

Stock Markets Correlation Dynamics among India and European Nations

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ABSTRACT

Globalization and liberalization have spurred active investor participation in foreign markets, accelerating financial integration and increasing stock market co-movements globally. Analyzing inter-market connections is vital for shaping sound macroeconomic policies and developing effective investment strategies. The current study conducts an in-depth correlation analysis of calculated returns from India's S&P BSE SENSEX and six major European stock indices—UK (FTSE 100), Germany (DAX PERFORMANCE-INDEX), France (CAC 40), Netherlands (EURONEXT 100), Belgium (BEL 20), and Italy (FTSE MIB)—across two intervals: an extended 16-year period from June 3, 2003, to December 30, 2019, and the post-2008-09 global crisis phase from April 20, 2009, to December 30, 2019. Considering calculated returns from daily adjusted index closing values, the analysis incorporates descriptive statistics and correlation measures to evaluate market integration. The diagnostic normality test guided the adoption of the non-parametric Spearman Rank Correlation method. The results reveal persistently weak correlations between the S&P BSE SENSEX (India) and each of the six European indices over both periods, indicating low financial integration and underscoring opportunities for portfolio diversification in these markets. Conversely, the analysis identifies high interconnectivity among the European indices, demonstrating a substantial degree of regional market integration, which constrains diversification potential within Europe.

Keywords: Stock Market Correlation, S&P BSE SENSEX, European Economies, Post-Crisis Period.

Introduction

Globalization has driven the investors to engage actively in foreign capital markets, fueling a remarkable surge in international investments. Liberalization has further intensified financial integration, characterized by heightened co-movements among the stock indices. The technological revolution has further deepened the economic integration, reshaping the landscape of financial interconnectivity. Financial integration serves as a catalyst for economic development endorsing risk-sharing, optimizing resource allocation, and supporting specialization in production (Acemoglu & Zilibotti, 1997). Additionally, open financial systems attract foreign capital to capital-scarce markets, enabling higher output and improved domestic financial infrastructure through enhanced competition. Understanding inter-market linkages is crucial for effective macroeconomic policymaking and investment strategy formulation. Diversification remains a cornerstone of risk management, as investors leverage the imperfect correlations between international stock indices to reduce portfolio risks while maintaining competitive returns. Theoretical and empirical research identifies economic integration, structural market characteristics, and global investor behavior as pivotal factors influencing market co-movements. Trade relationships, market size disparities, and volatility convergence also play significant roles in shaping the extent of financial integration (Kearney & Lucey, 2004; Pretorius, 2002). An integrated financial market holds substantial significance, serving as a crucial mechanism for fostering domestic savings, stimulating investment, and driving economic growth (Mohan, 2004).

