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A CROSS-REGIONAL ANALYSIS OF STOCK MARKET CORRELATION AMONG INDIA AND KEY EUROPEAN ECONOMIES

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ABSTRACT

The study of stock market correlations is essential for understanding financial integration, uncovering prospects for risk diversification, and guiding investors aimed at minimizing the effects of eco-financial decay within a globally interconnected environment. This study offers a detailed correlation analysis among the calculated returns from the indices of India (S&P BSE SENSEX) and six leading European nations, namely the UK (FTSE 100), Germany (DAX, PERFORMANCE-INDEX) France(CAC 40), Netherlands (EURONEXT 100), Belgium(BEL 20), and Italy (FTSE MIB)—over two critical economic episodes: the pre-global recession period (June 3, 2003 – August 2, 2007) and the global recession period (August 7, 2007 – April 16, 2009). Initially the study employs descriptive statistics to study the nature of the data series, followed by normality diagnostics to determine the most suitable correlation technique. Since normality tests found that none of the return series follow normal distribution, and the non-parametric Spearman Rank Correlation is applied. The analysis concludes consistently low correlations between the S&P BSE SENSEX (India) and each of the European indices, signaling limited connectedness across both periods. The correlation between returns from India and six European stock indices weakened from the pre-crisis to the crisis periods. This outcome points to modest financial integration between India and the specified European markets, underscoring the potential for diversification benefits. These insights are instrumental in shaping investment strategies that aim to withstand market fluctuations by leveraging distinct market behaviors across regions. However, among the European nations, very strong significant associations have been found in this study.

***Keywords**: Stock Market Correlation, S&P BSE SENSEX, European Indices, Pre- Global Crisis, Global Financial Crisis.*

Introduction

The wave of globalization has encouraged nations to liberalize their financial policies, easing across borders fund transfer. Developed economies, with their mature financial infrastructures, saw early benefits from consolidation, boosting both efficiency and investor confidence. Emerging economies, however, approached liberalization with caution later, gradually integrating to harness the benefits of foreign capital. Hence, financial liberalization serves as a double-edged sword, offering economic growth

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through market access while also exposing economies to global financial volatility and potential contagion risks. The integration of global financial systems is instrumental in shaping a robust global economy, enhancing cross-border capital mobility, and promoting efficient financial intermediation. The process minimizes price discrepancies and standardizes returns for investors in integrated stock markets. It enhances the operational efficiency of domestic financial structure and make the system more dynamics by fostering competition, leading to increased effectiveness in financial services and positive growth outcomes (Klein and Olivei, 2000, Trichet, 2005). In recent years, stock market integration has gained prominence. Countries with robust financial frames experience higher degrees of integration, facilitating unified asset trading across borders. This integrated system standardizes stock returns that are exposed to similar risks, regardless of geographical or socio-economic. By allowing for more efficient portfolio diversification, financial integration optimizes investment opportunities. Harmonized stock exchanges also ensure more efficient price discovery, incorporating all factors that influence asset prices, thus contributing to financial stability and growth. Although financial globalization promotes economic cohesion and greater investment opportunities, it can also magnify vulnerabilities. The stability of integrated markets relies heavily on the speed of information flow between borrowers and lenders, as well as on the effectiveness of managing risks from information asymmetry. However, rapid information transmission can introduce significant risks, as economic disturbances in major economies may quickly ripple through interconnected markets, triggering broader financial downturns. Beyond the direct risks, other factors, particularly, unrestricted capital account convertibility and unregulated cross-border capital flows can worsen financial instability, amplifying systemic risks, particularly in integrated markets where financial shocks can easily spread (Stiglitz, 2002). Integrated markets amplify systemic risks, as financial shocks in one region can quickly spread to other interconnected markets, as seen during the 2008-09 global financial crisis, which began with the U.S. housing bubble and escalated into a worldwide economic catastrophe.

The 2008-09 financial crisis highlights how integrated global markets can rapidly transmit shocks, leading to contagion effects. A domestic crisis, like the U.S. housing market collapse, quickly escalated into a global-wise recession, intensifying financial instability through declining investments, credit contraction, and stock market crashes. While emerging markets tend to react more sharply to localized crises, the growing interconnectedness of global financial systems amplifies these risks over time. This integration increases the likelihood of widespread financial instability, particularly during economic downturns (Berger and Pukthuanthong, 2012). While financial integration can foster economic growth and stability, it also requires careful management of systemic risks and global interconnections.

