closing prices for the selected Indian (SENSEX) and global (Nikkei 225, SSECI, DAX, CAC40, S&P500, NASDAQ100, DOW JONES, HANG SENG) stock indices from 2018 to 2023. This dataset will be obtained from Yahoo Finance. The sampling frame ensures that all relevant data points are

available for potential inclusion in the sample, contributing to the representativeness and accuracy of the analysis.

4. ANALYSIS

Descriptive statistics, correlation, and regression analyses were performed on returns data of Indian and global indices to study their integration. Descriptive statistics summarized data distributions. Correlation analysis explored relationships between indices. Regression analysis assessed potential predictive connections. These analyses unveiled insights into integration patterns, aiding investment decisions within the realm of Indian and global indices relation and co-movement.

4.1 Year Data (2022)

4.1.1 Descriptive statistics

In the year 2022, major stock market indices displayed varied performance in the Table 1. The mean represents the average return for each of the indices. SENSEX has a positive mean of 0.45, indicating a positive average return. Most

indices, such as SSECI, DAX, CAC40, S&P500, NASDAQ, DJI, and HSI, have negative means, indicating that, on average, they have experienced negative returns. Nikkei has a slightly negative mean of -0.71. HSI has the highest standard deviation (10.72), indicating significant volatility. Other indices like DJI, NASDAQ, S&P500, DAX, and CAC40 also exhibit relatively high standard deviations. SSECI and Nikkei have moderate standard deviations. SENSEX has the lowest standard deviation (4.45), suggesting lower volatility compared to the others.

Negative kurtosis values (e.g., SENSEX and Nikkei) indicate thinner tails compared to a normal distribution. Positive kurtosis values (e.g., DJI, HSI) indicate thicker tails, suggesting more extreme values. Positive skewness (e.g., HSI, DJI) indicates a distribution skewed to the right (positively skewed). Negative skewness (e.g., SENSEX, SSECI) indicates a distribution skewed to the left (negatively skewed). Overall, diverse indices experienced fluctuations, indicating the need for careful risk assessment and potential opportunities in a dynamic financial landscape.

Table 1. Descriptive statistics of popular international indices for the period of one year (2022)

Particulars	SENSEX	Nikkei	SSECI	DAX	CAC40	S&P500	NASDAQ	DJI	HSI
Mean	0.45	-0.71	-1.21	-1.57	-0.67	-1.58	-3.02	-0.57	-0.89
Standard Error	1.28	1.41	1.62	2.57	1.71	1.91	2.21	1.9	3.09
Median	-1.49	-0.36	-3.12	-2.71	-2.02	-3.69	-4.03	-3.42	-2.08
Stan Deviation	4.45	4.87	5.6	8.89	5.93	6.63	7.66	6.59	10.72
Sample Var	19.79	23.7	31.39	79.07	35.13	43.97	58.65	43.47	114.84
Kurtosis	-1.19	-1.36	-0.95	-0.05	-0.73	-1.3	-0.35	0.62	3.64
Skewness	0.55	0.01	0.71	0.59	0.76	0.47	0.62	1.03	1.43
Range	13.17	14.03	16.56	30.91	17.31	18.45	25.61	22.79	41.35
Minimum	-4.58	-7.67	-7.65	-15.4	-8.44	-9.34	-13.26	-8.84	-14.72
Maximum	8.58	6.36	8.91	15.46	8.87	9.11	12.35	13.95	26.62
Sum	5.42	-8.48	-14.6	-18.8	-8.04	-19.01	-36.28	-6.83	-10.72
Count	12	12	12	12	12	12	12	12	12

(Source: Author's calculations by using the available data)

Table 2. Pearson's correlation coefficients of popular international stock indices for the one-year (2022) period

