



## Cross-border market dynamics: Analyzing stock markets correlation among india and major asian economies with a special focus on pre-recession period

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### Abstract

The interconnectedness of stock indices has deepened considerably over recent decades, propelled by the profound influences of eco-financial liberalization and the advancing wave of market globalization. While associated markets promote efficient capital allocation and enhance market liquidity, a low degree of correlation presents opportunities for strategic investment diversification. This study examines the nature of stock market correlations among India and ten Asia-Pacific nations over a sixteen-year period (June 3, 2003, to December 30, 2019), with a specific focus on the pre-crisis years (June 3, 2003, to August 2, 2007). Using Spearman Rank correlation, appropriate for non-normal series as identified by the Shapiro-Wilk normality test, the study finds very weak correlations between the calculated returns from daily adjusted market closing series of India (BSE SENSEX) and the sample Asia-Pacific economies. In contrast, low to moderate correlations were observed among the other indices in both intervals. These findings highlight the significant potential for portfolio diversification offered by the low correlation between India's stock market and those of the Asia-Pacific region.

**Keywords:** Stock market correlation, s&p bse sensex, asian markets, pre-crisis period

### Introduction

Over the last few decades, the integration of stock indices has evolved into a fundamental feature of the modern financial system, with globalization acting as the principal catalyst for this transformation (Rodriguez and Rodrik, 2011). As assimilated platform facilitates seamless asset trading, both domestically and internationally, countries with well-established financial structure are increasingly expected to embrace deeper stock market integration. The interconnectivity of capital markets holds significant importance for both macroeconomic policy perspective and investment strategies. Investors always seek to diminish market-specific risks and capitalize on heterogeneous assets maintaining the investment profile more diverse. This strategy proves advantageous because stock indices from different countries exhibit less-than-perfect correlation, enabling a reduction in portfolio risk while preserving competitive returns.

Hence, the study of stock market cointegration is crucial in understanding the intricate interdependencies among the global markets, particularly in the era of increasing cross-border speculations. Correlation analysis provides preliminary insights into market integration dynamics and risk diversification strategies. Countries with greater economic integration characterized by increased trade involvement and harmonized economic indicators, often result in stronger stock market interconnections (Pretorius (2002). While international diversification of portfolio assets can improve the risk-reward ratio, the benefits diminish when equity markets are termed "cointegrated," or "correlated" as high co-movement reduces diversification advantages.

Stock market integration delivers significant advantages, such as enhanced liquidity, improved investor access, and

increased market efficiency, fostering economic growth and resilience. However, heightened financial interconnectedness introduces complexities, particularly during periods of heightened market volatility, when rising global correlations diminish diversification benefits precisely when they are most needed (Solnik *et al.*, 1996)<sup>[9]</sup>. The 2008 financial crisis underscored the vulnerability of integrated markets to systemic shocks, as disruptions originating in the U.S. housing sector rapidly propagated globally, amplifying economic instability. These dynamics highlight the critical role of sophisticated risk management frameworks in mitigating systemic risks and preserving global financial resilience in an increasingly interconnected economic landscape.

### Review of Past Studies and Research Gap

Limba (2005)<sup>[4]</sup> investigated the short-term and long-term financial interdependence between the stock indices of three Asian countries—India (Nifty 50), Pakistan (Karachi 100), and Sri Lanka (All Share Index)—and five developed nations: France, Germany, Japan, the UK, and the USA, over the period from July 1997 to December 2003. Using daily index return series, the study employed correlation analysis, Johansen co-integration tests, Granger causality tests, and the Vector Error Correction Model (VECM) where co-integration was observed. The findings revealed a generally low yet positive correlation between India and the sample indices, with the exception of India and Japan, which showed a negative correlation. Singh and Singh (2010)<sup>[8]</sup> investigated the long-term and short-term dynamics between the Chinese stock indices (SZSE and SSE), Indian indices (SENSEX and Nifty), and four developed markets: the USA (DJIA), the UK (FTSE), Japan (Nikkei 225), and Hong Kong (Hang Seng Index). The