Past Studies and Research Gap

Mukherjee (2007) conducted an in-depth comparative evaluation of the Indian stock market (NSE) against global counterparts, including the New York Stock Exchange, Hong Kong Stock Exchange, Tokyo Stock Exchange, Russian Stock Exchange, and Korean Stock Exchange, over the period spanning January 1995 to July 2006. The study divided the timeline into four economic phases: the East Asian crisis (1995–97), the technology boom (1999–2001), the global recession recovery phase (2001–03), and the investment-driven market surge (2003–06). Using a mixed-methods approach, the analysis incorporated both qualitative and quantitative dimensions. The qualitative assessment evaluated stock markets on parameters such as market capitalization, the number of listed securities, listing frameworks, circuit breaker policies, and settlement mechanisms. Quantitatively, correlation matrices and exponential trend modeling explored inter-market dynamics and risk-return patterns. Mukherjee and Mishra (2010) analyzed stock market linkages between India and 12 Asian countries—China, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Hong Kong, and Singapore—over the period from July 1997 to April 2008. The study focused on three constructed return series like daily, intraday, and overnight return seriesderived from daily market price observation. The correlation tests were performed on both the return series and their volatility. Results indicated that BSE Sensex enjoyed significant positive correlations with most Asian markets for daily and intraday returns, excluding Sri Lanka. However, correlations for overnight return series were found weaker, with significant associations observed only with Hong Kong, Singapore, Korea and Thailand. Squared returns alternative to Volatility analysis, presented significant co-movements between India and most Asian markets in daily and intraday series, though weaker for overnight linkages, except for Hong Kong and Thailand. Further, Gupta and Agarwal (2011) analyzed the stock market correlation association between India (BSE Sensex) and five major Asian economies—Japan, Hong Kong, Indonesia, Malaysia, and Koreafrom January 2005 to December 2009. Using weekly returns derived from market closing index values under standardized return calculation, the study further computed yearly returns multiplying Simple average of weekly returns by 52. Stationary test and correlation applications were made in three consecutive intervals: 5 year correlation (2005-09), 1 year correlation (2009) and Last 6 months Correlation (July - Dec 2009). The presence of low correlation association had been observed between the indices of India and five Asian countries during the 3 intervals and in many cases the nature and degree of associations varied across time. However, weak correlation had been found, which suggested that India's stock market provides diversification benefits to the investors and mitigates risk for international investors, especially given its low integration with most Asian markets. Kaur (2017) conducted a 16-year study (2001–2016) examining the integration of Indian stock indices, considering both BSE and NSE, with four global indices: the USA (NSA), China (Shanghai Composite), Hong Kong (Hang Seng), and Japan (Nikkei 225). The analysis was bifurcated into qualitative and quantitative assessments. Qualitative evaluation focused on stock market characteristics such as market capitalization, listing standards, settlement systems, circuit breakers, and regulatory requirements. Quantitative analysis involved correlation tests and descriptive statistics to gauge interdependence. Results demonstrated moderate to high correlation levels between Indian indices, both SENSEX and Nifty and the selected global indices, reflecting significant but varying degrees of integration. Sharma and Bora (2019) conducted an extensive analysis comparing the Indian stock market (BSE) with seven major global markets: the USA (NYSE and NASDAQ), Japan (Nikkei), China (SSE), Hong Kong (SEHK), the UK (LSE), and Canada (TMX), covering the period from 2009 to 2019. Employing tools like correlation analysis, descriptive statistics, and measures of skewness and kurtosis, the study explored interdependencies and investment opportunities across these markets. Results revealed a strong correlation between India's BSE and markets like the USA (NYSE and NASDAQ), the UK (LSE), Japan (Nikkei), Canada (TMX), and Hong Kong (SEHK), indicating significant interconnectedness, while, weakest correlation hadfound with SSE index. The existing literature, however, leaves gaps, particularly in the examination of stock market correlation during the 2008-09 financial crisis itself, a period that remains underexplored. It is equally crucial to determine if and how these correlations changed from the pre-crisis to the crisis periods. Also the correlation analysis between India's stock indices and the selected European markets has largely been overlooked in previous research.

