Do Major and Emerging Economies Co-integrate with, Influence Over, or Make a Volatility Spillover Effect on the Indian Stock Market? An Empirical Analysis

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Abstract

Purpose : In order to protect the poor and rural investors, who make up 30% of all investors, it became imperative to look into the degree of dependency between the Indian stock market and other major economic stock markets once the pandemic began to threaten the world. There were 10 million investors in rural India out of 33.7 million investors in the country overall. Thus, the purpose of this study was to examine how India's economic reforms have affected other major economies and how dependent they are on India.

Methodology : The Augmented Dickey–Fuller test was used to determine whether a unit root exists. The Johnson co-integration test, Granger causality test, GARCH Model, serial correlation test, heteroskedasticity test, and Histogram normality test were used to determine whether an ARCH effect existed. The GARCH, GARCH M, and EGARCH models were used to determine whether volatility spillover effects existed.

Findings : We discovered that with the help of these instruments, the Indian stock market is more dependent on the Japanese stock market than it is on the Russian stock market.

Practical Implications : This would make it possible for government organizations to draft trading laws that would permit investors from both home and abroad to transact on the Indian stock exchanges. The co-integration era might influence how the government writes laws governing investment strategies and capital market investment restrictions.

Originality : A thorough analysis of the post-reform period is necessary, in contrast to earlier research on co-integration, as this will provide a comprehensive picture of the interdependence between the markets. A substantial sample of economies for the study must be gathered, which is another requirement. Three hundred eighty-four monthly data points were gathered throughout the post-economic reform era in order to compare 20 economies with India.

Keywords : co-integration, volatility spillover, GARCH, EGARCH, granger causality

JEL Classification Codes : C01, C32, G15

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India liberalized its economy in 1991. There has been better growth after its economy has undergone considerable reforms. The World Bank statistics portal states that after economic reforms, India's GDP has increased eight and a half times, from 0.3 trillion US dollars in 1991 to 2.72 trillion US dollars in 2018. Therefore, both the number of foreign and domestic investors in India has increased, making the country a desirable destination for investment. Furthermore, the stock market and the Indian economy are susceptible to

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any significant event that occurs in a big economy. Therefore, especially in light of India's economic reforms, it is imperative to research the co-integration and dependency between the Indian stock market and industrialized economies as well as a few chosen developing economies. In order to protect the impoverished and rural investors, who make up 30% of all investors, it became imperative to look at the extent of dependency between the stock markets of India and other major economies once the epidemic began to threaten the world. A total of 10 million investors are living in rural India among the total of 33.7 million investors in India. Thus, the purpose of this study is to examine how India's economic reforms have affected other major economies and how dependent they are on India. Previous research was limited to a few years post-remap and a select group of large economies. Therefore, in order to fully understand the interconnectedness between the markets, a thorough analysis of the post-reformation era is needed. Another prerequisite that must be met is gathering a sizable sample of economies for the study. We decide to use 384 monthly data points from the post-economic reform era to compare 20 economies with India.

Review of Literature

The majority of research conducted during that period that looked at co-integration, interdependence, or the spillover impacts of volatility did not restrict their investigation to post-economic events. Few recent studies that concentrated on the study years have been conducted.

Sachdeva et al. (2021) found that their study indicated that investors can develop diversified portfolio strategies to hedge their risk. Their analysis supported the notion that the US and Indian stock markets are co-integrating. The absence of co-integration between the stock markets of Brazil, Indonesia, and India was also discovered. Patel (2017) found that there was a co-integration between the Indian stock market and the US, UK, Japan, Korea, Taiwan, Brazil, and Hong Kong stock markets. Bhattacharjee and Swaminathan (2016) observed that the co-integration of India with other stock markets was increasingly improving over the years with financial liberalization. Furthermore, they discovered that, compared to the other sub-sample periods, the Indian stock market was more accountable to the other Asian stock markets during the recession era.

Mitraand Bhattacharjee (2015), the authors, surveyed the existing literature on linkages between international stock markets. They provide current coverage of research on the significance and motivators of relationships in the stock market. Additionally, a discussion of modern techniques for assessing the degree of integration between global stock markets was included in the paper. Babu and Srinivasan (2014) analyzed the relationship between spot and future prices in the Indian commodity market. The results of the study gave evidence that the prices of the commodities during the study period were independent. Bhatia and Ramasubramanian (2019) examined the cointegration among India, the US, Japan, China, France, Dubai, and Germany using multivariate co-integration techniques. The time of the study was between 2009 and 2018. The Johansen co-integration test was used to determine whether these markets were co-integrated. The markets included in the analysis were shown to have a short-term causal relationship and a long-term co-integrating association.

Kumara Kannan and Jesiah (2022) found that the US stock market and Hong Kong stock market showed co-integration with the Indian stock market during the maximum number of major stock market crashes. Vohra (2016) studied the co-movement among the indices of the Bombay Stock Exchange (BSE). He found there is a co-movement among a few indices of BSE. Gulzar et al. (2019) took India, China, Pakistan, Malaysia, Russia, and Korea as emerging Asian markets, and they analyzed daily stock returns from these markets between July 1, 2005 and June 30, 2015. They used the GARCH BEKK model, the vector error correction model, and the Johansen and Juselius co-integration test. They discovered that the US and emerging stock markets were long-term co-integrators and that this level of integration had risen since the crisis. Additionally, they discovered that a shock to the US market temporarily impacted the returns of developing Asian stock markets. During the crisis, there were volatility spillover effects between the KSE and BSE sensex.

Kumar (2019) studied the volatility spillover effects on the Indian stock market from China, Hong Kong, and Japan using the VAR-based GARCH model. He looked at the information from 2000 to 2017. He discovered that there was a notable degree of volatility in the Indian stock market, which was supported by the volatility of the Chinese stock market as well as the shock to the Hong Kong and Japanese stock markets. Hung (2019) examined return and volatility spillover effects between China and South Asian countries, viz., Vietnam, Thailand, Singapore, and Malaysia. He discovered that the volatility of the Chinese stock market significantly impacted the four South Asian markets. The pre-and post-global financial crisis periods covered by the study are as follows. Ozen and Tetik (2019) studied to determine whether the stock indices of developed and developing countries react similarly to the price movements in the Dow Jones Industrial Average (DJIA). The results indicated that the developed and emerging stock markets reacted differently to DJIA. Jaisinghani (2018) examined the nature of the co-integration of Indian markets with those of the developed markets. He seized the UK, Indonesia, Italy, France, Germany, India, and Turkey and used the time from January 2009 to August 2016. He discovered that the Indian stock market did not co-integrate with the markets that were chosen for the study, with the exception of the German stock market, with which the Indian stock market had a considerable co-integration.