study utilized daily intra-day prices over the period from January 2000 to December 2009 and employed correlation tests, Granger causality analysis, co-integration tests, and an error correction model to assess market integration. The results displayed significant positive correlations between India's two chosen indices (SENSEX and Nifty) and the other six indices, with India showing strong associations with the USA (DJIA), Hong Kong (Hang Seng Index), and China (SZSE and SSE), while moderate associations were observed with the UK (FTSE) and Japan (Nikkei 225). Granger causality analysis indicated that SENSEX was influenced by the USA (DJIA) and the UK (FTSE). Saha and Bhunia (2012) <sup>[7]</sup> analyzed the relationship between Indian stock markets (SENSEX and NIFTY) and those of leading South Asian countries to assess India's financial integration and its comparative efficiency. The study employed daily stock index data from August 2002 to August 2011, applying bivariate and multivariate cointegration tests, Granger causality tests, and correlation analysis. Indices from India (SENSEX and NIFTY) were examined alongside those from China (SSE), Japan (NIKKEI), Hong Kong (HSI), Singapore (STI), Malaysia (FTSE), Taiwan (TSEC), South Korea (KOSPI), and Indonesia (JSX). The results revealed that Indian markets exhibited moderate to high positive correlations with most sample indices, except for Japan, where associations were weak or negative. Jebran (2014) <sup>[1]</sup> studied the dynamic linkages among six Asian stock indices of Pakistan (KSE), India (BSE), Indonesia (JKSE), China (SSE), Malaysia (KLSE), and Sri Lanka (CSE) over the period from November 2003 to November 2013. Using monthly index closing data, the study calculated return series and employed a comprehensive range of statistical techniques, including unit root tests, correlation analysis, cointegration tests, and Granger causality tests, to examine the interdependencies among these stock markets. The correlation matrix revealed the strongest relationship between the Indian stock market (BSE) and the Indonesian stock market (JKSE), followed by a significant association between the Malaysian market (KLSE) and the Indonesian market (JKSE). Moderate correlations were identified between the Indian market (BSE) and the Malaysian market (KLSE), as well as between the Indian market (BSE) and the Chinese market (SSE). Kiranmai (2017) <sup>[2]</sup> conducted a comparative analysis of stock indices within the BRICS economies, focusing on inter-market relationships and volatility during period from 2004 to 2013. The study utilized index values of the BRICS nations and constructed return series. Employing statistical tools such as correlation and regression analysis, the research revealed a strong correlation between the stock markets of India and Russia, followed by India and South Africa, both demonstrating high correlation coefficients. Similarly, India and China, as well as South Africa and Russia, exhibited significant correlations. Conversely, Brazil showed the weakest correlation among the BRICS nations.

The existing body of research exposes significant gap in understanding stock market correlations, particularly in the years leading up to the 2008-09 Great Recession. Studies exploring correlations over extended periods have received limited attention, with a significant focus often restricted to regional markets. Consequently, many Asia-Pacific nations have been excluded from comprehensive analyses.

Moreover, there is a lack of robust investigations into the nature of market correlations during the phase prior to the onset of economic downturns. This study seeks to address these gaps by offering valuable insights into the correlation dynamics among the Indian stock market and ten major economies in the Asia-Pacific region over the 2003-2019 period, with a particular emphasis on the nature of association during the pre-crisis years.

### Objectives

Addressing the research gap, the study has formulated four objectives, outlined as follows:

1. Studying the statistical properties of the calculated return series derived from the daily adjusted stock market closing values of the eleven sample indices during the 16 years period from June 3, 2003 to December 30, 2019 (*Refer to Section 5.1*);
2. Examining the correlation among the calculated returns related to India's S&P BSE SENSEX and the indices of ten Asia-Pacific economies during the 16 years period (*Refer to Section 5.1*);
3. Exploring the statistical attributes of the calculated return series derived from the daily adjusted market closing values of eleven stock indices during the pre-global financial crisis period, from June 3, 2003 to August 2, 2007 (*Refer to Section 5.2*);
4. Analyzing the correlation among calculated returns related to India's S&P BSE SENSEX and the indices of ten Asia-Pacific economies during the pre-global financial crisis period (*Refer to Section 5.2*).

### Data and Methodology

#### 1. Sample Design & Data Period

Considering secondary data of daily adjusted index closing values collected from [www.yahoofinance.com](http://www.yahoofinance.com) and [www.investing.com](http://www.investing.com), the attempt has been made to study the stock market correlation analysis among the indices of India (S&P BSE SENSEX) and ten Asia-Pacific nations— China (SSE Composite), Israel (TA-125), Japan (Nikkei), Hong Kong (Hang Seng), Taiwan (TSEC), Indonesia (Jakarta Composite), South Korea (KOSPI), Australia (S&P/ASX 00), Singapore (FTSE), and Russia (MOEX Russia) during 16 years period from June 3, 2003 to December 30, 2019. The selection of sample countries is guided by the list of countries published in 2019 World Bank report, arranged in terms of GDP ranking (nominal). Judgment sampling technique was taken in selecting the sample countries from that list after considering the factors like data availability, review of past studies, etc. The study is conducted into two periodic intervals— entire study period (June 3, 2003 – December 30, 2019) and pre-global financial crisis period (June 3, 2003 – August 2, 2007).