Objectives of the Study

The found research gaps have led to the design of two key objectives for this study, which are outlined below:

- To analyze the statistical properties of the calculated return series derived from the daily adjusted index closing seriesof seven stock indices with a focus on analyzing the correlation among the calculated returns related to India's S&P BSE SENSEX and the indices of six European economies during the pre-crisis period*(Refer to section 5.1)*;
- To study the statistical properties of the calculated return series derived from the daily adjusted index closing series of seven stock indices with a focus on analyzing the correlation among the calculated returns related to India's S&P BSE SENSEX and the indices of six European economies during the global financial crisis period*(Refer to Section 5.2)*.

Data and Methodological Framework

Sample Design & Data Period

This research based on secondary data, considers the daily adjusted index market closing series of India (BSE SENSEX) and six European countries: UK (FTSE 100), Germany (DAX PERFORMANCE-INDEX), France (CAC 40), Netherland (EURONEXT 100), Belgium (BEL 20) and Italy (FTSE MIB) to study the correlation dynamics across two significant periods: Pre-Crisis Period, spanning from June 3, 2003 – August 2, 2007and Global Financial Crisis period(August 7, 2007 – April 16, 2009).

The selection of sample countries was made using judgment sampling considering the GDP ranking (nominal) published by World Bank, 2019 along with data availability. India and six European nations, along with their respective stock indices, were chosen for the analysis. The secondary data of daily adjusted index closing value series of all seven countries were obtained from www.yahoofinance.com and www.investing.com, and also from the official websites of the respective indices. With the purpose of continuing the correlation analysis, the stock market return series (in log transformation) were calculated applying the formula: $R_t = lnP_t - lnP_{t-1}$, where return (R_t) is the logarithmic transformation of the difference between daily adjusted closing stock market index and the previous day adjusted closing stock market index points (P_t and P_{t-1}).

The division and analysis of the study period were grounded in an extensive review of existing research. The crisis phase was delineated based on prior studies, such as those by Chudik and Fratzscher (2011), Wang (2014) etc., and further supported by the pronounced volatility evident in the seven stock indices during this turbulent period. The designated intervals, particularly the 2007–2009 global financial crisis, capture critical market disruptions and structural shifts within global capital markets. This crisis is generally acknowledged to have begun on August 7, 2007, marked by sharp market declines and concluded on April 16, 2009, with the G20 summit in London signaling a phase of global market stabilization.

Descriptive Statistics

Descriptive statistics summarize the dataset and provide a clear overview regarding the main features of the data without making inferences or predictions. The component of descriptive statistics are categorized into measures of central tendency that includes the analysis of mean, median, and mode of the series and the measures of dispersion such as range, variance, and standard deviation that measures the variability among the data. Other tools, such as skewness and kurtosis, assess the shape and distribution of the data.

Normality Test of the Series

A key postulation for any parametric application is that datasets must be normally distributed. This feature suggests that a normally distributed series, say, x_i, should have zero mean, or E(X)=0, indicating that most data points are concentrated near the mean value. The normally distributed series results in a bell-shaped curve or symmetrical at both sides. To verify the normality of the data, this study performs the Shapiro-Wilk test. The test hypothesis and decision rule are as follows:

Table 1: Hypothesis Testing and Decision Rule of Shapiro−Wilk Test

Test Specification	Hypothesis	Decision Rule
Shapiro−WilkTest of Normality	• H_0: the returns from daily adjusted index closing series of the select sample countries individually are normally distributed • Alternative hypothesis, H_1: the returns from daily adjusted index closing series of the select sample countries individually are non- normal in nature.	• If P−Value< 0.05, H_0 is rejected and hence, the return series are not following normal distribution • If P−Value > 0.05, H_0 is not rejected and hence, the return series are normally distributed

Correlation Test

Here, Correlation is implemented as a preliminary measure of integration among the chosen indices of India and six European countries. After carrying out theShapiro−Wilktest of Normality, if the series are found normal, the Pearson correlation test will be carried on, while for non-normal dataset, the Spearman rank correlation test, which does not assume normal distribution, will be used instead. Both tests provide correlation coefficient, which indicates how strong and in what direction the relationship is between market indices, helping to understand their connections and dependencies.