A nation's economic system is rephrased when economic reforms are implemented. Therefore, there will be value added to the research by doing a unique study on co-integration and interdependence that focuses on post-economic reforms and includes a large number of economies.

Research Methodology

The basic characteristics of the data used for the study were described in this paper using descriptive statistics. The existence of the unit root was tested using the test of stationarity, the Johansen co-integration test, the Granger causality test, the GARCH model to determine volatility, and the GARCHM and E GARCH models were tested.

Data Used

The purpose of this study is to look into how the top 20 economies in the world are affected by the Indian stock market. The top 20 economies in the world that are included in our analysis, along with the corresponding key indexes and abbreviations for each, are as follows:

(1) United States – S&P 500 Index–abbreviated as GSPC.

(2) United Kingdom – FTSE 100 Index– abbreviated as FTSE100.

(3) Japan – Nikkei 225 Index– abbreviated as Nikkei 225.

(4) France – CAC 40 Index– abbreviated as CAC 40.

(5) Germany – DAX Performance Index– abbreviated as DAX.

(6) Singapore – FTSE Straits Times Singapore Index– abbreviated as STI.

(7) Canada– S&P TSX Composite Index– abbreviated as TSX.

(8) Hongkong– HangSeng Index– abbreviated as HIS.

(9) Brazil –BovespaBrasil Sao Paulo Stock Exchange Index for Brazil –abbreviated as BSPI.

(10) South Africa –South Africa 40 Index for South Africa–abbreviated as Sa40.

(11) Russia – Modulation and Coding Scheme Index – abbreviated as MCSI.

(12) China –SSE Composite Index–abbreviated as CCI.

(13) South Korea – KOSPI Index – abbreviated as KOSPI.

(14) Taiwan – TSEC Taiwan 50 Index – abbreviated as TSEC50.

(15) Netherlands – Netherlands Amsterdam Exchange Index – abbreviated as AEX.

(16) Denmark – OMX Copenhagen 25 Index – abbreviated as OMXC25.

(17) Norway – Oslo Stock Exchange all shares index – abbreviated as OSEAX.

(18) Sweden – OMX Stockholm 30 Index –abbreviated as OMXS30.

(19) Finland – OMX Helsinki 25 Index – abbreviated as OMXH25.

(20) Iceland – All shares Index –abbreviated as IASI.

The rationale behind choosing these 20 economies' stock markets is as follows:

- Six countries are identified based on GDP in figures. They are the USA, China, Japan, Germany, the UK, and France.
- Nowadays, India gives more importance to BRICS for foreign trade. So, Brazil, Russia, and South Africa are included.
- The powerful economies in the Asia continent are Singapore, Hong Kong, South Korea, and Taiwan. These four countries are called Asian Tiger Economies.
- Two countries are among the 20 largest producers who put more FDI into India. They are Canada and the Netherlands.
- Nowadays, India is closer to Nordic countries. So, these five countries are also included.
- So, these 14 countries are finalized for studying the interdependenceof the Indian Stock Market.

Investigating the Interdependence

Descriptive Statistics

Table 1 tabulates the descriptive statistics of all the selected indices taken for the study. The India Sensex exhibits a negative mean monthly return, while all other indices display a positive mean monthly return. Singapore, Japan, and India have negative median returns. India received minimum monthly returns of 53.4% and maximum monthly returns of 25.3%, which is equivalent to the maximum monthly returns in Japan and the minimum monthly returns in Taiwan. The volatility of India was almost equivalent to the volatility of Singapore, South Korea, Russia, and Finland. Skewness of the US, UK, Germany, France, Canada, Netherlands, Taiwan, Russia, Hong Kong, South Africa, Denmark, Norway, Sweden, Finland, and Iceland are negative values, so they are skewed left. This means that even though monthly returns often fall within the range of the average, occasionally, they may fall short of it. The remaining indices have a rightward skewness. All indexes have leptokurtic kurtosis, which indicates that their volatility is higher.

Table 1. ***Descriptive Statistics of all Indices***

	Mean	Median	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
Sensex	–0.006	–0.008	0.242	–0.262	0.062	–0.012	5.682
GSPC	0.007	0.012	0.119	–0.186	0.043	–0.805	5.049
FTSE 100	0.003	0.008	0.116	–0.149	0.038	–0.797	4.803
Nikkei 225	–0.002	–0.002	0.272	–0.121	0.054	0.802	5.554
DAX	0.007	0.015	0.157	–0.226	0.053	–0.810	5.456
CAC 40	0.004	0.010	0.183	–0.189	0.049	–0.519	4.595
TSX	0.005	0.009	0.106	–0.195	0.039	–1.495	9.131
S T I	0.002	–0.007	0.504	–0.205	0.067	2.231	17.514
SCI	0.004	0.007	0.243	–0.283	0.076	–0.596	5.269
KOSPI	0.006	0.009	0.144	–0.267	0.053	–0.702	6.095
AEX	0.005	0.010	0.179	–0.209	0.053	–0.461	5.007
TSEC 50	0.007	0.014	0.199	–0.339	0.074	–1.130	6.744
MSCI	0.003	0.012	0.266	–0.254	0.061	–0.303	5.697
HIS	0.005	0.011	0.127	–0.220	0.049	–1.109	6.460
Bovespa	0.008	0.008	0.157	–0.355	0.067	–0.978	7.033
SA 40	0.009	0.010	0.142	–0.161	0.046	–0.162	3.893
OMX C20I	0.009	0.012	0.185	–0.208	0.049	–0.747	5.749
OSEAX	0.010	0.014	0.140	–0.274	0.054	–1.559	8.804
OMXS30I	0.006	0.010	0.157	–0.185	0.046	–0.732	4.999
OMX HEXI	0.006	0.011	0.227	–0.187	0.052	–0.435	5.293
OMX IASI	0.001	0.012	0.164	–1.256	0.104	–8.431	99.230

Testing for the Existence of Unit Root in the Time Series of 20 Economies'Indices and the Indian Stock Market Index

To test whether time series indices have unit roots, the most popular test among researchers is the Augmented Dickey–Fuller (ADF) test.