Review of Past Literature and Research Gap

Tripathi and Sethi (2010) investigated the integration of the Indian stock market (NIFTY) with the indices of Japan (NIKKEI), the United Kingdom (FTSE 100), the United States (S&P 500 and DJIA), and China (SSE) over the period from January 1, 1998, to October 31, 2008. Daily returns were computed from the closing values of the selected indices, and the analysis employed correlation tests, Johansen and Engle-Granger cointegration tests, as well as Granger causality tests to explore the degree of market integration. The results revealed a strong correlation between NIFTY (India) and DJIA (USA), while the weakest correlation was observed between NIFTY and NIKKEI (Japan). **Gupta (2011)** analyzed the dynamic linkages among the BRIC nations—Brazil (IBOVESPA), Russia (RTSI), India (CNX Nifty), and China (SCI)—during the financial crises period from January 2008 to November 2011, including the US Subprime crisis and European debt crises. Considering daily index closing data, the study calculated daily returns by taking the natural logarithm of the daily index closing value relatives and employed statistical methods such as unit root tests, correlation, and Granger causality tests. The correlation analysis revealed weak associations among the BRIC indices, indicating limited market integration. **Palamalai et al. (2013)** studied stock market integration among major emerging Asia-Pacific indices of India (NIFTY), Malaysia (KLSE), Hong Kong (HSI), Singapore (STI), South Korea (KOSPI), Taiwan (TWI), Japan (NIKKEI 225), China (SSE), and Indonesia (JFX), and developed markets of the UK (FTSE 100) and the USA (S&P 500), from January 4, 2000, to January 31, 2013. The study used daily returns as the first difference of the natural logarithms of the closing index values for consecutive trading days across all sample indices and applied various statistical techniques, including correlation, unit root tests, Johansen cointegration, VECM, and Granger causality tests. **Kishor and Singh (2017)** investigated the stock market returns of BRICS nations—Brazil (BOVESPA), Russia (MOEX), India (Nifty), China (SSE Composite), South Africa (JSE) from 2007 to 2014, focusing on linkages and relationships among their indices. Using Johansen Co-integration, ADF Unit Root, Granger Causality, Impulse Response Function, and Variance Decomposition, it finds significant positive correlations among BRICS indices, with the highest correlation between India-South Africa and India-Brazil. However, no long-term co-integration was observed, allowing international investors to benefit from portfolio diversification. **Patjoshi et al. (2021)** investigated the stock market linkages between India (BSE SENSEX) and seven indices of six nations, including Germany (DAX), the US (DJIA and NASDAQ), Hong Kong (HANG SENG), Japan (NIKKEI 225), Australia (S&P ASX), and Canada (S&P/TSX), over the period from January 1, 2009, to December 31, 2019. Using daily index returns calculated from the stock market closing values of all sample countries, the study employed correlation and regression analyses, treating SENSEX returns as the dependent variable and other indices' returns as **regressor**.

The existing literature reveals critical gap in the understanding of stock market correlations, particularly concerning on the post- 2008-09 great recession period. Studies investigating correlation dynamics over extended timeframes remain sparse. Furthermore, a few studies had applied pre-statistical assumption test, such as Normality checking before carried on correlation. The current study endeavors to bridge these gaps by offering a nuanced exploration of the correlation patterns among the Indian stock market and six major European economies over the 2003–2019 period, with a distinct focus on capturing the intricacies of market integration during the post-crisis years.

Objectives

Addressing the research gap, the major objectives of the study outlined are as follows:

- Examining the statistical properties of the calculated return series of seven stock indices during the 16 years period from June 3, 2003 to December 30, 2019 (*Refer to section 5.1*);
- Exploring the correlation among the calculated returns related to India's S&P BSE SENSEX and the indices of six European economies during the during the 16 years period (*Refer to section 5.1*);
- Investigating the statistical properties of the calculated return series of seven stock indices during Post-Crisis Period spanning from April 20, 2009 to December 30, 2019 (*Refer to Section 5.2*);
- Analyzing the correlation among the calculated returns related to India's S&P BSE SENSEX and the indices of six European economies during Post-Crisis Period (*Refer to Section 5.2*).

Data and Methodological Approach

Sample Design & Study Period

The study considers the returns from the daily adjusted market closing values of the sample indices of India (BSE SENSEX) and six European countries: UK (FTSE 100), Germany (DAX PERFORMANCE-INDEX), France (CAC 40), Netherlands (EURONEXT 100), Belgium (BEL 20) and Italy (FTSE MIB). The log-transformed return series are calculated applying the formula: $R_t = \ln P_t - \ln P_{t-1}$, where return (R_t) is the logarithmic transformation of the difference between daily adjusted closing index and the previous day adjusted closing index points (P_t and P_{t-1}). The study periods consider two periodic intervals: over sixteen-year period from June 3, 2003 to December 30, 2019 and Post-Crisis Period spanning from April 20, 2009 to December 30, 2019. The secondary data of index closing series are obtained from www.yahooofinance.com and www.investing.com, and also from the official websites of the respective indices.