Spearman Rank Correlation

If the normality test fails to provide evidence in support of the presence of normally distributed series, the non-parametric Spearman Rank Correlation method will be employed as an alternative. This test assesses the nature and strength of a monotonic relationship by using ranked values rather than raw data. Spearman's test focuses on rank-based associations and can identify monotonic relationships without assuming linearity. The formula for calculating Spearman Coefficient is as follows:

$$r_{R(x)R(y)} = \frac{cov\ (R(X), R(Y))}{\sigma_{R(X)}\sigma_{R(Y)}}$$

Cov (R(X), R(Y)) is the covariance of the ranked values of the original series and $\sigma_{R(X)}$ and $\sigma_{R(Y)}$ stand for the standard deviations of the ranked variables. Normally, Spearman Correlation is computed by using the following formula:

$$r_{R(x)R(y)} = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Where, d_i is the difference between the two ranks of the each observation, i.e. R(X)-R(Y).

The correlation coefficient varies between -1 and +1, with a positive value signifying that the two variables move in the same direction, reflecting a positive correlation and vise-versa. The general rule of thumb in interpreting correlation coefficient is shown in following Table-2.

Table 2: Interpretation of Observed Correlation Coefficient

Correlation Coefficient Ranges	Interpretation
(±)0.00—(±)0.10	Irrelevant correlation (positive/ negative)
(±)0.11—(±)0.39	Very Weak correlation (positive/ negative)
(±)0.40—(±)0.49	Weak correlation (positive/ negative)
(±)0.50—(±)0.69	Moderate correlation (positive/ negative)
(±)0.70—(±)0.89	Strong correlation (positive/ negative)
(±)0.90—(±)0.01	Very Strong correlation (positive/ negative)
(±)1.00	Perfectly Correlated

After performing the correlation test, hypothesis testing is used to assess whether the observed sample correlation accurately reflects the true population correlation. This test evaluates 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). The decision rule of the significance of Correlation Coefficient is presented as follows:

Table 3: Hypothesis Testing and Decision Rule of Spearman Rank Correlation Coefficient

Test	Hypothesis	Decision Rule
Significance of Correlation Coefficient	• Null hypothesis, H_0: ρ=0, i.e., the population correlation coefficient is not significantly different from zero; • Alternative hypothesis, H_1: ρ≠0, i.e., the population correlation coefficient is significantly different from zero	• If $r_{crit}< r_{obs}$ is rejected, concluding the presence of significant correlation • If $r_{crit}> r_{obs}$ then null hypothesis is not rejected, concluding there exist no significant correlation

After estimating correlation coefficient r (r_{obs}), critical t-statistics, critical r (r_{crit}) has to be found out from the t-table according to the particular df and the level of significance.

Empirical Results and Interpretations

This section presents the empirical results aimed at addressing the objectives of this analysis, focusing on the correlation dynamics among the calculated returns from daily adjusted index closing series of India and six major European economies. Before diving into the correlation analysis, an overview of the descriptive statistics was presented along with the test of Normality to ensure the appropriateness of the correlation methods employed.

Addressing to Objective-1: Analyzing the descriptive statistics of the calculated return series derived from the daily adjusted market closing values 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 in Pre-Crisis Period

Descriptive Statistics

The descriptive statistics table is attached as follows:

Table 4: A Summary of Descriptive Statistics

Parameters	Sample Size	Minimum Statistics	Maximum Statistics	Mean Value	Standard Deviation	Variance	Skewness		Kurtosis	
							statistics	Standard Error	statistics	Standard Error
India (S&P BSE SENSEX)	564	-0.1810773992742481	0.1172372924185337	0.002765485984400	0.021072991546235	0.000	-1.082	0.103	12.733	0.205