Let X_t be a time series. The ADF Test finds the following equation :

$$\Delta X_t = \alpha + \beta\, t + (\rho - 1)\, X_{t-1} + \sum_{i=1}^{k-1} \varphi_i \Delta X_{t-i} + \varepsilon_i \text{ and testing whether } \rho = 1.$$

In this equation, $\Delta = L$ (where L is a lag operator); t is a trend; and ε_i is a white noise term. Phillips and Perron (1988) tests were also conducted, which allow for more general error terms (heteroskedastic and autocorrelated errors).

The ADF is a unit root test for stationarity. Unit roots can cause unpredictable results in time series analysis. The unit root of the time series used for the investigation is the null hypothesis for the ADF test. An alternate hypothesis for the ADF test is that the time series used for the investigation contains no unit root. Another popular test for determining if unit roots exist in time series is the Philips Perron Test.

Table 2. *Test of Stationarity : Unit Root Test of all Indices – ADF Test Results*

	ADF Test Value (Variable in Levels)	ADF Test Value (Variable in First Differences)	PP Test Value (Variable in Levels)	PP Test Value (Variable in First Differences)
Sensex	–7.47**	–10.70**	–14.82**	–13.49**
GSPC	–9.65**	–14.44**	–28.27**	–47.38**
FTSE 100	–26.64**	–14.68**	–26.39**	–98.89**
Nikkei 225	–9.99**	–14.67**	–10.27**	–26.39**
DAX	–9.35**	–12.06**	–23.04**	–27.12**
CAC 40	–21.34**	–11.80**	–21.34**	–108.19**
TSX	–13.65**	–12.46**	–35.44**	–47.36**
S T	7.67**	5.93**	20.68**	8.95**
SCI	7.74**	6.81**	23.97**	3.66**
KOSPI	–1.21**	–8.83**	–4.29**	–13.01**
TSEC 50	–9.26**	–15.13**	–15.64**	–37.57**
MSCI	–6.10**	–12.27**	–14.57**	–17.23**
HIS	–6.77**	–11.50**	–12.97**	–20.68**
AEX	–26.99**	–12.76**	–27.69**	–44.27**
Bovespa	–26.99**	–12.76**	–27.69**	–44.27**
SA 40	–10.22**	–11.47**	–19.27**	–130.07**
OMX C20I	–17.87**	–16.43**	–18.10**	–85.60**
OSEAX	–12.87**	–12.79**	–12.87**	–76.07**
OMXS30I	–9.34**	–12.48**	–18.40**	–183.56**
OMX HEXI	–15.94**	–12.21**	–15.90**	–102.46**
OMX IASI	–7.41**	–17.52**	–13.07**	–78.89**

Note. The critical values are as follows:

1. At 99% confidence level –3.4500
2. At 95% confidence level –2.8701
3. At 90% confidence level –2.5714

A **indicates rejection of the null hypothesis of non-stationarity at a 1% level of significance, at a 5% level of significance, and 10% level of significance. Table 2 displays the unit root test results for all 20 indices from the ADF tests and PP Tests. The results indicate null hypothesis of the existence of non-stationarity can be rejected for all stock indices expressed in levels themselves. Also, the null hypothesis of the existence of non-stationarity can be rejected if the indices data are converted into first differences. Therefore, we may conclude that all five stock indices are integrated of order zero.

Testing for Co-integration Among the 20 Economies' Indices and the Indian Stock Market Index

For testing co-integration, testing the existence of the unit root is the first step. We have already tested all five indices for the existence of the unit root. Both the ADF and PP tests confirm the absence of unit roots in all the five indices' data series. Unit root tests suggest that they are all differenced at zero.

Hence, the co-integration test may now be used to determine whether or not these stock markets are co-integrated. The Johansen and Juselius co-integration test is used to assess co-integration. There will be less opportunity for arbitrage if the test demonstrates that these markets are co-integrated.

Table 3. *The Johansen Cointegration Test Results*

Co-integration of India With	Number of Co-integrating Vectors	The Trace Value		The Maximal Eigenvalue	
		Test Statistics	CV (95%)	Test Statistics	CV (95%)
US S & P 500	None*	122.8729	15.4947	65.8094	14.2646
	At most 1*	57.0634	3.8414	55.5594	3.8414
UK FTSE100	None*	99.2438	15.4947	68.4356	14.2646
	At most 1*	30.8081	3.8414	30.8081	3.8414
Japan Nikkei 225	None*	113.1826	15.4947	91.6174	14.2646
	At most 1*	21.5652	3.8414	21.5652	3.8414
Germany DAX	None*	136.2345	15.4947	80.5000	14.2646
	At most 1*	55.7344	3.8414	55.7344	3.8414
France CAC40	None*	111.2599	15.4947	68.0853	14.2646
	At most 1*	43.1745	3.8414	43.1745	3.8414
Canada TSX	None*	151.8022	15.4947	87.4240	14.2646
	At most 1*	64.3781	3.8414	64.3781	3.8414
Singapore STI	None *	67.8547	15.4947	63.0338	14.2646
	At most 1*	6.8208	3.8414	6.8208	3.8414
China SCI	None *	90.3050	15.4947	75.5197	14.2646
	At most 1*	14.7852	3.8414	14.7852	3.8414
Korea KOSPI	None*	89.2281	15.4947	71.0454	14.2646
	At most 1*	18.1821	3.8414	18.1821	3.8414
Taiwan TSEC50	None*	105.2400	15.4947	67.2477	14.2646
	At most 1*	37.9822	3.8414	37.9822	3.8414
Russia MSCI	None*	100.1075	15.4947	55.7081	14.2646
	At most 1*	44.3983	3.8414	44.3983	3.8414
Hong Kong HIS	None*	135.4976	15.4947	76.6454	14.2646
	At most 1*	58.8521	3.8414	58.8521	3.8414
Netherlands AEX	None*	118.4120	15.4947	76.2057	14.2646
	At most 1*	42.2062	3.8414	42.2062	3.8414
Brazil BOVESPA	None*	67.3000	15.4947	63.1852	14.2646
	At most 1*	4.1147	3.8414	4.1147	3.8414
South Africa SA 40	None*	138.9212	15.4947	83.9681	14.2646
	At most 1*	55.9530	3.8414	55.9530	3.8414
Demark OMXC20I	None*	121.0432	15.4947	71.7562	14.2646
	At most 1*	48.2869	3.8414	47.7658	3.8414
Norway OSEAX	None*	68.1771	15.4947	54.1605	14.2646
	At most 1*	34.0165	3.8414	34.0165	3.8414
Sweden OMXS30I	None*	125.2162	15.4947	69.0817	14.2646
	At most 1*	56.1345	3.8414	56.1345	3.8414
Finland OMXHEXI	None*	130.5746	15.4947	71.4375	14.2646
	At most 1*	59.1371	3.8414	59.1371	3.8414

Iceland OMXIASI	None*	63.3774	15.4947	38.8854	14.2646
	At most 1*	24.4920	3.8414	24.4920	3.8414

Note.* Through the trace values, at a 95% confidence level, the null hypothesis of "No co-integration between India Sensex and any other specific index taken for study" is rejected.