From the closing series, the returns (in log transformation) were generated by taking the formula  $R_t = \ln P_t - \ln P_{t-1}$ , where stock market 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  $P_{t-1}$ ), allowing for a granular analysis of returns.

The identification of the pre-crisis period aligns with some prior research, including studies by Cheung *et al.* (2010) <sup>[10]</sup>, Wang (2014) etc. and the significant volatility observed in the stock indices of the selected countries during that time.

The crisis began on August 7, 2007, with significant market declines, prompting liquidity interventions by U.S. central banks.

**2. Descriptive Statistics**

Descriptive statistics are broadly classified into measures of central tendency, which include the mean, median, and mode, and measures of dispersion, such as range, variance, and standard deviation, which quantify the variability within the data. Additionally, metrics like skewness and kurtosis

evaluate the shape and distribution of the dataset.

**3. Normality of the Dataset**

An essential supposition of any parametric statistical test is that the dataset must follow a normal distribution. To assess whether the dataset meets this normality assumption, the Shapiro-Wilk test is applied. The corresponding hypotheses and decision criteria for the test are outlined as follows

**Table-1:** Hypothesis Testing and Decision Rule of Shapiro–Wilk Test

Test	Hypothesis	Decision Rule
Shapiro–Wilk Test	<ul style="list-style-type: none"> <li>▪ <math>H_0</math>: the estimated return series individually are normally distributed</li> <li>▪ <math>H_1</math>: the estimated return series individually are non-normal in nature.</li> </ul>	<ul style="list-style-type: none"> <li>▪ If <math>P\text{-Value} &lt; 0.05</math>, <math>H_0</math> is rejected and the return series are not following normal distribution</li> <li>▪ If <math>P\text{-Value} &gt; 0.05</math>, <math>H_0</math> is not rejected and the return series are normally distributed</li> </ul>

**4. Correlation Test**

Here, the correlation test serves as a preliminary measure to evaluate the relationship between the selected indices of India and ten Asia-Pacific countries. Based on the results of the Shapiro-Wilk normality test, the appropriate correlation method is chosen according to the dataset's distribution. If the data is normally distributed, the Pearson correlation test will be applied. Conversely, for non-normally distributed data, the Spearman rank correlation test will be employed. Both tests provide the

correlation coefficient that quantifies the strength and direction of the relationships between market indices, offering valuable insights into their interconnections and dependencies.

**4.1 Spearman Rank Correlation**

When the series are observed as non-normal, the Spearman Rank Correlation method serves as a suitable alternative. The rule of thumb in elucidating correlation coefficient is shown here.

**Table-2:** Table to Capture the Degree of Observed Correlation Coefficient

Correlation Coefficient Ranges	Interpretation
(±)0.00—(±)0.10	Presence of Insignificant correlation (positive/ negative)
(±)0.11—(±)0.39	Presence of Weak correlation (positive/ negative)
(±)0.40—(±)0.49	Presence of Low correlation (positive/ negative)
(±)0.50—(±)0.69	Presence of Moderate correlation (positive/ negative)
(±)0.70—(±)0.89	Presence of Strong correlation (positive/ negative)
(±) 0.90— (±)0.99	Presence of very Strong correlation (positive/ negative)
(±)1.00	Perfectly correlated (positive/ negative)

Hypothesis testing must follow the correlation analysis to determine whether the sample correlation accurately reflects the true population correlation. This involves assessing if the population correlation coefficient ( $\rho$ ) is approximately zero, signifying no significant linear relationship, or significantly different from zero, indicating a meaningful

association. The test compares the observed correlation coefficient ( $r_{obs}$ ) to the critical value ( $r_{crit}$ ), obtained from the t-distribution table based on the degrees of freedom ( $n-2$ ). This comparison forms the basis for accepting or rejecting the null hypothesis ( $H_0$ ). Formally, the Null Hypothesis ( $H_1$ ) can be stated as:

**Table 3:** Hypothesis Testing and Decision Rule of Pearson Correlation Coefficient

Test	Hypothesis	Decision Rule
Significance of Correlation Coefficient	<ul style="list-style-type: none"> <li>▪ Null hypothesis, <math>H_0: \rho=0</math>, i.e., the population correlation coefficient is not significantly different from zero;</li> <li>▪ Alternative hypothesis, <math>H_1: \rho \neq 0</math>, i.e., the population correlation coefficient is significantly different from zero</li> </ul>	<ul style="list-style-type: none"> <li>▪ If <math>r_{crit} &gt; r_{obs}</math> then study fails to reject null hypothesis concluding there exist no significant correlation</li> <li>▪ If <math>r_{crit} &lt; r_{obs}</math> then study rejects null hypothesis concluding the presence of significant correlation</li> </ul>

After estimating observed  $r$  ( $r_{obs}$ ), critical t-statistics, critical  $r$  ( $r_{crit}$ ) has to be found out from the t-table according to the particular degrees of freedom and the level of significance. In this study, all statistical calculations are performed in SPSS software package of version 21.

