Investigating Causal Relationship between Indian and American Stock Markets

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Abstract: This study investigates the vibrant relationship between the Indian and American Stock markets. Financial markets across the globe are widely integrated, with global investors seeking to invest simultaneously in many markets. The Indian Stock markets have become open to a large extent, thereby attracting investors from overseas markets. The international financial markets have witnessed various crests and troughs due to widespread economic crisis and it can be observed that slowly all the markets are bouncing back to normalcy. With the latest developments in the information and communication technology, information passes in no second across nations and continents. This has led to a situation where the rise and fall in one market has an immediate impact over the other markets, largely due to the presence of global investors. Hence, this paper examines the nature of the relationship between Indian and American markets using the Granger causality test. The Granger causality test is used to detect if there is a cause- and-effect relationship between the popular Indian stock index BSE SENSEX and the leading American Stock indices (NASDAQ and NYSE) during the period 2009-2012. The results confirm that the Granger causality runs in one way, from American markets to Indian market, but not the other way.
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1. Introduction

The problem of stock market integration has been studied for several decades from many different perspectives (Baumohl and Vyrost, 2010). Financial markets across the globe are widely integrated, with global investors seeking to invest simultaneously in many markets. With increased market integration, the current world financial markets have become more closely correlated and interdependent over time (Lee K Lim, 2008). The Indian Stock markets have become open to a large extent, thereby attracting investors from overseas markets. The international financial markets have witnessed various crests and troughs due to widespread economic crisis and it can be observed that slowly all the markets are bouncing back to normalcy. The extent to which stock markets move together depends on the relative amounts of firm-level and market-level information capitalized into stock prices (Roll, 1988). With the latest development in the information and communication technology (ICT) sector, information passes in no seconds across nations and continents. This has led to a situation where the rise and fall in one market has an immediate impact on the other markets, largely due to the presence of global investors. An interesting study by Kearney (2000) showed that the world equity market volatility is predominantly caused by volatility in Japanese/US markets rather than by volatility in European stock markets.

Numerous studies have been carried out to examine the integration of stock markets, linking the portfolio theory and effective international diversification (Grubel, 1968; Ripley, 1973; Lessard 1974, 1976; Panton et al., 1976; Hilliard, 1979; and others). Most of these studies used the mean-variance model and justified the need for international diversification citing low-level of correlations between returns of various stock market returns. Eun and Shim (1989) examine the information transmission from US to other markets using the Vector autoregression model and the results supported the evidence of US dominance over other markets. There are lot of studies carried out in foreign stock markets to investigate the cointegration, international dependencies and efficiency of the markets. Malliaris and Urrutia (1992) investigated the Granger causalities of six stock market indices before, during, and after the October 1987 crash to identify the origin of the crisis. No significant lead-lag relationship is found in the pre-crash or post-crash periods. Marios (2000) studied the dynamic relationship between stock return and dividend yields in the American and Japanese markets. Černý and Koblas (2008) studied the extent of integration and the speed of information transmission among the Polish, Hungarian, and Czech stock market indices

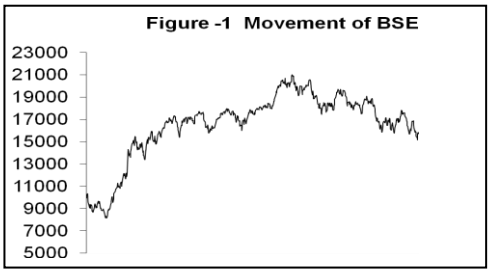
and compared them with other developed markets. Rajiv and Subha (2008) studied the cointegration between Indian and American and South East Asian markets using Engle-Granger Cointegration method. Lee K Lim (2008) examined the linkages between the stock markets of the five original member countries of the Association of Southeast Asian Nations (ASEAN).

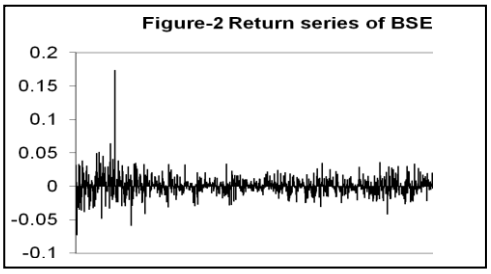
As there are large numbers of Indian companies listed in the American markets and with sizeable foreign institutional investors (FII) from America in Indian stock market, the influence of one market on the other cannot be undermined. Hence, this paper examines the causal relationship between the Indian and American stock markets using the Granger causality test. The Augmented Dickey Fuller (ADF) test is carried out to check the stationarity of the time series. The Engle-Granger test is also done on the stationary time series as a prelude to study the interrelationships between the stock indices series. The Granger causality test is used to detect if there is a cause- and-effect relationship between Bombay stock exchange (BSE) and the leading American Stock Indices (NASDAQ Composite Index, NYSE Composite Index).