The findings of the Johansen co-integration test are reported in Table 3. The Indian stock market and the other stock indices used for the study show co-integration, according to the same table. Johansen and Juselius (1990) recommended the use of trace statistics when these two statistics provide conflicting results. In this table, if the inference of trace statistic and max eigenvalue contradict, the trace statistics are finally considered.

Testing the Causality Using the Granger Causality Test

Granger causality is assumed to exist in at least one sense when two-time series co-integrate. That is, Granger causes the other series in at least one of the two. It seems obvious that for a series to be co-integrated, they need to be "related"— that is, in the Granger-causality sense. The markets that are represented by the indices are co-integrated when the Granger causality test is applied, and one index causes another index, or an index is a Granger induced by another index. The Granger causality test results are depicted in Table 4.

Table 4. ***Granger Causality Test Results Summary***

Null Hypothesis:	Obs.	*F*-Statistic	Prob.
_2_US_GSP does not Granger Cause _1_INDIA_SENSEX	**384**	**21.7758**	**0.0000**
_1_INDIA_SENSEX does not Granger Cause _2_US_GSP		0.17621	0.8385
_3_UK_FTSE_100 does not Granger Cause _1_INDIA_SENSEX	337	1.45811	0.2342
_1_INDIA_SENSEX does not Granger Cause _3_UK_FTSE_100		0.77472	0.4617
_4_JAPAN_NIKKEI_225 does not Granger Cause _1_INDIA_SENSEX	**384**	**14.7107**	**0.0000**
_1_INDIA_SENSEX does not Granger Cause _4_JAPAN_NIKKEI_225		0.80941	0.4459
_5_GERMANY_DAX does not Granger Cause _1_INDIA_SENSEX	**384**	**20.7820**	**0.0000**
_1_INDIA_SENSEX does not Granger Cause _5_GERMANY_DAX		1.04403	0.3531
_6_FRANCE_CAC_40 does not Granger Cause _1_INDIA_SENSEX	384	1.42339	0.2422
_1_INDIA_SENSEX does not Granger Cause _6_FRANCE_CAC_40		0.70591	0.4943
_7_CANADA_TSX does not Granger Cause _1_INDIA_SENSEX	384	2.41969	0.0904
_1_INDIA_SENSEX does not Granger Cause _7_CANADA_TSX		0.02192	0.9783
_8_SINGAPORE_STRAITS_TIMES does not Granger Cause _1_INDIA_SENSEX	**384**	**3.47413**	**0.0322**
_1_INDIA_SENSEX does not Granger Cause _8_SINGAPORE_STRAITS_TIMES		1.05335	0.3500
_9_CHINA_SCI does not Granger Cause _1_INDIA_SENSEX	384	0.24893	0.7798
_1_INDIA_SENSEX does not Granger Cause _9_CHINA_SCI		**6.18277**	**0.0023**
_10_SOUTH_KOREA_KOSPI does not Granger Cause _1_INDIA_SENSEX	**384**	**6.12469**	**0.0024**
_1_INDIA_SENSEX does not Granger Cause _10_SOUTH_KOREA_KOSPI		0.02036	0.9798
_11_TAIWAN_TSEC_50 does not Granger Cause _1_INDIA_SENSEX	**310**	**3.53095**	**0.0306**
_1_INDIA_SENSEX does not Granger Cause _11_TAIWAN_TSEC_50		1.31803	0.2693
_12_RUSSIA_MCI does not Granger Cause _1_INDIA_SENSEX	301	2.39253	0.0932
_1_INDIA_SENSEX does not Granger Cause _12_RUSSIA_MCI		0.98525	0.3746
_13_HONG_KONG_HANGSENG_INDEX does not Granger Cause _1_INDIA_SENSEX	**378**	**7.00699**	**0.0010**

_1_INDIA_SENSEX does not Granger Cause _13_HONG_KONG_HANGSENG_INDEX		0.49353	0.6109
_14_NETHERLANDS_AEX does not Granger Cause _1_INDIA_SENSEX	**368**	**29.9079**	**0.0000**
_1_INDIA_SENSEX does not Granger Cause _14_NETHERLANDS_AEX		0.12430	0.8832
_15_BRAZIL_BOVESPA does not Granger Cause _1_INDIA_SENSEX	**384**	**8.10484**	**0.0004**
_1_INDIA_SENSEX does not Granger Cause _15_BRAZIL_BOVESPA		0.10740	0.8982
_16_SOUTH_AFRICA_SA_40 does not Granger Cause _1_INDIA_SENSEX	334	1.95221	0.1437
_1_INDIA_SENSEX does not Granger Cause _16_SOUTH_AFRICA_SA_40		2.24984	0.1071
_17_DENMARK_OMX_C20I does not Granger Cause _1_INDIA_SENSEX	381	1.90593	0.1502
_1_INDIA_SENSEX does not Granger Cause _17_DENMARK_OMX_C20I		0.20448	0.8152
_185_NORWAY_OSEAX does not Granger Cause _1_INDIA_SENSEX	235	0.56999	0.5664
_1_INDIA_SENSEX does not Granger Cause _185_NORWAY_OSEAX		0.11249	0.8937
_19_SWEDEN_OMX_S30I does not Granger Cause _1_INDIA_SENSEX	**381**	**5.60231**	**0.0040**
_1_INDIA_SENSEX does not Granger Cause _19_SWEDEN_OMX_S30I		1.32648	0.2667
_20_FINLAND_OMX_HEXI does not Granger Cause _1_INDIA_SENSEX	**381**	**6.62059**	**0.0015**
_1_INDIA_SENSEX does not Granger Cause _20_FINLAND_OMX_HEXI		1.99407	0.1376
_21_ICELAND_OMX_IASI does not Granger Cause _1_INDIA_SENSEX	227	1.49912	0.2258
_1_INDIA_SENSEX does not Granger Cause _21_ICELAND_OMX_IASI		1.33519	0.2654

The following causalities are derived:

- US S&P500 Granger causes India Sensex.
- Japan Nikkei 225 Granger causes India Sensex.
- Germany DAX Granger causes India Sensex.
- Singapore Straits Times Index Granger causes India Sensex.
- India Sensex Granger causes China Shanghai Composite Index.
- South Korea KOSPI index Granger causes India Sensex.
- Taiwan Stock Exchange Corp. 50 Index Granger causes India Sensex.
- Hong Kong Hang Seng Index Granger causes India Sensex.
- Netherlands Amsterdam Exchange Index Granger causes India Sensex.
- Brazil Bovespa Index Granger causes India Sensex.
- Sweden OMX Stockholm 30 Index Granger causes India Sensex.
- Finland OMX Helsinki 25 Index Granger causes India Sensex.