**Results and Explanations**

**1. Studying the statistical properties and the**

**correlation of the calculated return series among the eleven sample indices during June 3, 2003 to December 30, 2019**

**a. Descriptive Statistics**

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

**Table 4:** A Summary of Descriptive Statistics

Parameter (return of daily adjusted closing series)	Samp le Size	Minimum Statistics	Maximum Statistics	Mean Value	Standard Deviation	Variance	Skewness		Kurtosis	
							statistics	Standard Error	statistics	Stand ard Error
S&P BSE SENSEX (India)	2035	-.1810773992742481	.1441259584904207	.001259086604974	.019742623509262	.000	-0.250	.054	10.286	.108
SSE Composite Index (China)	2035	-.1323935186991752	.1652114136216888	.000327148195812	.023576406243086	.001	-0.205	.054	5.503	.108
TA-125 (Israel)	2035	-.1713360015110009	.0901738508314406	.000637816835088	.014946243193154	.000	-1.130	.054	14.567	.108
Nikkei 225 (Japan)	2035	-.1673958351384789	.1187552065060645	.000503019467785	.020141401091289	.000	-0.936	.054	7.846	.108
Hang Seng Index (Hong Kong)	2035	-.2224672365828107	.1491139438477665	.000528383876174	.020614618765753	.000	-0.311	.054	14.910	.108
TSEC weighted index (Taiwan)	2035	-.1179929764912467	.1405466399286000	.000465090990784	.017147418848707	.000	-0.510	.054	8.841	.108
Jakarta Composite Index (Indonesia )	2035	-.1437621773338945	.1855581564992766	.001242660981087	.019483204791938	.000	-0.556	.054	13.867	.108
KOSPI Composite Index (S Korea)	2035	-.1452255826046557	.1734204115390968	.000608588446763	.017578488263250	.000	-0.566	.054	13.770	.108
S&P/ASX 200 (Australia )	2035	-.1110683953985868	.0858875705296752	.000398101697638	.013462411067742	.000	-0.690	.054	7.195	.108
FTSE Singapore (Singapore)	2035	-.1215151895102618	.1682124107971973	.000424791616618	.016017464758119	.000	0.151	.054	16.176	.108
MOEX Russia Index (Russia)	2035	-.3762389632960584	.2584118060979166	.000973535280397	.027577552526470	.001	-1.003	.054	27.923	.108

**Findings**

The third column of the above table reveals that the return from the Hang Seng series (Hong Kong) has the minimum return value, while the returns from MOEX Russia (Russia) exhibits the maximum value. The relatively low standard deviation values indicate that the data points in these series are more concentrated around their respective means. The seventh column highlights the skewness values. Among the return series, only the returns from FTSE Singapore shows a positive skewness value, indicating a longer tail on the right side of the distribution curve. In contrast, the remaining series display negative skewness, reflecting longer tails on the left side. None of the skewness values equal zero,

suggesting that the return series do not conform to a normal distribution. Most of the return series exhibit skewness values between  $\pm 0.5$  and  $\pm 1$ , indicating moderate skewness. The returns from TA-125 (Israel) and MOEX Russia display skewness values exceeding  $\pm 1$ , signifying high skewness. The kurtosis values for all series are positive and exceed  $+2$ , indicating a highly peaked distribution. This leptokurtic nature confirms that the distributions deviate from normality.