The selection of sample countries is strategically directed by the GDP (nominal) rankings listed in the World Bank's 2019 report. This initial framework was meticulously refined through considerations of data availability and an in-depth review of relevant prior studies. Employing a judgment sampling approach, India and six European nations, along with their respective stock indices, are identified as the focus for the analysis, ensuring both relevance and robustness in the study's scope. The division of periodic intervals and analysis were anchored in a thorough review of prior research and supported by the marked volatility observed across the seven stock indices during the 2008-09 global financial crisis. The crisis phase, was delineated based on established studies, including those by Dooley and Hutchison (2009) and Chudik and Fratzscher (2011) among others. The onset of the crisis is attributed to significant market declines and liquidity interventions by U.S. central banks, while its conclusion aligns with the G20 summit in London, signifying the beginning of post-crisis stabilization.

Statistical Tools Adopted

Descriptive statistics like mean, median, mode, range, variance, and standard deviation, skewness and kurtosis are used here. Parametric analysis assumes that the dataset follows a normal distribution. To verify this assumption, the study employs the Shapiro-Wilk test. Following the Shapiro-Wilk test for normality, the Spearman rank correlation test, suitable for non-normal data, is used here. The correlation coefficient ranges from -1 to +1, where a positive value indicates that the two variables move in the same direction, signifying a positive correlation, while a negative value denotes an inverse relationship. After carrying out the correlation test, hypothesis testing is used to evaluate whether the observed sample correlation correctly reflects the true population correlation. This test finds whether the population correlation coefficient (ρ) is near zero, indicating no monotonic association among the population, against the alternative hypothesis (H_1) that there is a presence of monotonic association among the population. The comparison of the observed correlation coefficient (r_{obs}) with the critical value (r_{crit}) from the t-distribution table, based on the degrees of freedom ($n-2$), determines the acceptance or rejection of the null hypothesis (H_0). Here, all statistical applications are performed in SPSS software package of version 21.

Analysis and Interpretation

This section presents the empirical findings addressing the study's objectives, with a focus on the correlation dynamics among the calculated daily returns derived from the daily adjusted closing index series of India and six major European economies. Prior to conducting the correlation analysis, descriptive statistics and normality tests were performed to validate the suitability of the chosen correlation methods. The analysis is conducted across two distinct periods: the entire 16-year span from June 3, 2003, to December 30, 2019, and the post-crisis phase from April 20, 2009, to December 30, 2019.

Studying the descriptive statistics of the calculated return series of the seven indices and exploring the correlation dynamics among the calculated returns from chosen indices of India (S&P BSE SENSEX) and the Six European economies in a sixteen-year timespan June 3, 2003, to December 30, 2019

Descriptive Statistics

The descriptive statistics of the estimated return from the seven indices, including that of India is as follows.

Table-4: A Summary of Descriptive Statistics

Parameters (return from daily adjusted closing series)	Sample Size	Minimum Statistics	Maximum Statistics	Mean Value	Standard Deviation	Variance	Skewness		Kurtosis	
							statistics	Standard Error	statistics	Standard Error
S&P BSE SENSEX (India)	2035	- 0.1810 773992 742481	0.14412 595849 04207	0.0012 59086 60497 4	0.01974 262350 9262	0.000	-0.250	0.054	10.286	.108
FTSE 100 (UK)	2035	- 0.1243 757765 924892	0.09640 444764 30571	0.0003 00560 42920 5	0.01446 362106 2060	0.000	-0.961	0.054	9.037	.108
DAX- PERFORMANCE INDEX (Germany)	2035	- 0.1361 993118 651471	0.12084 772752 31617	0.0007 25508 71232 6	0.01788 087297 6972	0.000	-0.750	0.054	6.714	.108
CAC 40 (France)	2035	- 0.1298 821638 060806	0.10371 701982 36646	0.0003 32741 22063 4	0.01731 765432 1163	0.000	-0.759	0.054	5.902	.108
EURONEXT 100 (Netherlands)	2035	- 0.1347 280942 025920	0.10082 195609 20743	0.0003 84678 09751 5	0.01611 849577 8801	0.000	-0.951	0.054	7.690	.108
BEL 20 (Belgium)	2035	- 0.2093 553963 667288	0.08705 363591 90407	0.0003 49618 22309 4	0.01661 087467 6528	0.000	-1.715	0.054	18.350	.108
FTSE MIB (Italy)	2035	- 0.1735 587432 669311	0.90882 624783 65300	0.0004 09877 01319 4	0.02859 157611 0946	0.001	15.387	0.054	502.46 9	.108