So, based on the above results, the Indian stock market is co-integrated with the following economies: the US, Japan, Germany, Singapore, China, South Korea, Taiwan, Hong Kong, Netherlands, Brazil, Sweden, and Finland.

Testing the volatility through the GARCH model. Before applying any sort of ARCH model, we need to run the preliminary tests to ensure that there is an ARCH effect in the data.

Preliminary tests: A serial correlation test is conducted to find whether a serial correlation exists in the index data.

The null hypothesis, "There is no serial correlation," cannot be disproved based on Table 5. Thus, the test

Table 5. ***Results of Testing for the Serial Correlation Test***

Sample : 1991M01 2022M12

Included observations : 384

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat.</th><th>Prob.*</th></tr>
<tr><td>.|. |</td><td>.|. |</td><td>1</td><td>0.019</td><td>0.019</td><td>0.1193</td><td>0.730</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>2</td><td>–0.004</td><td>–0.004</td><td>0.1242</td><td>0.940</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>3</td><td>–0.047</td><td>–0.047</td><td>0.8789</td><td>0.831</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>4</td><td>–0.031</td><td>–0.029</td><td>1.1951</td><td>0.879</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>5</td><td>0.006</td><td>0.007</td><td>1.2077</td><td>0.944</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>6</td><td>0.009</td><td>0.007</td><td>1.2369</td><td>0.975</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>7</td><td>0.138</td><td>0.135</td><td>7.6502</td><td>0.364</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>8</td><td>0.002</td><td>–0.003</td><td>7.6510</td><td>0.468</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>9</td><td>0.005</td><td>0.007</td><td>7.6582</td><td>0.569</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>10</td><td>–0.062</td><td>–0.051</td><td>8.9916</td><td>0.533</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>11</td><td>0.001</td><td>0.010</td><td>8.9921</td><td>0.623</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>12</td><td>0.040</td><td>0.039</td><td>9.5354</td><td>0.657</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>13</td><td>–0.021</td><td>–0.029</td><td>9.6870</td><td>0.719</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>14</td><td>–0.007</td><td>–0.028</td><td>9.7064</td><td>0.783</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>15</td><td>–0.042</td><td>–0.039</td><td>10.333</td><td>0.798</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>16</td><td>0.003</td><td>0.003</td><td>10.336</td><td>0.849</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>17</td><td>–0.024</td><td>–0.012</td><td>10.531</td><td>0.880</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>18</td><td>–0.018</td><td>–0.024</td><td>10.643</td><td>0.909</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>19</td><td>–0.055</td><td>–0.067</td><td>11.690</td><td>0.898</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>20</td><td>–0.010</td><td>–0.006</td><td>11.729</td><td>0.925</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>21</td><td>0.020</td><td>0.024</td><td>11.874</td><td>0.943</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>22</td><td>–0.015</td><td>–0.005</td><td>11.950</td><td>0.958</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>23</td><td>0.009</td><td>0.002</td><td>11.977</td><td>0.971</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>24</td><td>0.006</td><td>0.009</td><td>11.989</td><td>0.980</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>25</td><td>0.019</td><td>0.024</td><td>12.117</td><td>0.986</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>26</td><td>–0.042</td><td>–0.025</td><td>12.766</td><td>0.986</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>27</td><td>0.010</td><td>0.015</td><td>12.799</td><td>0.990</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>28</td><td>–0.022</td><td>–0.031</td><td>12.970</td><td>0.993</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>29</td><td>0.006</td><td>0.002</td><td>12.984</td><td>0.995</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>30</td><td>–0.021</td><td>–0.026</td><td>13.147</td><td>0.997</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>31</td><td>–0.005</td><td>–0.002</td><td>13.155</td><td>0.998</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>32</td><td>–0.030</td><td>–0.044</td><td>13.480</td><td>0.998</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>33</td><td>0.019</td><td>0.023</td><td>13.608</td><td>0.999</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>34</td><td>–0.057</td><td>–0.068</td><td>14.828</td><td>0.998</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>35</td><td>0.002</td><td>0.010</td><td>14.830</td><td>0.999</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>36</td><td>–0.015</td><td>–0.024</td><td>14.910</td><td>0.999</td></tr>
</table>

Note. *Probabilities may not be valid for this equation specification.

indicates that the residuals do not exhibit serial correlation. A heteroskedasticity test is conducted to find the existence of the ARCH effect in the index data. The outcomes of the heteroskedasticity test, which was performed using Indian stock market data, are as follows.

Heteroskedasticity Test: ARCH

F-statistic	0.117333	Prob. *F*(1,327)	0.7322
Obs. * *R*-squared	0.118008	Prob. Chi-Square(1)	0.7312

It is found that the null hypothesis "No ARCH effect exists in the data" is not rejected. So, it is confirmed that there is no ARCH effect in the Sensex data.

The same test is run on data from other countries in addition to India's data. Table 6 presents the tabulated results. The findings of the test for the ARCH effect are shown in Table 6. The null hypothesis is accepted when an asterisk (*) appears. "There is no ARCH effect" is the null hypothesis. The histogram normality test is conducted to find whether the data is normally distributed or not.