Index	SENSEX	Nikkei	SSECI	DAX	CAC40	S&P500	NASDAQ	DJI	HSI
SENSEX	1								
Nikkei 225	0.816*	1							
SSECI	-0.206	0.087	1						
DAX	0.633*	0.592	0.159	1					
CAC40	0.826*	0.721*	-0.047	0.888*	1				
S&P500	0.866*	0.884*	0.074	0.809*	0.908*	1			
NASDAQ100	0.860*	0.866*	0.131	0.674*	0.819*	0.965*	1		
DOW JONES	0.808*	0.840*	0.01	0.847*	0.929*	0.942*	0.834*	1	
HANG SENG	-0.047	-0.092	0.644*	0.343	0.091	0.058	0.051	-0.006	1

(Correlation Coefficients, using the observations 2022:01 - 2022:12; 5% critical value (two-tailed) = 0.5760 for n = 12)
(Source: Author's calculations by using the available data)

4.1.2 Correlation analysis

Table 2 shows, SENSEX has a strong positive correlation with several indices, including Nikkei 225 (0.816), DAX (0.633), CAC40 (0.826), S&P500 (0.866), NASDAQ100 (0.860), and DOW JONES (0.808). This suggests that SENSEX tends to move in a similar direction with these indices, indicating potential interdependencies. Nikkei 225 exhibits a strong positive correlation with most other indices, including SENSEX (0.816), DAX (0.592), CAC40 (0.721), S&P500 (0.884), NASDAQ100 (0.866), and DOW JONES (0.840). Like SENSEX, Nikkei 225 also shows a tendency to move similarly to these international indices. SSECI has relatively weak correlations with most indices in this dataset, ranging from -0.206 to 0.159. This suggests that SSECI's movements are less closely aligned with the other indices, indicating a lower degree of correlation.

DAX, CAC40, S&P500, NASDAQ100, and DOW JONES; these indices from Europe and the U.S. exhibit strong positive correlations with each other, typically above 0.8. They tend to move in tandem, reflecting some level of global market integration. Hang Seng, representing the Hong Kong stock market, shows relatively low correlations with other indices, ranging from -0.092 to 0.644. Its correlation with SSECI is the highest (0.644), suggesting some alignment with Chinese markets, but weaker connections with other global indices. In summary, some indices, like SENSEX and Nikkei 225, are strongly correlated, while others, like SSECI and Hang Seng, exhibit weaker correlations with the rest of the indices. Understanding these correlations is crucial for portfolio diversification and risk management in international investing.

4.1.3 Regression analysis

The Table 3 to be the output of a regression analysis with SENSEX as the dependent variable and various international indices as independent variables. The intercept value of 2.354 represents the estimated value of SENSEX when all independent variables are zero. NASDAQ100 has the highest coefficient, which is 2.264 and S&P 500 has the lowest coefficient, which is -3.706. These coefficients represent the estimated impact of each respective independent variable on SENSEX, assuming all other variables remain constant in the regression model. For SSECI, DOW JONES, and HANG SENG, the standard errors appear relatively small, suggesting more precise estimates for these variables. In this analysis, SSECI has a low p-value (0.03*), suggesting it is statistically significant in explaining SENSEX's variations. Other variables have higher p-values, indicating weaker statistical significance.

R Square (0.9679) represents the proportion of the variance in SENSEX explained by the independent variables in the model. Adj R Square (0.8822) adjusts R Square for the number of predictors in the model, providing a more realistic estimate of the model's goodness of fit. These values indicate that the independent variables in the model collectively explain a significant portion of the variance in SENSEX. The F-statistic (11.2946) and its associated p-value (0.0357) test the overall significance of the regression model. A low p-value (0.0357) suggests that the model as a whole is statistically significant in explaining SENSEX's variation. In summary, this regression analysis provides insights into the relationship between SENSEX and various international indices. SSECI appears to be statistically significant in explaining SENSEX's variations, as indicated by its low p-value. The overall regression model is also statistically significant, and it explains a significant portion of SENSEX's variance, as suggested by the high R Square value. Other variables may have weaker statistical significance in this specific model.