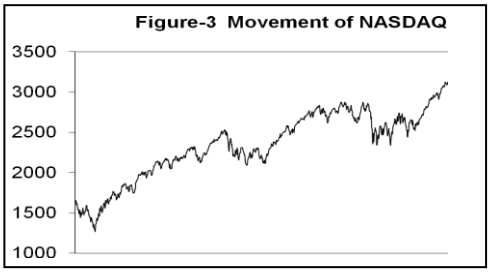
Apart from this introductory section, this paper comprises of four sections. Section two describes the data, sources of data and the time period considered for the study. Section three explains the methodology and various time series analytical tools employed in this study. Section four highlights the empirical results and Section five concludes the study.

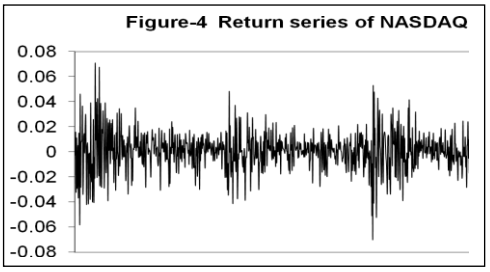
2. Data and Sources of Data

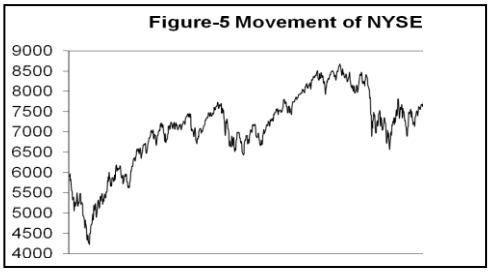
This study examines the causality among leading stock indices of India and America. Being the top two largest stock exchanges in the world in terms of market capitalization, composite indices of NYSE and NASDAQ are chosen to represent the American market. The sensitivity index of BSE - the largest stock exchange in India - BSE-SENSEX is chosen to represent the Indian stock market. The daily share prices of the indices are downloaded from the respective websites of the stock exchanges. The period chosen for the study is from 1st January 2009 to 31st July 2012. The observations for this period comprise of closing values of the three indices of about 900 trading days. Figures 1, 3 and 5 show the movement of BSE-Sensex, NASDAQ and NYSE, respectively during the study period. Figures 2, 4, 6 illustrate the series of returns of BSE, NASDAQ, and NYSE during the same period. Summary statistics of the returns of the three indices is given in the following tables:











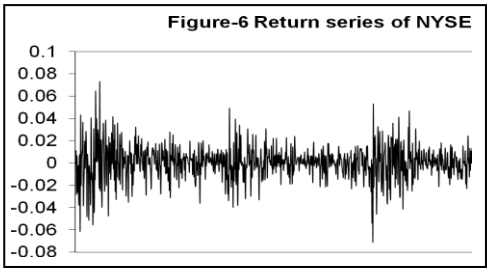


Table 1- Summary Statistics (Total market returns)

	BSE	NASDAQ	NYSE
Mean	0.00073399	0.000764	0.000434
Standard Deviation	0.01524701	0.014755	0.014898
Minimum	-0.0724705	-0.06899	-0.07051
Maximum	0.17339334	0.070658	0.073204

The above table shows the summary statistical values of the returns of the indices under study. Figures 1-5 show that the stock index values have shown high volatility in returns. The high standard deviation of the BSE show that the markets have been volatile when compared to other markets.

3. Methodology

3.1. Test for Stationarity

A time series is said to be stationary if it's mean, variance and autocovariances are constant over time (i.e., they are time in-variant). As test of stationarity is a pre-requisite for any study on time-series analysis; here we employ the most popular unit root tests of Augmented Dickey Fuller (ADF) test. The ADF test is based on the regression equation of the form

$$\Delta y_t = \alpha + \delta y_{t-1} + u_t \quad \text{---------- (1)}$$

Where α is a constant, δ is the regression coefficient called tau and u_t is a pure error term.