The output is shown in Figure 1. In Figure 1, it is found that the null hypothesis "Data are normally distributed"

Table 6. ***Results of the Heteroskedasticity Test Applied to all Stock Market Data***

Country	**US**	**UK**	**Japan**	**Germany**	**France**
F statistic	0.000965*	0.036254*	0.419628*	0.135778*	0.020985*
Obs**R*-squared	0.000971*	0.036512*	0.421563*	0.136551*	0.021112*
Country	**Canada**	**Singapore**	**Hong Kong**	**Netherlands**	**Taiwan**
F statistic	0.000617*	0.006518*	0.824705*	0.001099*	0.003103*
Obs**R*-squared	0.000621*	0.006565*	0.827661*	0.001106*	0.003128*
Country	**South Korea**	**Brazil**	**Russia**	**China**	**South Africa**
F statistic	1.616229*	0.066116*	0.259308*	0.112019*	0.128954*
Obs**R*-squared	1.618117*	0.066506*	0.261141*	0.112665*	0.129837*
Country	**Denmark**	**Norway**	**Sweden**	**Finland**	**Iceland**
F statistic	0.570900*	0.524141*	0.007272*	1.453127*	0.935108*
Obs**R*-squared	0.573445*	0.528574*	0.007317*	1.455599*	0.941073*

Figure 1. ***Results of the Histogram Normality Test Applied to Indian Stock Market Data***

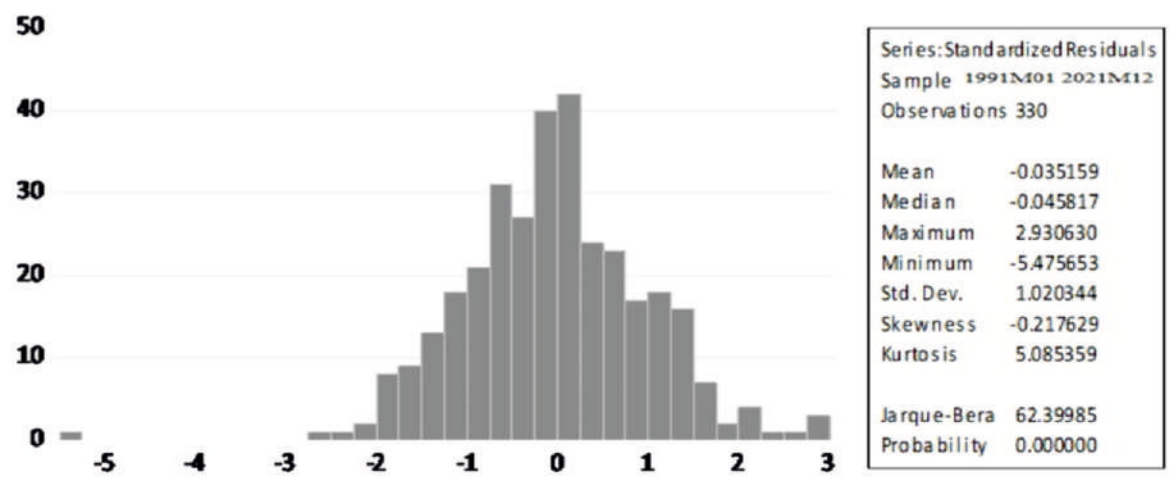

Table 7. *Volatility Details of 20 Leading Economies' Stock Market Indices and Indian Stock Market Index*

Country	Index	Gamma	Alpha	Beta	Long-Term Variance Rate
India	Sensex	0.0001	0.053	0.9192	0.0036
US	Standard and Poor	0.0001	0.1756	0.7968	0.0036
UK	FTSE 100	0.0001	0.154	0.7489	0.0010
Japan	Nikkei 225	0.0005	0.0937	0.7549	0.0033
Germany	DAX	0.0004	0.1539	0.7299	0.0034
France	CAC 40	0.0004	0.1793	0.6786	0.0028
Canada	TSX	0.0002	0.1793	0.6786	0.0014
Singapore	Straits Times	0.0001	0.2179	0.7764	0.0175
China	Shanghai Composite	0.0002	0.3426	0.6529	0.0444
South Korea	KOSPI	0.00003	0.1365	0.7741	0.0003
Taiwan	TSEC 50	0.00006	0.1933	0.8004	0.0095
Russia	MCI	0.0003	0.2307	0.72963	0.0076
Hong Kong	Hang Sang	0.0003	0.2001	0.7453	0.0055
Netherlands	AEX	0.0003	0.2348	0.6651	0.0030
Brazil	Bovespa	0.0005	0.2118	0.7391	0.0102
South Africa	SA 40	0.0002	0.1861	0.7688	0.0044
Denmark	OMX Copenhagen 30	0.0002	0.0972	0.8128	0.0022
Norway	Oslo Stock Exchange all Share Prices	0.0001	0.1318	0.8128	0.0018
Sweden	OMX Sweden 30	0.0002	0.1683	0.7876	0.0045
Finland	OMX Helsinki Exchange	0.0001	0.1129	0.858	0.0034
Iceland	OMX Iceland all shares	0.0009	0.0572	0.1627	0.0012

is rejected. So, data are not normally distributed. So, it can be concluded that there is no serial correlation (desirable), there is no ARCH effect (desirable), and data are not normally distributed (not desirable). So ARCH model can be applied to the index data.

It is important to study the volatility in the returns generated by the Indian stock market along with the returns generated by developed economies' major stock markets. The GARCH model predicts the long-term volatility of the time series. Table 7 presents the long-term variances of the selected indices.

Based on the long-term variance rate arrived at using the GARCH model, there is nearly the same variance prevails between the Indian stock market and German stock market, France stock market, China stock market, Hong Kong stock market, Brazil stock market, and Denmark stock market.

Analyzing Volatility Spillover Effects Using the GARCHM Model

Table 8 presents the summary of GARCHM model findings, which are used to determine the volatility spillover effects of the corresponding country on the stock market in India. The volatility spillover effects of the stock markets in the US, UK, Japan, Germany, France, Canada, Singapore, China, South Korea, Taiwan, Russia, Hong Kong, Netherlands, Brazil, South Africa, Norway, Sweden, and Finland are estimated. It is found that both ARCH and GARCH effects are sensitive to these effects. When we estimate the volatility spillover effects of the Iceland