**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

Name of Stock Index	Statistic	P-Value	Decision Rule	Decision on H <sub>0</sub> (H <sub>0</sub> : The return series are normally distributed.)	Inferences
S&P BSE SENSEX (India)	0.894	0.000	P<0.05	Rejected	Non-normal series

SSE Composite Index (China)	0.916	0.000	P<0.05	Rejected	Non-normal series
TA-125 (Israel)	0.886	0.000	P<0.05	Rejected	Non-normal series
Nikkei 225 (Japan)	0.906	0.000	P<0.05	Rejected	Non-normal series
Hang Seng Index (Hong Kong)	0.870	0.000	P<0.05	Rejected	Non-normal series
TSEC weighted index (Taiwan)	0.890	0.000	P<0.05	Rejected	Non-normal series
Jakarta Composite Index (Indonesia)	0.848	0.000	P<0.05	Rejected	Non-normal series
KOSPI Composite Index (S Korea)	0.874	0.000	P<0.05	Rejected	Non-normal series
S&P/ASX 200 (Australia)	0.919	0.000	P<0.05	Rejected	Non-normal series
FTSE Singapore (Singapore)	0.847	0.000	P<0.05	Rejected	Non-normal series
MOEX Russia Index (Russia)	0.819	0.000	P<0.05	Rejected	Non-normal series

The observed p-values are found to be less than 0.05, clearly indicating the rejection of the null hypothesis. This result confirms that the return series do not follow normal distribution. Consequently, due to the evidence of non-normality (p-values < 0.05), the analysis proceeds with a

non-parametric correlation method, specifically the Spearman Rank Correlation test.

**Spearman Rank Correlation Test**

The Spearman rank correlation matrix is given as follows:

**Table 6:** The Spearman Rank Correlation Matrix of the Return from adjusted market closing Series among India and the select ten sample countries' Stock Indices belong to the Asia-Pacific Region during June 3, 2003, to December 30, 2019

Indices (Countries)	S&P BSE SENSEX (India)	SSE Composite Index (China)	TA-125 (Israel)	Nikkei 225 (Japan)	Hang Seng Index (Hong Kong)	TSEC weighted index (Taiwan)	Jakarta Composite Index (Indonesia)	KOSPI Composite Index (S Korea)	S&P/ASX 200 (Australia)	FTSE Singapore (Singapore)	MOEX Russia Index (Russia)
S&P BSE SENSEX (India)	1.000	0.075** (0.001)	0.202** (0.000)	0.148** (0.000)	0.278** (0.000)	0.251** (0.000)	0.253** (0.000)	0.267** (0.000)	0.229** (0.000)	0.245** (0.000)	0.242** (0.000)
SSE Composite Index (China)	0.075** (0.001)	1.000	0.162** (0.000)	0.119** (0.000)	0.449** (0.000)	0.281** (0.000)	0.236** (0.000)	0.278** (0.000)	0.234** (0.000)	0.293** (0.000)	0.197** (0.000)
TA-125 (Israel)	0.202** (0.000)	0.162** (0.000)	1.000	0.205** (0.000)	0.408** (0.000)	0.333** (0.000)	0.323** (0.000)	0.361** (0.000)	0.348** (0.000)	0.403** (0.000)	0.368** (0.000)
Nikkei 225 (Japan)	0.148** (0.000)	0.119** (0.000)	0.205** (0.000)	1.000	0.288** (0.000)	0.310** (0.000)	0.205** (0.000)	0.346** (0.000)	0.317** (0.000)	0.321** (0.000)	0.171** (0.000)
Hang Seng Index (Hong Kong)	0.278** (0.000)	0.449** (0.000)	0.408** (0.000)	0.288** (0.000)	1.000	0.601** (0.000)	0.510** (0.000)	0.611** (0.000)	0.544** (0.000)	0.682** (0.000)	0.399** (0.000)
TSEC weighted index (Taiwan)	0.251** (0.000)	0.281** (0.000)	0.333** (0.000)	0.310** (0.000)	0.601** (0.000)	1.000	0.439** (0.000)	0.648** (0.000)	0.504** (0.000)	0.555** (0.000)	0.347** (0.000)
Jakarta Composite Index (Indonesia)	0.253** (0.000)	0.236** (0.000)	0.323** (0.000)	0.205** (0.000)	0.510** (0.000)	0.439** (0.000)	1.000	0.459** (0.000)	0.410** (0.000)	0.507** (0.000)	0.335** (0.000)
KOSPI Composite Index (S Korea)	0.267** (0.000)	0.278** (0.000)	0.361** (0.000)	0.346** (0.000)	0.611** (0.000)	0.648** (0.000)	0.459** (0.000)	1.000	0.513** (0.000)	0.572** (0.000)	0.355** (0.000)
S&P/ASX 200 (Australia)	0.229** (0.000)	0.234** (0.000)	0.348** (0.000)	0.317** (0.000)	0.544** (0.000)	0.504** (0.000)	0.410** (0.000)	0.513** (0.000)	1.000	0.548** (0.000)	0.331** (0.000)
FTSE Singapore (Singapore)	0.245** (0.000)	0.293** (0.000)	0.403** (0.000)	0.321** (0.000)	0.682** (0.000)	0.555** (0.000)	0.507** (0.000)	0.572** (0.000)	0.548** (0.000)	1.000	0.379** (0.000)
MOEX Russia Index	0.242** (0.000)	0.197** (0.000)	0.368** (0.000)	0.171** (0.000)	0.399** (0.000)	0.347** (0.000)	0.335** (0.000)	0.355** (0.000)	0.331** (0.000)	0.379** (0.000)	1.000