Germany (DAX PERFORMANCE-INDEX)	564	-0.0368455744055117	0.0427744891814404	0.000754943695070	0.009262499497569	0.000	-0.296	0.103	2.001	0.205
UK (FTSE 100)	564	-0.0881229106362996	0.0615463320174380	0.001616898515669	0.014011218261027	0.000	-0.527	0.103	3.879	0.205
France (CAC 40)	564	-0.0452943824496371	0.0456320221166107	0.001109312381847	0.011810785850831	0.000	-0.265	0.103	1.528	0.205
Netherland (EURONEXT 100)	564	-0.0401948286947396	0.0401706327254857	0.001156919950860	0.010916706975067	0.000	-0.372	0.103	1.603	0.205
Belgium (BEL 20)	564	-0.0425399472094222	0.0341988268254317	0.001415116288667	0.009871131852933	0.000	-0.503	0.103	2.049	0.205
Italy (FTSE MIB)	564	-0.0516506954098871	0.9088262478365300	0.002408566167725	0.039572853869361	0.002	21.403	0.103	491.142	0.205

Source: Compilation of secondary data using SPSS 21.0

Findings

It has been seen that no series has any missing observation. The return series from FTSE MIB (Italy) series has both maximum and minimum return values. The low SD values indicate that the observations are close to mean values of the series and less scatter. The negative skewness describe the longer left tail of the distribution. The kurtosis of the return series of S&P BSE SENSEX (India), DAX Performance Index (Germany) and FTSE MIB (Italy) are greater than 3 that means the curves are leptokurtic in nature and have more picked in top. A very high kurtosis has been found for the return series of FTSE MIB (Italy) that means the distribution is more peaked than normal distribution. The rest of the series have kurtosis less than 3 and indicate platykurtic distribution or flat peak than normal distribution.

Normality Test of the Return Series

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

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

Name of Stock Index	Statistic	P−Value	Decision Rule	**Decision on H_0**(H_0: The return series are normally distributed.)	Inferences
India (S&P BSE SENSEX)	0.889	0.000	P<0.05	Rejected	Non-normal series
Germany (DAX PERFORMANCE-INDEX)	0.976	0.000	P<0.05	Rejected	Non-normal series
UK (FTSE 100)	0.963	0.000	P<0.05	Rejected	Non-normal series
France (CAC 40)	0.981	0.000	P<0.05	Rejected	Non-normal series
Netherland (EURONEXT 100)	0.978	0.000	P<0.05	Rejected	Non-normal series
Belgium (BEL 20)	0.973	0.000	P<0.05	Rejected	Non-normal series
Italy (FTSE MIB)	0.149	0.000	P<0.05	Rejected	Non-normal series

Source: Compilation of secondary data using SPSS 21.0

The Shapiro-Wilk test results expose that all observed p-values are below the 0.05 threshold, unequivocally rejecting the null hypothesis of normality and accept the alternative hypothesis of non-normality. This suggests that none of the return series exhibit normal distribution. Given the evidence of non-normality, the analysis proceeds with a non-parametric approach Spearman Rank Correlation test.

Spearman Rank Correlation

The Spearman rank correlation matrix is given as follows:

Table 6: Spearman Rank Correlation Matrix of the Return of adjusted market closing Series of India and the select six sample European Stock Indices during Pre-Crisis Period

Countries and Representative Indices	India (S&P BSE SENSEX)	Germany (DAX PERFORMANCE-INDEX)	UK (FTSE 100)	France (CAC 40)	Netherland (EURONEXT 100)	Belgium (BEL 20)	Italy (FTSE MIB)
India (S&P BSE SENSEX)	1.000	0.270** (0.000)	0.312** (0.000)	0.306** (0.000)	0.320** (0.000)	0.275** (0.000)	0.271** (0.000)
Germany (DAX PERFORMANCE-INDEX)	0.270** (0.000)	1.000	0.774** (0.000)	0.852** (0.000)	0.858** (0.000)	0.753** (0.000)	0.796** (0.000)
UK (FTSE 100)	0.312** (0.000)	0.774** (0.000)	1.000	0.906** (0.000)	0.913** (0.000)	0.753** (0.000)	0.842** (0.000)
France (CAC 40)	0.306** (0.000)	0.852** (0.000)	0.906** (0.000)	1.000	0.987** (0.000)	0.817** (0.000)	0.866** (0.000)
Netherland (EURONEXT 100)	0.320** (0.000)	0.858** (0.000)	0.913** (0.000)	0.987** (0.000)	1.000	0.840** (0.000)	0.865** (0.000)
Belgium (BEL 20)	0.275** (0.000)	0.753** (0.000)	0.753** (0.000)	0.817** (0.000)	0.840** (0.000)	1.000	0.753** (0.000)
Italy (FTSE MIB)	0.271** (0.000)	0.796** (0.000)	0.842** (0.000)	0.866** (0.000)	0.865** (0.000)	0.753** (0.000)	1.000
**** Correlation is significant at the 0.01 level (2-tailed) / P values are in parenthesis**							