4.2 Three Years Analysis (2020 – 2022)

4.2.1 Descriptive statistics

The mean values of returns across the indices range from positive to negative, indicating varying levels of historical performance during the specified period (2020 - 2022) from the Table 4. The highest mean is observed for the SENSEX at 1.3, suggesting that it had the highest average returns among the listed indices during the period. The lowest mean is for HSI at -0.73, indicating that it had the lowest average returns among the listed indices. Except HIS, all other indices mean are in positive. Among the listed indices, DAX has the highest standard deviation at 7.82, indicating that it experienced the highest volatility during the specified period. SSECI has the lowest standard deviation at 4.49, suggesting relatively lower volatility compared to other indices. It is observed that all the indices were having moderate volatility during the last three years. SENSEX and HSI have positive kurtosis, suggesting fatter tails compared to a normal distribution. SENSEX has negative skewness, indicating a left-skewed distribution, while the others are close to zero, suggesting nearly symmetric distributions.

Table 3. Multiple regression analysis of the popular international stock indices impact on BSE SENSEX during one year (2022); (n = 12)

Particulars	Coefficients	Standard Error	t Stat	P-value	R Square	Adj R	F stat	Sign F
Intercept	2.354	0.76	3.112	0.053	0.9679	0.8822	11.2946	0.0357*
Nikkei 225	0.512	0.26	1.997	0.14				
SSECI	-0.618	0.17	-3.596	0.031*				
DAX	0.342	0.25	1.376	0.263				
CAC40	-0.22	0.37	-0.588	0.598				
S&P500	-3.706	1.57	-2.359	0.099				
NASDAQ100	2.264	0.87	2.613	0.079				
DOW JONES	1.346	0.65	2.071	0.130				
HANG SENG	0.179	0.08	2.275	0.107				

(Source: Author's calculations by using the available data) (Significance @ 5 percent level)*

Table 4. Descriptive statistics of popular international indices for the period of three years (2020 – 2022)

Particulars	SENSEX	Nikkei	SSECI	DAX	CAC40	S&p500	NASDAQ	DJIA	HSI
Mean	1.3	0.41	0.13	0.04	0.42	0.66	0.67	0.6	-0.73
Standard Error	1.09	0.88	0.75	1.3	1.07	1.02	1.17	1.02	1.22
Median	0.94	0.47	0.17	0.45	0.31	2.03	1.05	1.24	-0.32
Stan Deviation	6.55	5.29	4.49	7.82	6.42	6.11	6.99	6.12	7.33
Sam Variance	42.85	27.97	20.12	61.19	41.2	37.27	48.89	37.49	53.66
Kurtosis	4.38	0.57	-0.34	-0.06	2.35	-0.55	-0.54	0.04	4.58
Skewness	-1.12	0.22	0.33	-0.02	0.25	-0.24	-0.06	-0.01	1.14
Range	37.47	25.57	18.55	34.04	37.33	25.2	28.71	27.69	41.35
Minimum	-23.05	-10.53	-7.65	-17.47	-17.21	-12.51	-13.26	-13.74	-14.72
Maximum	14.42	15.04	10.9	16.57	20.12	12.68	15.45	13.95	26.62
Sum	46.91	14.68	4.77	1.48	15.14	23.86	23.99	21.55	-26.15
Count	36	36	36	36	36	36	36	36	36

(Source: Author's calculations by using the available data)

Table 5. Pearson's correlation coefficients of popular international stock indices for the three years period

Index	SENSEX	Nikkei	SSECI	DAX	CAC40	S&p500	NASDAQ	DJIA	HIS
SENSEX	1								
Nikkei 225	0.691*	1							
SSECI	0.396*	0.335*	1						
DAX	0.666*	0.723*	0.397*	1					
CAC40	0.713*	0.771*	0.245	0.878*	1				
S&P500	0.729*	0.751*	0.367*	0.866*	0.839*	1			
NASDAQ100	0.662*	0.705*	0.407*	0.754*	0.709*	0.945*	1		
DOW JONES	0.725*	0.788*	0.295	0.913*	0.896*	0.951*	0.826*	1	
HANG SENG	0.336*	0.216	0.623*	0.434*	0.319	0.269	0.262	0.244	1