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

It reveals that the returns from the S&P BSE SENSEX (India) exhibit very weak associations with the returns of all indices from the ten Asia-Pacific countries. While the correlations are positive, the coefficient values remain below 0.3. Among the observations, the returns from the SENSEX (India) show the weakest association with the SSE Composite Index (China) and the strongest with the Hang Seng Index (Hong Kong). P-values, displayed in parentheses below the coefficient values, are all less than 0.01, signifying statistical significance at the 1%, 5%, and 10% levels at two-tailed test.

The matrix also highlights correlations between the S&P BSE SENSEX (India) and the ten Asia-Pacific countries, alongside the interrelationships among the Asia-Pacific indices themselves. A mixed pattern emerges. Weak associations are observed for the returns of the SSE Composite Index (China), TA-125 (Israel), Nikkei 225 (Japan), and MOEX Russia, with all coefficient values  $\leq$

0.4. Conversely, strong associations are noted among the returns of the Hang Seng Index (Hong Kong), TSEC Weighted Index (Taiwan), Jakarta Composite Index (Indonesia), KOSPI Composite Index (South Korea), S&P/ASX 200 (Australia), and FTSE Singapore (Singapore), with coefficients exceeding 0.5. All these correlations are also statistically significant at the 1%, or 5% significance levels, with p-values less than 0.01.

**Exploring the statistical attributes and the correlation of the calculated return series of eleven stock indices during the pre-financial crisis period from June 3, 2003 to August 2, 2007**

**Descriptive Statistics**

The descriptive statistics table of the calculated return series of the daily adjusted stock market closing values of eleven stock indices, including India’s S&P BSE SENSEX is as follows

**Table 7:** A Summary of Descriptive Statistics

Parameters	Sample Size	Minimum Statistics	Maximum Statistics	Mean Value	Standard Deviation	Variance	Skewness		Kurtosis	
							statistic	Standard Error	statistic	Standard Error
S&P BSE SENSEX (India)	564	-0.1810773992742481	0.1172372924185337	0.002765485984400	0.021072991546235	0.000	-1.082	0.103	12.733	0.205
SSE Composite Index (China)	564	-0.1130379061373988	0.1031627882446285	0.001839079797371	0.021917226428970	0.000	0.330	0.103	5.010	0.205
TA-125 (Israel)	564	-0.0437558475835834	0.0563776266571022	0.001587229878287	0.013009650934448	0.000	-0.010	0.103	1.526	0.205
Nikkei 225 (Japan)	564	-0.0850672385808076	0.0788373987816856	0.001213924737498	0.015868919849465	0.000	-0.316	0.103	3.982	0.205
Hang Seng Index (Hong Kong)	564	-0.0764548036486895	0.0480158377978773	0.001494156626601	0.013354482881123	0.000	-0.398	0.103	3.179	0.205
TSEC weighted index (Taiwan)	564	-0.1066261806834566	0.0530677421871482	0.001150406755180	0.015957559028687	0.000	-1.252	0.103	8.055	0.205
Jakarta Composite Index (Indonesia)	564	-0.1004813758238511	0.0774445119874448	0.002674583210618	0.018137099516848	0.000	-0.690	0.103	4.796	0.205
KOSPI Composite Index (South Korea)	564	-0.0805512258587827	0.0582635170062403	0.001893481401264	0.016723718349006	0.000	-0.634	0.103	2.654	0.205
S&P/ASX 200 (Australia)	564	-0.0584330413756421	0.0324939199260511	0.001216698936402	0.008980162982712	0.000	-1.071	0.103	5.121	0.205
FTSE Singapore (Singapore)	564	-0.0792820748299819	0.0553537935235401	0.001667209628576	0.012763358655823	0.000	-0.320	0.103	4.379	0.205
MOEX Russia Index (Russia)	564	-0.1064367940386749	0.1204559009601601	0.002491377330049	0.027393718979232	0.001	-0.382	0.103	3.414	0.205