Source: Compilation of secondary data using SPSS 21.0

It has been studied from the Spearman correlation matrix that the return from daily market closing series from S&P BSE SENSEX (India) had very feeble correlation association with the returns from other six sample European indices. Although, the positive correlations have been found, but the coefficients were less than 0.4 and specify very low associations. The p-values are shown in parentheses beneath the coefficient figures. All observed p-values are below 0.01, indicating that the coefficients are statistically significant at the 1%, 5% and 10% levels, at two-tailed test. In addition to the correlation between the returns of S&P BSE SENSEX (India) and the six European indices, the matrix also presents strong associations among the European indices themselves, with all coefficients exceeding 0.70. Strongest association was found between CAC 40 (France) and EURONEXT 100 (Netherland). All these coefficients are statistically significant at the 1%, 5% and 10% levels having p-values less than 0.01.

Addressing to Objective-2: Studying the descriptive statistics of the calculated return series derived from the daily adjusted market closing values of the seven indices and analyzing the correlation dynamics among the calculated returns from chosen indices of India (S&P BSE SENSEX) and the six European economies in the Crisis Period

Descriptive Statistics

The descriptive statistics table is presented in the following table:

Table-7:A Summary of Descriptive Statistics

Parameters	Sample Size	Minimum Statistics	Maximum Statistics	Mean Value	Standard Deviation	Variance	Skewness		Kurtosis	
							statistics	Standard Error	statistics	Standard Error
India (S&P BSE SENSEX)	200	–0.1366709681067407	0.1190428280310384	–0.001586212193554	0.035279060633961	0.001	–.163	0.172	1.855	0.342
Germany (DAX PERFORMANCE-INDEX)	200	–0.1243757765924892	0.0964044476430571	–0.002205699363671	0.026878330218372	0.001	–0.744	0.172	4.093	0.342
UK (FTSE 100)	200	–0.1361993118651471	0.1208477275231617	–0.002456663218473	0.028258736453107	0.001	–0.372	0.172	5.570	0.342
France (CAC 40)	200	–0.1298821638060806	0.1037170198236646	–0.003130284712322	0.027576706775397	0.001	–0.426	0.172	3.435	0.342
Netherland (EURONEXT 100)	200	–0.1347280942025920	0.1008219560920743	–0.003331387960494	0.026914784707093	0.001	–0.646	0.172	4.527	0.342
Belgium (BEL 20)	200	–0.2093553963667288	0.0870536359190407	–0.004183510961341	0.031195665696906	0.001	–1.645	0.172	10.480	0.342
Italy (FTSE MIB)	200	–0.1481603645088333	0.1341453773257802	–0.003913560615294	0.029148445368589	0.001	–0.388	0.172	5.848	0.342

Source: Compilation of secondary data using SPSS 21.0

It has been observed from the descriptive statistics table that there are total 200 observations in each return series and no series has any missing value. The maximum return value has been found in the FTSE MIB (Italy), while, returns from BEL 20 (Belgium) has minimum return value. The low standard deviation scores that are very close to zero mention that the observation are not very spread away from the mean values of the series. The negative skewness have been found in all of the return series that indicate the shape of the distributions that have longer left tail as well as no series are following normal distribution. The positive kurtosis have been found for all of the series, although S&P BSE SENSEX (India) has been showing platykurtic distribution as it has the kurtosis less than 3, while the rest of the series of the European region have leptokurtic distribution with more sharp peaks than the standard normal curve. Hence, from the descriptive statistics table is confirmed that no series has been following the normal distribution.