(Correlation Coefficients, using the observations 2020:01 - 2022:12; 5% critical value (two-tailed) = 0.3291 for n = 36)
((Source: Author's calculations by using the available data)

4.2.2 Correlation analysis

The Table 5 displays Pearson's correlation coefficients between popular international stock indices over a three-year period. SENSEX has a strong positive correlation with several other indices, including Nikkei 225 (0.691*), DAX (0.666*), CAC40 (0.713*), S&P500 (0.729*), NASDAQ100 (0.662*), and DOW JONES (0.725*). These correlations are marked as significant, indicating a strong linear relationship between these indices. Nikkei 225 shows strong positive correlations with DAX (0.723*), CAC40 (0.771*), S&P500 (0.751*), and DOW JONES (0.788*). All of these correlations are marked as significant, indicating a significant linear relationship.

DAX, CAC40, S&P500, NASDAQ100, and DOW JONES have strong positive correlations with

each other. All of these correlations are marked as significant, suggesting a meaningful linear relationship between these indices. SSECI has relatively weaker correlations with most other indices, and all of these correlations are marked as significant. This indicates a lower degree of linear relationship with the other indices. HANG SENG shows negative correlations with most indices, but none of these correlations are marked as significant. This implies that the performance of HANG SENG tends to move in the opposite direction or has a weak, nonsignificant relationship with the other indices.

4.2.3 Regression analysis

The Table 6 presents the results of a multiple regression analysis of the impact of popular international stock indices on the BSE SENSEX during a three-year period (2020 – 2022). The intercept is not statistically significant at common significance levels (e.g., 0.05). This suggests that the intercept term does not have a significant impact on the dependent variable (BSE SENSEX) in this regression model. None of the coefficients for the international stock indices are statistically significant at the 0.05 significance level. This suggests that, based on this model and data, there is no strong evidence to conclude that any of these indices have a significant impact on the BSE SENSEX. The model's R-squared value (0.6281) indicates that it explains a significant portion of the variance in BSE SENSEX, but the individual coefficients do not hold statistical significance.

The very low P-value (0.0000*) suggests that the overall model is statistically significant, indicating that at least some of the independent variables have an impact on BSE SENSEX. Overall, the

results of this multiple regression analysis suggest that the model as a whole is statistically significant (F-statistic), but the significance of individual coefficients varies. The coefficients for Nikkei 225, SSECI, DAX, CAC40, S&P500, NASDAQ100, DOW JONES, and HANG SENG do not appear to be statistically significant based on their respective P-values. However, the R-square value indicates that the model explains a significant portion of the variance in BSE SENSEX, even though not all independent variables are individually significant.

4.3 Five Years Analysis (2018 – 2022)

4.3.1 Descriptive statistics

Table 7 presents, SENSEX has the highest mean among the indices, indicating that, on average, it has performed the best over the specified period (2018 - 2022). HSI has a negative mean, indicating below-average average performance and potential losses on average. NASDAQ has one of the highest means, suggesting strong average performance. DJIA also has a positive mean, indicating that it has shown positive average performance, although not as high as NASDAQ. SENSEX and NASDAQ have the highest mean values, signifying better average performance, while SSECI, DAX, and HSI have means close to zero or negative, indicating below-average or negligible average performance. Indices with higher standard deviations (such as DAX, NASDAQ, and HSI) are associated with greater volatility and risk, while those with moderate standard deviations (like SENSEX, Nikkei, CAC40, S&P500, and DJIA) have shown relatively stable but still somewhat fluctuating returns.