The descriptive statistics table displays that the dataset comprises a total of 564 observations, with no missing values in any series. Among the indices, the returns from MOEX Russia exhibits the highest value, while the S&P BSE SENSEX records the lowest return value. Standard deviation scores for all return series are below 1, indicating that the observations are closely clustered around their respective mean values. A negative skewness value for the return from the SSE Composite Index (China) is observed, whereas positive skewness is observed for the remaining series. Negative skewness indicates a longer left tail, while positive skewness suggests a longer right tail in the

distribution. All return series display positive kurtosis values, with most exceeding 3, indicating leptokurtic distributions characterized by sharper peaks. However, the return series for the TA-125 (Israel) and KOSPI Composite Index (South Korea) have kurtosis below 3, signifying platykurtic distributions with flatter peaks. Overall, the descriptive statistics indicate that none of the return series follows normal distribution.

**Shapiro-Wilk Test of Normality**

The p-values, decision criteria, and corresponding inferences of the Shapiro-Wilk test are presented as follows:

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

Name of Stock Index	Statistic	P-Value	Decision Rule	Decision on H <sub>0</sub> (H <sub>0</sub> : The return series are normally distributed.)	Inferences
S&P BSE SENSEX (India)	0.889	0.000	P<0.05	Rejected	Non-normal series
SSE Composite Index (China)	0.917	0.000	P<0.05	Rejected	Non-normal series
TA-125 (Israel)	0.981	0.000	P<0.05	Rejected	Non-normal series
Nikkei 225 (Japan)	0.950	0.000	P<0.05	Rejected	Non-normal series
Hang Seng Index (Hong Kong)	0.963	0.000	P<0.05	Rejected	Non-normal series
TSEC weighted index (Taiwan)	0.900	0.000	P<0.05	Rejected	Non-normal series
Jakarta Composite Index (Indonesia)	0.934	0.000	P<0.05	Rejected	Non-normal series
KOSPI Composite Index (S Korea)	0.963	0.000	P<0.05	Rejected	Non-normal series
S&P/ASX 200 (Australia)	0.942	0.000	P<0.05	Rejected	Non-normal series
FTSE Singapore (Singapore)	0.944	0.000	P<0.05	Rejected	Non-normal series
MOEX Russia Index (Russia)	0.936	0.000	P<0.05	Rejected	Non-normal series

The results from the Shapiro-Wilk test indicate that all observed p-values are below 0.05, prompting the rejection of the null hypothesis, which assumes that the return series follow a normal distribution. As a result, the alternative hypothesis of non-normality is accepted. Given this outcome, a non-parametric correlation method is deemed

appropriate. Therefore, the Spearman Rank Correlation test is utilized to assess the correlation among the return series.

**Spearman Rank Correlation Test**

The Spearman rank correlation matrix is tabulated as follows:

**Table-9:** The Spearman Rank Correlation Matrix of the Return of adjusted market closing Series among India and the select ten sample countries' Stock Indices belong to the Asia-Pacific Region during Pre-Crisis Period