Normality Test of the Return Series

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

Table 8: Result of the Shapiro-Wilk Test of Normality

Name of Stock Index	Statistic	P–Value	Decision Rule	Decision on H_0(H_0: The return series arenormally distributed.)	Inferences
India (S&P BSE SENSEX)	0.976	0.002	P<0.05	Rejected	Non-normal series
Germany (DAX PERFORMANCE-INDEX)	0.940	0.000	P<0.05	Rejected	Non-normal series
UK (FTSE 100)	0.904	0.000	P<0.05	Rejected	Non-normal series
France (CAC 40)	0.951	0.000	P<0.05	Rejected	Non-normal series
Netherland (EURONEXT 100)	0.936	0.000	P<0.05	Rejected	Non-normal series
Belgium (BEL 20)	0.872	0.000	P<0.05	Rejected	Non-normal series
Italy (FTSE MIB)	0.905	0.000	P<0.05	Rejected	Non-normal series

Source: Compilation of secondary data using SPSS 21.0

The Shapiro-Wilk test results clearly indicate that all observed p-values are below 0.05, suggesting the rejection of the null hypothesis. This outcome supports the acceptance of the alternative hypothesis, which asserts that all the data series are non-normal. As a result, the analysis shifts to a non-parametric correlation approach to account for the demonstrated non-normality of the dataset.

Spearman Rank Correlation

The Spearman rank correlation matrix is given below:

Table 9: The Spearman Rank Correlation Matrix of the Return of adjusted market closing Series of India and the select six sample European Stock Indices during Crisis Period

Countries and Representative Indices	India (S&P BSE SENSEX)	Germany (DAX PERFORMANCE-INDEX)	UK (FTSE 100)	France (CAC 40)	Netherland (EURONEXT 100)	Belgium (BEL 20)	Italy (FTSE MIB)
India (S&P BSE SENSEX)	1.000	0.415** (0.000)	0.346** (0.000)	0.373** (0.000)	0.380** (0.000)	0.441** (0.000)	0.388** (0.000)
Germany (DAX PERFORMANCE-INDEX)	0.415** (0.000)	1.000	0.883** (0.000)	0.923** (0.000)	0.917** (0.000)	0.842** (0.000)	0.884** (0.000)
UK (FTSE 100)	0.346** (0.000)	0.883** (0.000)	1.000	0.937** (0.000)	0.940** (0.000)	0.865** (0.000)	0.866** (0.000)

France (CAC 40)	0.373** (0.000)	0.923** (0.000)	0.937** (0.000)	1.000	0.989** (0.000)	0.891** (0.000)	0.926** (0.000)
Netherland (EURONEXT 100)	0.380** (0.000)	0.917** (0.000)	0.940** (0.000)	0.989** (0.000)	1.000	0.926** (0.000)	0.929** (0.000)
Belgium (BEL 20)	0.441** (0.000)	0.842** (0.000)	0.865** (0.000)	0.891** (0.000)	0.926** (0.000)	1.000	0.866** (0.000)
Italy (FTSE MIB)	0.388** (0.000)	0.884** (0.000)	0.866** (0.000)	0.926** (0.000)	0.929** (0.000)	0.866** (0.000)	1.000

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

Source: Compilation of secondary data using SPSS 21.0

Very weak and low level of correlations have been found between the returns from S&P BSE SENSEX (India) and each of the return series from the indices of the six European nations. Although, positive associations have been perceived, the coefficients are less than 0.50 The p-values, displayed in parentheses beneath the coefficient values, are all below 0.01, confirming that the coefficients are statistically significant at the 1%, 5%, and 10% levels at two-tailed test. Beyond the correlations between S&P BSE SENSEX (India) and the six European indices, the matrix highlights robust interconnections among the European indices themselves, with all coefficients exceeding 0.80. The strongest relationship was identified between CAC 40 (France) and EURONEXT 100 (Netherlands). All these associations are statistically significant across the tested levels, further underscored by p-values below 0.01.

Conclusion

The findings indicate that the S&P BSE SENSEX (India) had weak positive correlations with the indices of the sampled European countries, reflecting limited co-movement during both the pre-crisis and crisis periods. Despite being statistically significant with p-values below 0.01, the correlation coefficients remained under 0.50, highlighting weak inter-market associations. In contrast, European indices demonstrated strong interlinkages, emphasizing the close integration within European markets. The correlation between Indian and European indices further weakened from the pre-crisis to the crisis phase, suggesting that even under economic stress, significant interdependence with India did not emerge. This weak correlation suggests that Indian and European markets operated largely independently, offering robust portfolio diversification opportunities for investors. Conversely, the strong correlations among European indices indicate reduced diversification benefits within the European region.

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