Table 6. Multiple regression analysis of the popular international stock indices impact on BSE SENSEX during three years period (2020 – 2022); (n = 36)

Index	Coefficients	Standard Error	t Stat	P-value	R Square	Adj R	F stat	Sign F
Intercept	0.75	0.78	0.96	0.35	0.6281	0.5172	5.6942	0.0000*
Nikkei 225	0.34	0.28	1.22	0.23				
SSECI	0.19	0.25	0.75	0.46				
DAX	-0.25	0.29	-0.86	0.41				
CAC40	0.29	0.32	0.91	0.37				
S&P 500	0.91	1.12	0.83	0.41				
NASDAQ100	-0.31	0.53	-0.58	0.56				
DOW JONES	-0.08	0.77	-0.10	0.92				
HANG SENG	0.11	0.15	0.65	0.52				

(Source: Author's calculations by using the available data) (Significance @ 5 percent level)*

Table 7. Descriptive statistics of popular international indices for the period of five years (2018 – 2022)

Particulars	SENSEX	Nikkei	SSECI	DAX	CAC40	S&P500	NASDAQ	DJIA	HSI
Mean	1	0.4	-0.01	-0.02	0.58	0.76	0.94	0.58	-0.47
Stand Error	0.72	0.64	0.6	0.88	0.73	0.7	0.82	0.69	0.85
Median	0.68	1.08	-0.06	-0.03	0.76	1.82	1.29	1.24	-0.34
Sta Deviation	5.59	4.99	4.67	6.79	5.65	5.4	6.32	5.32	6.58
Sam Variance	31.25	24.89	21.83	46.08	31.9	29.17	39.88	28.35	43.28
Kurtosis	4.8	0.43	0.26	0.33	2.35	-0.2	-0.31	0.43	3.83
Skewness	-0.95	-0.15	0.49	0.03	0.17	-0.37	-0.2	-0.1	0.87
Range	37.47	25.57	21.8	34.04	37.33	25.2	28.71	27.69	41.35
Minimum	-23.05	-10.53	-8.01	-17.47	-17.21	-12.51	-13.26	-13.74	-14.72
Maximum	14.42	15.04	13.79	16.57	20.12	12.68	15.45	13.95	26.62
Sum	60.19	24.21	-0.32	-1.32	35.04	45.51	56.63	34.94	-28.29
Count	60	60	60	60	60	60	60	60	60

(Source: Author's calculations by using the available data)

Most indices have skewness values close to zero, indicating relatively symmetrical distributions. CAC40 and DJIA have positive skewness, suggesting a slight right skew (longer tail on the right) in their distributions. HSI has positive skewness, indicating a right-skewed distribution. SENSEX, Nikkei, SSECI, DAX, CAC40, S&P500, and DJIA have kurtosis values close to zero, indicating a normal distribution. NASDAQ has slightly negative kurtosis, suggesting a slightly flatter distribution. HSI has positive kurtosis, indicating a peaked distribution with heavier tails.

4.3.2 Correlation analysis

The correlation coefficients in the Table 8 represent the relationships between popular international stock indices over the five-year period from 2018 to 2022. SENSEX shows positive correlations with all other indices. The strongest correlation is with DAX (0.608), indicating that movements in the Indian stock market were moderately associated with those in the German market. These positive correlations imply that changes in SENSEX were often mirrored by corresponding changes in other global indices. NASDAQ100, representing the U.S. tech sector, exhibits positive correlations with all indices. The strongest correlation is with S&P500 (0.948), emphasizing the significant influence of the tech sector on the broader U.S. market.

HANG SENG, representing the Hong Kong stock market, displays positive correlations with all indices, albeit generally weaker than other correlations. The strongest correlation is with SSECI (0.635), indicating a moderate connection between the Hong Kong and Chinese stock markets. The correlation coefficients among the indices indicate varying degrees of positive relationships. Notably, all correlations are statistically significant (indicated by asterisks), suggesting strong linkages between these international stock indices over the five-year period from 2018 to 2022. These positive correlations signify that movements in one index are generally associated with corresponding movements in others, highlighting the interconnectedness of global stock markets during this period.