The hypotheses formulations are as follows:

H_0: $\delta = 0$ (presence of unit root or non-staionarity of time series)

H_1: $\delta \neq 0$ (absence of unit root or stationarity of time series)

3.2. Test for Cointegration

Cointegration is a concept introduced by Granger (1983) and further improved by Engle and Granger (1987). According to them, two variables are said to be cointegrated when a linear combination of the two variables is stationary implying that there is a long term relationship existing between them. Lack of cointegration suggests that no such relationship exists.

Testing for cointegration involves testing the residuals from an Ordinary Least Square regression for the time series and residuals are obtained.

$$Y_t = ß_0 + ß_1 x_t + ß_2 z_t + \varepsilon \quad \text{---------- (2)}$$

Regress y on x and z. The residuals are obtained from the Ordinary least square and a Dickey fuller unit root test is carried out to check for unit root. If a unit root is not present, the residuals are stationary and the variables are cointegrated.

The first difference of the residuals, ΔY_t is regressed against the first lag of the residual Y_{t-1} and sufficient lags of Y_t.

$$\Delta Y_t = (Y_t - Y_{t-1}) = u_t \quad \text{---------- (3)}$$

The results of the unit root test, t-statistics has to be compared with specially calculated critical values. If the estimated $|\tau|$ exceeds any of these critical values, the null hypothesis that there is no cointegration among the variables can be rejected, else the null hypothesis is accepted.

3.3. Test for Causality

To understand the causal relationship between Indian and American markets, Granger causality test is employed. According to Granger, if past values of a variable x significantly contribute to predict the future values of some other variable y, then x is said to Granger cause y. Also, if past values of a variable y significantly contribute to predict the future values of some other variable x , then y is said to Granger cause x. The test is based on the following regression

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots \alpha_l y_{t-l} + \beta_1 x_{t-1} + \ldots \beta_1 x_{t-l} + \varepsilon t \quad \text{---------- (4)}$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots \beta_1 y_{t-l} + u_t \quad \text{---------- (5)}$$

Where, xt and yt are the two variables, εt and ut are mutually uncorrelated error terms and l is the number of lags.

4. Empirical Results

This study tries to test the causal relationships between Indian and American stock markets for the period January 2009 to July 2012. The test for stationarity (ADF), test for cointegration (Engle-Granger test for Cointegration) and Granger causality tests are carried out on the market returns of the BSE-SENSEX (INDIA) and NASDAQ (CI), NYSE (CI) (AMERICA). All computations are carried out using the E-VIEWS software and the results are discussed in the following section.

4.1. Test for Stationarity-ADF Test

The results of the ADF test for BSE-30, NYSE, and NASDAQ are given below:

Table 2 - Results of the ADF Test

H_0 : $\delta = 0$ H_1 : $\delta \neq 0$		**t-Statistic**	**Prob.**
ADF test statistic for BSE		-2.544664	0.1053
ADF test statistic for NASDAQ		-1.468948	0.5491
ADF test statistic for NYSE		-1.816041	0.3728
Test Critical Values	1% level	-3.437385	
	5% level	-2.864535	
	10% level	-2.568418	

As the computed t-statistics for the three indices are less than the critical values at 1%, 5%, and 10% level of significance, we cannot reject the null hypothesis of the presence of unit roots which implies all the series are non stationary. In any time series analysis, it is mandatory for the time series to be made stationary. Taking the first difference of the time series, we further subject them to ADF unit root test and the

results are shown below:

Table 3 - Results of ADF for 1st difference

$H_0: \delta = 0$ $H_1: \delta \neq 0$		t-Statistic	Prob.
ADF test statistic for BSE		-28.31135	0.0000
ADF test statistic for NASDAQ		-31.87971	0.0000
ADF test statistic for NYSE		-32.0397	0.0000
Test critical values:	1% level	-3.437385	
	5% level	-2.864535	
	10% level	-2.568418	

As observed from Table-3, the computed *t*-statistics for the three indices are greater than the critical values at 1%, 5%, and 10% level of significance; we cannot accept the null hypothesis of the presence of unit root which implies series are stationary. Thus, the times series are found to be stationary at their first difference and they are ready to be tested for causal relationships among the two time series.