The dataset reveals no missing values across the table. Among the return series, FTSE MIB (Italy) exhibits the highest maximum value, while BEL 20 (Belgium) records the lowest. Standard deviation values are relatively low, indicating that observations are closely clustered around their respective means, as presented in the fifth column. All return series display negative skewness, except for FTSE MIB (Italy), suggesting distributions with longer left tails. The kurtosis values indicate that the return distributions are leptokurtic, reflecting heavier tails than a normal distribution. Collectively, the skewness and kurtosis metrics confirm that none of the series adhere to a normal distribution.

Shapiro-Wilk Test of Normality

The Shapiro-Wilk test results with p-value, decision rule and test inferences are as follows:

Table5: Result of the Shapiro-Wilk Test of Normality

Parameters (return from daily adjusted closing series)	Statistic	P-Value	Decision Rule	Decision on H_0 (H_0 : The return series are normally distributed.)	Inferences
S&P BSE SENSEX (India)	0.894	0.000	$P < 0.05$	Rejected	Non-normal series
FTSE 100 (UK)	0.904	0.000	$P < 0.05$	Rejected	Non-normal series
DAX PERFORMANCE- INDEX (Germany)	0.920	0.000	$P < 0.05$	Rejected	Non-normal series
CAC 40 (France)	0.927	0.000	$P < 0.05$	Rejected	Non-normal series
EURONEXT 100 (Netherlands)	0.913	0.000	$P < 0.05$	Rejected	Non-normal series
BEL 20 (Belgium)	0.871	0.000	$P < 0.05$	Rejected	Non-normal series
FTSE MIB (Italy)	0.529	0.000	$P < 0.05$	Rejected	Non-normal series

The estimated p-values are found less than 0.01, leading to a clear rejection of the null hypothesis at 1%, 5% and 10% confidence interval. This outcome confirms that the return series deviate from normal distribution. Consequently, given the evidence of non-normality, the analysis transitions to a non-parametric approach, employing the Spearman Rank Correlation test.

Spearman Rank Correlation

The Spearman rank correlation matrix is given as follows:

Table 6: The Spearman Rank Correlation Matrix of the Returns among India and the select six sample countries' Stock Indices belong to the European Region during 16-year span from June 3, 2003, to December 30, 2019

Parameters (return from daily adjusted closing series)	S&P BSE SENSEX (India)	FTSE 100 (UK)	DAX PERFORMANCE- INDEX (Germany)	CAC 40 (France)	EURONEXT 100 (Netherland)	BEL 20 (Belgium)	FTSE MIB (Italy)
S&P BSE SENSEX (India)	1.000	0.282** (0.000)	0.298** (0.000)	0.295** (0.000)	0.299** (0.000)	0.297** (0.000)	0.264** (0.000)
FTSE 100 (UK)	0.282** (0.000)	1.000	0.794** (0.000)	0.844** (0.000)	0.859** (0.000)	0.776** (0.000)	0.733** (0.000)
DAX PERFORMANCE- INDEX (Germany)	0.298** (0.000)	0.794** (0.000)	1.000	0.908** (0.000)	0.911** (0.000)	0.821** (0.000)	0.806** (0.000)
CAC 40 (France)	0.295** (0.000)	0.844** (0.000)	0.908** (0.000)	1.000	0.986** (0.000)	0.868** (0.000)	0.856** (0.000)
EURONEXT 100 (Netherland)	0.299** (0.000)	0.859** (0.000)	0.908** (0.000)	0.986** (0.000)	1.000	0.895** (0.000)	0.849** (0.000)
BEL 20 (Belgium)	0.297** (0.000)	0.776** (0.000)	0.821** (0.000)	0.868** (0.000)	0.895** (0.000)	1.000	0.800** (0.000)
FTSE MIB (Italy)	0.264** (0.000)	0.733** (0.000)	0.806** (0.000)	0.856** (0.000)	0.849** (0.000)	0.800** (0.000)	1.000