Table 8. Pearson's correlation coefficients of popular international stock indices for the five years (2018 – 2022) period

Index	SENSEX	Nikkei	SSECI	DAX	CAC40	S&P500	NASDAQ	DJIA	HSI
SENSEX	1								
Nikkei 225	0.571*	1							
SSECI	0.299*	0.412*	1						
DAX	0.608*	0.698*	0.422*	1					
CAC40	0.613*	0.781*	0.369*	0.842	1				
S&P500	0.627*	0.774*	0.431*	0.812	0.835*	1			
NASDAQ100	0.549*	0.726*	0.446*	0.715	0.727*	0.948*	1		
DOW JONES	0.625*	0.792*	0.378*	0.829	0.873*	0.953*	0.835*	1	
HANG SENG	0.318*	0.364*	0.635*	0.483	0.431*	0.394*	0.393*	0.349*	1

(Correlation Coefficients, using the observations 2018:01 - 2022:012; 5% critical value (two-tailed) = 0.2542 for n = 60.)
(Source: Author's calculations by using the available data)

Table 9. Multiple regression analysis of the popular international stock indices impact on BSE SENSEX during five years period (2018 – 2022)

Index	Coefficients	Standard Error	t Stat	P-value	R Square	Adj R	F stat	Sign F
Intercept	0.671	0.599	1.121	0.268	0.4514	0.3653	5.2447	0.0000*
Nikkei 225	0.220	0.211	1.045	0.301				
SSECI	-0.009	0.169	-0.053	0.958				
DAX	0.136	0.178	0.762	0.450				
CAC40	0.093	0.249	0.373	0.710				
S&P 500	1.254	0.919	1.366	0.178				
NASDAQ100	-0.516	0.436	-1.183	0.242				
DOW JONES	-0.447	0.574	-0.780	0.439				
HANG SENG	0.026	0.124	0.212	0.833				

(Source: Author's calculations by using the available data) (* Significance @ 5 percent level)

4.3.3 Regression analysis

The Table 9 presents the results of a multiple regression analysis, examining the impact of various international stock indices on BSE SENSEX during the five-year period from 2018 to 2022. The intercept represents the expected value of BSE SENSEX when all other independent variables are zero. Its associated p-value is 0.268, which is greater than the typical significance level of 0.05. Therefore, the intercept is not statistically significant in explaining the variation in SENSEX. Among the individual indices, only S&P 500 exhibits a borderline statistically significant impact on SENSEX, with a coefficient of 1.254. However, this significance is not robust enough to draw definitive conclusions about its impact. Indices such as Nikkei 225, SSECI, DAX, CAC40, NASDAQ100, DOW JONES, and HANG SENG do not demonstrate statistically significant relationships with SENSEX during this period.

R-squared of 0.4514 suggests that the model provides some explanatory power, it also indicates that a substantial portion of the variability in SENSEX remains unexplained and may be influenced by other factors not considered in the model. The p-value is 0.0000*, which is extremely small. This means that the overall model, which includes all the considered international stock indices, is highly significant in explaining the fluctuations in SENSEX during the specified period. In other words, the international stock indices, taken together, have a statistically significant impact on SENSEX. This result suggests that, although individual indices may not have strong relationships with SENSEX, when considered as a group, they collectively provide valuable information for understanding and predicting SENSEX movements. Therefore, the model as a whole is considered statistically significant and relevant for analysing SENSEX variations during the specified time frame.
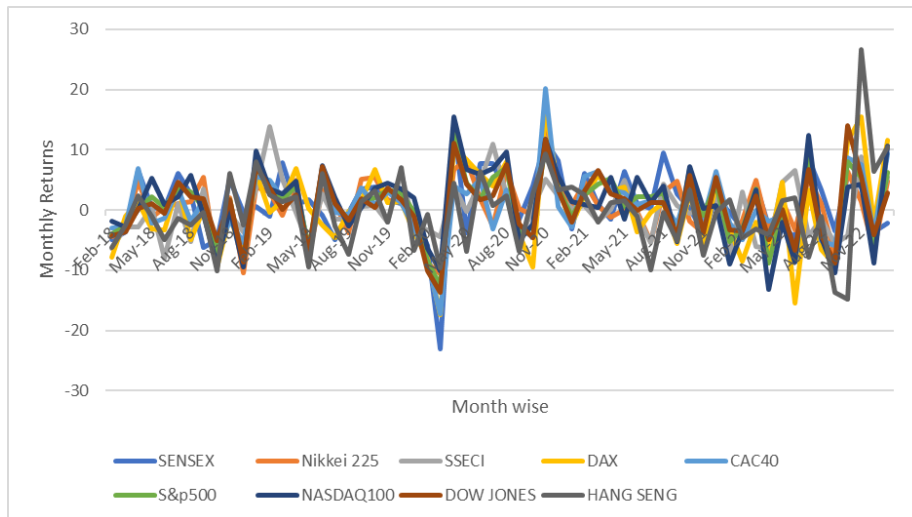