4.2. Test for Cointegration – Engle-Granger Test

The three series of indices are found to be stationary at their first difference and those stationary time series are further subjected to Engle-Granger cointegration test to find out whether Indian and American markets are cointegrated. The hypotheses for Engle-Granger cointegration tests are

H_0: BSE and NASDAQ are not cointegrated.

H_1: BSE and NASDAQ are cointegrated.

Table 4 - Engle Granger Cointegration Test for BSE and NASDAQ

Dependent	tau-statistic	Probability
BSE	-30.43067	0.0000
NASDAQ	-34.84235	0.0000
Dependent	z-statistic	Probability
BSE	-890.7582	0.0000
NASDAQ	-1005.322	0.0000

High values of tau statistics and MacKinnon probability values (0.000) make it evident that the null hypothesis cannot be accepted and hence it is evident that BSE and NASDAQ are cointegrated with each other. Similarly, BSE and NYSE are subjected to Engle-Granger cointegration test and the results are as follows:

H_0: BSE and NYSE are not cointegrated.

H_1: BSE and NYSE are cointegrated

Table 5 - Engle Granger Cointegration Test for BSE and NYSE

Dependent	tau-statistic	Probability
BSE	-30.63958	0.0000
NYSE	-35.25302	0.0000
Dependent	z-statistic	Probability
BSE	-896.5745	0.0000
NYSE	-1014.933	0.0000

High values of tau statistics and MacKinnon probability values make it evident that the null hypothesis cannot be accepted and hence it is evident that BSE and NYSE are cointegrated with each other.

4.3 Granger Causality Test

The null hypothesis is that x does not Granger cause y in Equation 3 and y does not Granger cause *x* in Equation 4. The results of Granger causality test for BSE and NASDQA are shown below.

Table – 6 Granger causality test for BSE and NASDAQ

Null Hypothesis	F-Statistic	Probability
NASDAQ does not Granger cause BSE	37.2423	3.E-16
BSE does not Granger cause NASDAQ	1.61582	0.1993

From the high value of F-statistics and a very low probability, it is evident that the null hypothesis "NASDAQ does not Granger cause BSE" cannot be accepted. It implies that NASDAQ does Granger cause BSE. From the low value of F-statistics and high probability, it is evident that the hypothesis "BSE does not Granger cause NASDAQ" cannot be rejected. Therefore, it appears that Granger causality runs in one way from NASDAQ to BSE and not the other way.

Table – 7 Granger causality test for BSE and NYSE

Null Hypothesis	F-Statistic	Probability
NYSE does not Granger cause BSE	34.4115	4.E-15
BSE does not Granger cause NYSE	0.95599	0.3848

From the high value of F-statistics and a very low probability, it is evident that the null hypothesis "NASDAQ does not Granger cause BSE" cannot be accepted. It implies that NASDAQ does Granger cause BSE. From the low value of F-statistics and high probability, it is evident that the hypothesis "BSE does not Granger cause NASDAQ" cannot be rejected. Therefore, it appears that Granger causality runs in one way from NASDAQ to BSE and not the other way.

Table – 7 Granger causality test for BSE and NYSE

Null Hypothesis	F-Statistic	Probability
NYSE does not Granger cause BSE	34.4115	4.E-15
BSE does not Granger cause NYSE	0.95599	0.3848

The results of Granger causality test for BSE and NYSE are shown in the Table-7. From the high value of F-statistic and a very low probability, it is evident that the null hypothesis "NYSE does not Granger cause BSE" cannot be accepted. It implies that NYSE does Granger cause BSE. From the low value of F-statistics and high probability, it is evident that the hypothesis "BSE does not Granger cause NYSE" cannot be rejected. Therefore, it appears that Granger causality runs in one way from NASDAQ to BSE and not the other way.

5. Conclusion

This paper examines the presence of causal relationships between Indian and American markets using Granger causality test. The ADF unit root test is employed to check the stationarity of the time series. The results of the unit root tests show that the time series of stock indices are stationary at their first differences. The Engle-Granger cointegration test is done as a prelude to study the interrelationship between the indices series. This confirms that there is a long term relationship between the Indian and American stock markets. Then the Granger causality test is employed to detect if there is a cause- and-effect relationship between BSE and the leading American indices, NASDAQ and NYSE. The causality tests indicate that the Indian stock market does not Granger cause the American markets but confirm that the American markets Granger cause Indian market. The outcome of the study shows the influence of American stock markets on Indian markets and indicates the dominance of American stock markets over Indian stock market.

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