Table 8. ***Summary of the Results of the GARCHM Model***

Country	Index	φ_1	*p*-value	Φ_2	*p*-value	Φ_3	*p*-value
US	Standard and Poor Index	0.9174	0.0000	0.0571	0.0007	–0.0078	0.0000
UK	FTSE 100	0.8669	0.0000	0.0948	0.0137	–0.0096	0.0000
Japan	Nikkei 225	0.9332	0.0163	0.0298	0.0000	0.0038	0.1124
Germany	DAX	0.9108	0.0003	0.0700	0.0000	–0.0052	0.0001
France	CAC 40	0.9061	0.0000	0.0675	0.0006	–0.0048	0.0000
Canada	TSX	0.9064	0.0000	0.0707	0.0002	–0.0066	0.0000
Singapore	Straits Times	0.6872	0.0000	0.1726	0.0073	–0.0065	0.0000
China	Shanghai Composite	0.9197	0.0000	0.0501	0.0026	0.0007	0.5653
South Korea	KOSPI	0.9088	0.0000	0.0701	0.0011	–0.0049	0.0001
Taiwan	TSEC 50	0.8687	0.0000	0.0905	0.0114	–0.0078	0.0001
Russia	MCI	0.8506	0.0000	0.1078	0.0248	–0.0023	0.0149
Hong Kong	Hang Sang	0.9126	0.0000	0.0612	0.0008	–0.0027	0.0282
Netherlands	AEX	0.8826	0.0000	0.0877	0.0100	–0.0054	0.0007
Brazil	Bovespa	0.9228	0.0000	0.055	0.0035	–0.006	0.5161
South Africa	SA 40	0.8645	0.0000	0.1080	0.0023	–0.0066	0.0001
Denmark	OMX Copenhagen 30	0.9165	0.0000	0.0494	0.0006	–0.0050	0.027
Norway	Oslo Stock Exchange all Share Prices	0.8368	0.0000	0.1011	0.014	–0.0073	0.0000
Sweden	OMX Sweden 30	0.8951	0.0000	0.0743	0.0001	–0.0061	0.0007
Finland	OMX Helsinki Exchange	0.9038	0.0000	0.0680	0.0001	–0.0050	0.0000
Iceland	OMX Iceland all shares	0.7608	0.0000	0.0849	0.1485	–0.0070	0.0004

stock market, it is found that ARCH effects are not sensitive. The volatility spillover effects of Denmark's stock market are estimated, and the GARCH and ARCH effects are sensitive to the volatility spillover effects. Furthermore, the volatility spillover effects do not affect GARCH effects. The potential for stock market volatility to spill over to India's stock market is seen in Table 8 for 20 major economies.

Table 9 indicates that the stock market volatility among the 20 selected top economies, including the US, UK, Japan, Germany, Canada, Singapore, South Korea, Taiwan, Netherlands, South Africa, Denmark, Norway, Sweden, Finland, and Iceland, contributed to the volatility of the Indian stock market.

Table 9. ***Summary of the Results of the GARCHM Model***

Country	Index	Internal shocks found through ARCH and GARCH	Volatility Spillover Effects
US	Standard and Poor Index	Significant	Are caused
UK	FTSE 100	Significant	Are caused
Japan	Nikkei 225	Significant	Are not caused
Germany	DAX	Significant	Are caused
France	CAC 40	Significant	Are caused
Canada	TSX	Significant	Are caused
Singapore	Straits Times	Significant	Are caused
China	Shanghai Composite	Significant	Are not caused

South Korea	KOSPI	Significant	Are caused
Taiwan	TSEC 50	Significant	Are caused
Russia	MCI	Significant	Are caused
Hong Kong	Hang Sang	Significant	Are caused
Netherlands	AEX	Significant	Are caused
Brazil	Bovespa	Significant	Are not caused
South Africa	SA 40	Significant	Are caused
Denmark	OMX Copenhagen 30	Significant	Are caused
Norway	Oslo Stock Exchange All Share Prices	Significant	Are caused
Sweden	OMX Sweden 30	Significant	Are caused
Finland	OMX Helsinki Exchange	Significant	Are caused
Iceland	OMX Iceland All shares	Not Significant	Are caused

The US, UK, Japan, Germany, Canada, Singapore, South Korea, Taiwan, Netherlands, South Africa, Denmark, Norway, Sweden, Finland, and Iceland stock markets' volatility had a spillover effect on the Indian stock market. No volatility spillover effects from France, China, Russia, Taiwan, Hong Kong, or Brazil were observed in the Indian stock market.

Analyzing Volatility Spillover Effects Using the EGARCH Model

In Table 10, Ω indicates intercept, α indicates the ARCH effect, β indicates the GARCH effect in the EGARCH model, ϒ indicates the Leverage effect, and φ indicates the influence of the respective country volatility on the volatility of the Indian stock market. Table 11 displays the summarized results of the EGARCH model .

Table 10. ***Summary of the Results of the EGARCH Model***

Country	Index	A	*p*-value	*B*	p-value	Φ	*p*-value
US	Standard and Poor Index	0.0057	0.0003	0.0849	0.0000	0.6817	0.0049
UK	FTSE 100	0.0012	0.0032	0.3284	0.0000	–3.9519	0.0000
Japan	Nikkei 225	0.0065	0.7414	0.9591	0.0000	1.9470	0.0000
Germany	DAX	0.1141	0.0001	0.9635	0.0000	–1.1142	0.0001
France	CAC 40	0.1083	0.0003	0.9655	0.0000	–1.0276	0.0262
Canada	TSX	0.1238	0.0002	0.9663	0.0000	–2.1512	0.0007
Singapore	Straits Times	0.2020	0.0152	0.9228	0.0000	–1.9402	0.0000
China	Shanghai Composite	0.0691	0.0105	0.9743	0.0000	0.4619	0.0105
South Korea	KOSPI	0.164	0.0000	–0.906	0.0000	–0.741	0.0003
Taiwan	TSEC 50	0.270	0.0001	0.933	0.0000	–1.238	0.0343
Russia	MCI	0.228	0.0070	0.939	0.0000	–0.245	0.4941
Hong Kong	Hang Sang	0.220	0.0000	0.970	0.0000	0.650	0.1732
Netherlands	AEX	0.175	0.0089	0.943	0.0000	–1.232	0.0087
Brazil	Bovespa	0.304	0.0001	0.904	0.0000	0.263	0.1277
South Africa	SA 40	0.249	0.0000	0.955	0.0000	–2.458	0.0000

Denmark	OMX Copenhagen 30	0.311	0.0022	0.129	0.2266	–5.933	0.0000
Norway	Oslo Stock Exchange All Share Prices	0.633	0.0000	–0.347	0.0328	2.298	0.0405
Sweden	OMX Sweden 30	0.542	0.0000	–0.017	0.8600	–2.782	0.0051
Finland	OMX Helsinki Exchange	0.695	0.0000	0.334	0.0040	–1.682	0.0015
Iceland	OMX Iceland All shares	0.189	0.0068	0.831	0.0000	–1.332	0.0404