Chart 1. Five years return (2018 – 2022) analysis index wise
(Source: Author's Calculations)

4.4 Five Years Return Analysis (2018 – 2022)

Chart 1 display, SENSEX showed mixed performance during this period. It had periods of both positive and negative returns. SENSEX displayed moderate to high volatility, with significant fluctuations in its value. The Nikkei 225 index shows relatively higher volatility compared to some other indices. It experienced significant fluctuations, including both sharp declines and substantial gains. DAX, and CAC 40 representing the German, and French markets, had relatively similar patterns. They showed both positive and negative returns over the period, with occasional significant fluctuations. U.S. indices like the S&P 500, NASDAQ 100, and Dow Jones demonstrated overall positive performance during the period, with substantial gains. They generally exhibited lower volatility compared to some other global indices. The Hang Seng Index showed relatively higher volatility and had periods of both gains and losses, making it sensitive to market conditions.

The monthly returns for these indices vary significantly over the five-year period. Some months show positive returns, while others show negative returns, reflecting the volatility in the financial markets. Returns for each index and month can be quite erratic. Some months exhibit substantial gains, while others experience notable losses. This indicates that market conditions were subject to frequent changes and external influences. There are some extreme outliers in the data, such as the sharp declines in March 2020 and significant gains in November 2020. The most prominent extreme events during this period were the significant market downturn in March 2020 due to the COVID-19 pandemic and the subsequent strong recovery in the latter part of 2020 and 2021.

5. CONCLUSION

In conclusion, the analysis of BSE SENSEX and its relationship with international stock indices over three distinct research periods reveals intriguing insights into the dynamic nature of India's stock market. These research periods, spanning from 2018 to 2022, 2020 to 2022, and 2022 shed light on the varying degrees of interdependence between SENSEX and global indices.

During the five-year period from 2018 to 2022, SENSEX exhibited robust positive correlations with several prominent international indices, indicating a significant degree of synchronization with global market trends. This alignment suggested that the Indian stock market was influenced by economic and financial developments on a global scale. Additionally, a regression analysis revealed that, when considered collectively, international indices played a substantial role in explaining variations in SENSEX. This underscores the importance of considering the combined impact of global markets on the Indian stock market.

Conversely, the three-year research period from 2020 to 2022 revealed a shift in this relationship. While SENSEX still demonstrated positive correlations with international indices, these correlations were not statistically significant on an individual basis. However, the overall regression model remained significant, implying that the combined influence of international indices continued to impact SENSEX. This change in significance underscores the need for investors and analysts to adapt their strategies and consider a broader range of factors when assessing the Indian stock market.

In essence, these findings emphasize the ever-evolving nature of financial markets and the importance of adaptability in investment strategies. While global economic conditions undoubtedly influence BSE SENSEX, the strength and significance of these relationships can fluctuate over time. Therefore, staying informed about both quantitative analyses and qualitative factors is essential for effectively navigating India's stock market in an increasingly interconnected world economy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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