Indices (Countries)	S&P BSE SENSEX (India)	SSE Composite Index (China)	TA-125 (Israel)	Nikkei 225 (Japan)	Hang Seng Index (Hong Kong)	TSEC weighted index (Taiwan)	Jakarta Composite Index (Indonesia)	KOSPI Composite Index (S Korea)	S&P/ASX 200 (Australia)	FTSE Singapore (Singapore)	MOEX Russia Index (Russia)
S&P BSE SENSEX (India)	1.000	0.075 (0.077)	0.213** (0.000)	0.316** (0.000)	0.396** (0.000)	0.310** (0.000)	0.369** (0.000)	0.369** (0.000)	0.271** (0.000)	0.375** (0.000)	0.275** (0.000)
SSE Composite Index (China)	0.075 (0.077)	1.000	0.052 (0.214)	0.080 (0.058)	0.222** (0.000)	0.122** (0.000)	0.190** (0.000)	0.157** (0.000)	0.130** (0.000)	0.185** (0.000)	0.077 (0.067)
TA-125 (Israel)	0.210** (0.000)	0.052 (0.214)	1.000	0.332** (0.000)	0.354** (0.000)	0.234** (0.000)	0.286** (0.000)	0.288** (0.000)	0.290** (0.000)	0.344** (0.000)	0.252** (0.000)
Nikkei 225 (Japan)	0.316** (0.000)	0.080 (0.058)	0.332** (0.000)	1.000	0.511** (0.000)	0.512** (0.000)	0.390** (0.000)	0.569** (0.000)	0.520** (0.000)	0.541** (0.000)	0.275** (0.000)
Hang Seng Index (Hong Kong)	0.396** (0.000)	0.222** (0.000)	0.354** (0.000)	0.511** (0.000)	1.000	0.527** (0.000)	0.531** (0.000)	0.563** (0.000)	0.458** (0.000)	0.625** (0.000)	0.336** (0.000)
TSEC weighted index (Taiwan)	0.310** (0.000)	0.122** (0.000)	0.234** (0.000)	0.512** (0.000)	0.527** (0.000)	1.000	0.408** (0.000)	0.599** (0.000)	0.402** (0.000)	0.498** (0.000)	0.243** (0.000)
Jakarta Composite Index (Indonesia)	0.369** (0.000)	0.190** (0.000)	0.286** (0.000)	0.390** (0.000)	0.531** (0.000)	0.408** (0.000)	1.000	0.431** (0.000)	0.397** (0.000)	0.512** (0.000)	0.252** (0.000)
KOSPI Composite Index (S Korea)	0.369** (0.000)	0.157** (0.000)	0.288** (0.000)	0.569** (0.000)	0.563** (0.000)	0.599** (0.000)	0.431** (0.000)	1.000	0.462** (0.000)	0.532** (0.000)	0.290** (0.000)
S&P/ASX 200 (Australia)	0.271** (0.000)	0.130** (0.000)	0.290** (0.000)	0.520** (0.000)	0.458** (0.000)	0.402** (0.000)	0.397** (0.000)	0.462** (0.000)	1.000	0.478** (0.000)	0.348** (0.000)
FTSE Singapore (Singapore)	0.375** (0.000)	0.185** (0.000)	0.344** (0.000)	0.541** (0.000)	0.625** (0.000)	0.498** (0.000)	0.512** (0.000)	0.532** (0.000)	0.478** (0.000)	1.000	0.321** (0.000)
MOEX Russia Index (Russia)	0.275** (0.000)	0.077 (0.067)	0.252** (0.000)	0.275** (0.000)	0.336** (0.000)	0.243** (0.000)	0.252** (0.000)	0.290** (0.000)	0.348** (0.000)	0.321** (0.000)	1.000

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

The correlation matrix presents very weak associations between the returns from S&P BSE SENSEX (India) and

the ten indices in the sample. Although all correlations are positive, the coefficients are less than 0.4, indicating very

poor correlations. The p-values, presented in parentheses below the coefficient values, are all less than 0.01, signifying that the coefficients are statistically significant at the 1%, 5%, and 10% levels in a two-tailed test, except for the correlation with SSE Composite Index (China), where the p-value exceeds 0.10, indicating an insignificant association. The returns from SSE Composite Index (China), MOEX Russia, and TA-125 (Israel) exhibit weak associations with the returns of the other indices. Specifically, there is no significant association between the returns of SSE Composite Index (China) and TA-125 (Israel) or MOEX Russia, as their p-values exceed 0.10, confirming the lack of statistical significance at the 1%, 5%, and 10% levels. Moderate correlations are found among the returns from TSEC Index (Taiwan), Jakarta Composite Index (Indonesia), S&P/ASX 200 (Australia), and FTSE Singapore, with correlation coefficients less than 0.6. However, these associations are statistically significant at the 1%, or 5% significance levels, as indicated by the p-values being less than 0.01.

### Conclusion

It is evident that the returns from India's S&P BSE SENSEX consistently demonstrated low correlations with the returns from ten Asia-Pacific indices throughout the sixteen-year study, from June 3, 2003 to December 30, 2019. While positive and statistically significant correlations were observed, the strength of these associations remained weak, with coefficients below 0.3. During the pre-crisis period (June 3, 2003, to August 2, 2007), the nature of these associations did not change meaningfully. In the pre-crisis period weak correlations persisted between the returns from BSE SENSEX (India) and the ten Asia-Pacific indices, with slightly higher but still weak coefficients below 0.4, indicating feeble associations. Beyond the correlation analysis between India and the Asia-Pacific nations, the matrix also highlights the interrelationships among the ten Asia-Pacific indices during these two study intervals. The findings show that none of the indices exhibited very strong associations with others, as no correlation coefficients exceeded 0.7. The returns from SSE Composite Index (China), MOEX Russia, and TA-125 (Israel) displayed low correlations with the other indices, whereas the remaining indices showed moderate associations. The observed low correlation between India's stock market and the Asia-Pacific indices suggests significant potential for portfolio diversification. This provides global investors with a buffer against synchronized market downturns, enabling them to mitigate risk by investing in markets with less interconnected dynamics. Given the consistently low associations between returns from SENSEX (India) and other Asian indices, India emerges as a favorable investment destination, offering robust opportunities for diversification benefits.

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