** Correlation is significant at the 0.01 level (2-tailed)/ P values are in parenthesis

The correlation matrix demonstrated that the returns from the S&P BSE SENSEX (India) established very weak associations with the returns of all indices from the six European countries, with positive correlation coefficients remaining below 0.3. Among these, the weakest association is observed with the FTSE MIB (Italy), while the strongest association was with the EURONEXT 100 (Netherland). The P-values, provided in parentheses beneath the coefficients, are all below 0.01, indicating statistical significance at the 1%, or 5% significance levels at the two-tailed test. In contrast, the returns from the European indices exhibited very strong interrelations, with correlation coefficients exceeding 0.7. These relationships are also statistically significant at all conventional levels (p-values < 0.01).

Examining the descriptive statistics of the calculated return series of the seven indices and studying the correlation dynamics among the calculated returns from chosen indices of India (S&P BSE SENSEX) and the Six European economies during post-crisis phase from April 20, 2009, to December 30, 2019

Descriptive Statistics

The descriptive statistics of the estimated return from the seven indices, including that of India is as follows.

Table 4: A Summary of Descriptive Statistics

Parameters (return from daily adjusted closing series)	Sample Size	Minimum Statistics	Maximum Statistics	Mean Value	Standard Deviation	Variance	Skewness		Kurtosis	
							Statistics	Standard Error	statistics	Standard Error
S&P BSE SENSEX (India)	1271	-0.07847	0.144126	0.001038	0.015167	0.00	0.987	0.069	10.529	0.137
FTSE 100 (UK)	1271	-0.0765	0.050379	0.000493	0.013516	0.00	-0.654	0.069	4.021	0.137
DAX PERFORMANCE- INDEX (Germany)	1271	-0.10132	0.067325	0.000831	0.017261	0.00	-0.788	0.069	3.941	0.137
CAC 40 (France)	1271	-0.10263	0.074555	0.000533	0.017237	0.00	-0.745	0.069	4.345	0.137
EURONEXT 100 (Netherland)	1271	-0.09978	0.06923	0.000627	0.015725	0.00	-0.833	0.069	4.96	0.137
BEL 20 (Belgium)	1271	-0.10762	0.067806	0.00059	0.01557	0.00	-0.755	0.069	5.052	0.137
FTSE MIB (Italy)	1271	-0.17356	0.079464	0.000203	0.021843	0.00	-1.068	0.069	6.464	0.137

The dataset comprises a total of 1,271 observations for each series, with no missing values detected. The FTSE MIB (Italy) series recorded both the highest and lowest return values. Low standard deviation values indicate that the observations are closely clustered around the mean for all series. Negative skewness was identified across all series, suggesting distributions with longer left tails. Additionally, positive kurtosis values indicate leptokurtic distributions, characterized by sharper peaks and heavier tails.

Shapiro-Wilk Test of Normality

The Shapiro-Wilk test results with p-value, decision rule and test inferences are as follows:

Table 5: Result of the Shapiro-Wilk Test of Normality

Parameters (return from daily adjusted closing series)	Statistic	P-Value	Decision Rule	Decision on H_0 (H_0 : The return series are normally distributed.)	Inferences
S&P BSE SENSEX (India)	0.914	0.002	$P < 0.05$	Rejected	Non-normal series
FTSE 100 (UK)	0.942	0.000	$P < 0.05$	Rejected	Non-normal series
DAX PERFORMANCE-INDEX (Germany)	0.942	0.000	$P < 0.05$	Rejected	Non-normal series
CAC 40 (France)	0.940	0.000	$P < 0.05$	Rejected	Non-normal series
EURONEXT 100 (Netherland)	0.933	0.000	$P < 0.05$	Rejected	Non-normal series
BEL 20 (Belgium)	0.936	0.000	$P < 0.05$	Rejected	Non-normal series
FTSE MIB (Italy)	0.929	0.000	$P < 0.05$	Rejected	Non-normal series

The obtained p-values are consistently below the 0.05, conclusively rejecting the null hypothesis. This result verifies that the return series deviate from a normal distribution. As a result, the analysis adopts a non-parametric approach, utilizing the Spearman Rank Correlation test to account for the observed non-normality (p-values < 0.05).