Table 11. ***Summary of the Results of the EGARCH Model***

S. No.	Country	Index	Internal Shocks Found Through ARCH and GARCH	Volatility Spillover Effects
1	US	Standard and Poor Index	Significant	Are caused
2	UK	FTSE 100	Significant	Are caused
3	Japan	Nikkei 225	Significant	Are caused
4	Germany	DAX	Significant	Are caused
5	France	CAC 40	Not Significant	Are not caused
6	Canada	TSX	Not Significant	Are caused
7	Singapore	Straits Times	Significant	Are caused
8	China	Shanghai Composite	Significant	Are caused
9	South Korea	KOSPI	Significant	Are caused
10	Taiwan	TSEC 50	Significant	Are caused
11	Russia	MCI	Significant	Are not caused
12	Hong Kong	Hang Sang	Significant	Are not caused
13	Netherlands	AEX	Significant	Are caused
14	Brazil	Bovespa	Significant	Are not caused
15	South Africa	SA 40	Significant	Are caused
16	Denmark	OMX Copenhagen 30	Significant	Are caused
17	Norway	Oslo Stock Exchange All Share Prices	Not Significant	Are caused
18	Sweden	OMX Sweden 30	Not Significant	Are caused
19	Finland	OMX Helsinki Exchange	Significant	Are caused
20	Iceland	OMX Iceland all Shares	Significant	Are caused

Conclusion

The null hypothesis, "No co-integration between India Sensex and any other specific index taken for study," is rejected at a 95% confidence level by the Trace values; as a result, there is co-integration between the Indian stock market and other stock indices taken for study. So, there is interdependence between the Indian stock market and all the twenty economies' stock markets taken for the study. So based on the Granger causality test results, the Indian stock market is Granger caused, or Granger causes the following economies' stock markets: US, Japan, Germany, Singapore, China, South Korea, Taiwan, Hong Kong, Netherlands, Brazil, Sweden, and Finland. The GARCH model yielded similar volatility, which led to the deduction that the stock markets of Germany, France, Japan, and Brazil are dependent on each other.

Furthermore, there is an investigation into any volatility spillover effects that happen in the Indian stock

Table 12. ***Summary of the Results of all Tests***

		Interdependence with the Indian stock market through				
Country	**Index**	**Co-integration**	**Granger Causality**	**Similarity in Volatility through the GARCH Model Model**	**Volatility Spillover Effects using the GARCHM Model**	**Volatility Spillover Effects using the EGARCH Model**
US	Standard and Poor Index	Yes	Yes		Yes	Yes
UK	FTSE 100	Yes			Yes	Yes
Japan	Nikkei 225	Yes	Yes		Yes	Yes
Germany	DAX	Yes	Yes	Yes	Yes	Yes
France	CAC 40	Yes				
Canada	TSX	Yes			Yes	Yes
Singapore	Straits Times	Yes	Yes	Yes	Yes	Yes
China	Shanghai Composite	Yes	Yes	Yes		Yes
South Korea	KOSPI	Yes	Yes		Yes	Yes
Taiwan	TSEC 50	Yes	Yes	Yes	Yes	Yes
Russia	MCI	Yes		Yes		
Hong Kong	Hang Sang	Yes	Yes	Yes		
Netherlands	AEX	Yes	Yes		Yes	Yes
Brazil	Bovespa	Yes	Yes			
South Africa	SA 40	Yes		Yes	Yes	Yes
Denmark	OMX C30 I	Yes			Yes	Yes
Norway	OSEAX	Yes			Yes	Yes
Sweden	OMX S30 I	Yes	Yes	Yes	Yes	Yes
Finland	OMX HEXI	Yes	Yes	Yes	Yes	Yes
Iceland	OMX IASI	Yes			Yes	Yes

market from selected economies' stock markets after economic reforms done in India. It is confirmed through both the GARCHM model and the EGARCH model that few developed economies create volatility spillover on the Indian stock market. The GARCH M model has established that the stock markets of South Africa, Denmark, Japan, Singapore, and the Netherlands cause volatility in the Indian stock market. Based on the EGARCH model, the volatility of the stock market in India is influenced by the following countries: the US, the UK, Japan, Germany, China, South Korea, Taiwan, Hong Kong, Netherlands, Denmark, Norway, Sweden, Finland, and Iceland.

Table 12 suggests that the stock markets of Germany, Singapore, Taiwan, Sweden, and Finland are more interdependent on the Indian stock market. Excellent and significant interdependence with the stock markets of the US, Japan, China, South Korea, Netherlands, and South Africa; moderate interdependence with the stock markets of the UK, Canada, Hong Kong, Denmark, Norway, and Iceland; a lesser degree of interdependence with the stock markets of Russia and Brazil; and the least amount of interdependence with the stock market of France. The French stock market and the Indian stock market are less dependent on each other.

Implications

Macroeconomic factors and stock market operations are closely related. Therefore, macroeconomic factors can be used to predict changes in the stock market. Stock market fluctuations are also important economic indicators for forecasting macroeconomic factors. The volume traded in the stock market can also be the best indicator of major macroeconomic variables. Stock market functions also depend upon the co-integration among the major stock markets in the world. The co-integration of the world's major stock markets is essential to the operation of the stock market as well. This study clearly demonstrates the author's attempt to ascertain the extent of the relationship between the stock markets of industrialized economies and India. This will help government organizations create trading rules that will enable investors from around the world to trade on the Indian stock markets.

A policy pertaining to investment plans and capital market investment limits that would impact all industries may be drafted by the government with input from the co-integration phase. This research will be especially helpful to the industries in understanding the market and economic integration between industrialized nations and India, emerging economies, and India, as it focuses on the interconnection of national stock markets.

It would be more evident to someone looking at all of the 1990 co-integration studies that there was economic integration between Western European and American nations. Recent polls indicate that North and South America, as well as Europe, are the main sources of foreign direct investment for Asian countries. A good illustration of how all stock markets are interdependent is the collapse of all stock markets worldwide as a result of the US Subprime crisis.

This study confirms the existence or non-existence of co-integration among the economies taken for study and the Indian stock market. The findings can be used to develop policies to shield investors from the negative effects of those economies' stock markets on the Indian stock market. The causal relationship between India's stock market and the developed economy's stock market suggested that the governments should take into consideration the stock market fluctuation based on the other stock markets. This study has been conducted using econometric tools and statistical tools for analysis and interpretation. Newer and better techniques should be developed and evaluated based on the need and analysis.

Limitations of the Study

- Only 16 developed economies and four emerging economies are taken for the study.
- The selected tools are only used to determine interdependence.
- Yahoo! Finance and investing.com are the only two data sources that are taken into consideration for this data.

Authors' Contribution

Dr. R. Kumara Kannan's Ph.D. thesis under the guidance of Dr. Selvam Jesiah has been summarized into an article. Dr. R. Kumara Kannan did the research, and Dr. Selvam Jesiah supervised the preparation of this article. Dr. R. Kumara Kannan wrote the manuscript in consultation with the co-author.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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