Spearman Rank Correlation

The Spearman rank correlation matrix is given as follows:

Table 6: The Spearman Rank Correlation Matrix of the Returns among India and the select six sample countries' Stock Indices belong to the European Region during Post-crisis Period from April 20, 2009, to December 30, 2019

Parameters (return from daily adjusted closing series)	S&P BSE SENSEX (India)	FTSE 100 (UK)	DAX Performance-INDEX (Germany)	CAC 40 (France)	EURONEXT 100 (Netherland)	BEL 20 (Belgium)	FTSE MIB (Italy)
S&P BSE SENSEX (India)	1.000	0.280** (0.000)	0.291** (0.000)	0.285** (0.000)	0.290** (0.000)	0.289** (0.000)	0.252** (0.000)
DAX PERFORMANCE-INDEX (Germany)	0.280** (0.000)	1.000	0.785** (0.000)	0.907** (0.000)	0.912** (0.000)	0.841** (0.000)	0.791** (0.000)
FTSE 100 (UK)	0.291** (0.000)	0.785** (0.000)	1.000	0.821** (0.000)	0.841** (0.000)	0.765** (0.000)	0.698** (0.000)
CAC 40 (France)	0.285** (0.000)	0.907** (0.000)	0.821** (0.000)	1.000	0.985** (0.000)	0.880** (0.000)	0.848** (0.000)
EURONEXT 100 (Netherland)	0.290** (0.000)	0.912** (0.000)	0.841** (0.000)	0.985** (0.000)	1.000	0.907** (0.000)	0.837** (0.000)
BEL 20 (Belgium)	0.289** (0.000)	0.841** (0.000)	0.765** (0.000)	0.880** (0.000)	0.907** (0.000)	1.000	0.805** (0.000)
FTSE MIB (Italy)	0.252** (0.000)	0.791** (0.000)	0.698** (0.000)	0.848** (0.000)	0.837** (0.000)	0.805** (0.000)	1.000

** Correlation is significant at the 0.01 level (2-tailed) / P values are in parenthesis

The returns from the indices of India (S&P BSE SENSEX) displayed weak positive associations with the returns of all six European stock indices, with correlation coefficients consistently below 0.3. The weakest correlation was identified with the FTSE MIB (Italy), while the strongest was observed with the DAX PERFORMANCE-INDEX (Germany). P-values, listed in parentheses beneath the coefficients, were all below 0.01, signifying statistical significance at the 1%, or 5% significance levels in a two-tailed test. Conversely, returns from the European indices demonstrated strong interrelationships, with correlation coefficients surpassing 0.6, all of which were statistically significant at conventional levels (p-values < 0.01). The strongest association is found between the returns from EURONEXT 100 (Netherland) and CAC 40 (France).

Conclusion

It is observed that the returns from India's S&P BSE SENSEX consistently demonstrated weak correlations with six European indices across the 16-year period from June 3, 2003, to December 30, 2019. Despite being positive and statistically significant, these correlations remained low, with coefficients consistently below 0.3. During the post-crisis period (April 20, 2009, to December 30, 2019), this trend of weak associations persisted, as correlation coefficients continued to remain below 0.3, reflecting limited integration between India's market and sample European indices. In contrast, the analysis of stock market interrelationships among the six European indices over the same intervals revealed very strong associations, with correlation coefficients exceeding 0.7. These findings suggest a high degree of market integration within the European region, highlighting strong interconnectedness among their financial markets limiting the scope for investment diversification. The persistently low correlations between India's stock market and the European indices emphasize India's unique position as a relatively independent market. This low level of integration signals significant potential for portfolio diversification, enabling global investors to hedge against synchronized market downturns and mitigate risk through investments in less correlated markets. India's relatively weak correlation with major international markets enhances its appeal as an investment destination, offering robust opportunities for diversification benefits. By incorporating Indian equities into their portfolios, investors can achieve greater risk-adjusted returns while shielding their portfolios from global financial shocks.

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