# How far India has gone down the road towards financial integration with US since subprime crisis? An Econometric Analysis

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**Abstract**

The present paper aims to study the causal relationship between the US and Indian equity markets using Johansen's cointegration and variance decomposition analyses. Since the opening up of the economy and subsequent economic and political reforms, India has made tremendous strides in the global equity markets and also been impinged on by the recent happenings. Eviews 7 package program has been used for arranging the data and conducting econometric analyses. The ADF test shows that the time series data used for the study are stationary and integrated of order one. The Johansen's co-integration test reveals that there exists long run equilibrium relation between the selected variables. The Granger causality test in the vector error correction model suggests the evidence of feedback causality running between the six stock exchanges. However, there is no dependence of any of the individual exchange over the other.

Key-words: Stock Market Integration; India; United States; Johansen's Cointegration Analysis; Vector Error Correction Model; Variance Decomposition Analysis.

## 1. Introduction

The national stock markets in the world are poignant towards more intensive linkages during the last few years in the light of globalization and liberalization of financial markets. The progressive removal of restrictions, relaxation of controls over capital movements (Abas, 2009), rapid expansion of international trade in commodities, services and financial assets (Kearney and Lucey, 2004), emergence of new capital markets and the effects of financial and economic crises are binding the emerging stock markets with each other (Aktan *et al*, 2009). Regional economic integration, greater co-movement in the stock prices and foreign investments, more interdependence among global equity markets and the regional markets in particular, are often observed, especially in times of financial crises and when the contagion and spill-over effects are prominent. The recent subprime crisis and subsequent developments in the global economies not only affected the US but the entire financial system in the world. While some of the developed economies plunged into recession the spill-over effects have also affected the developing countries as well.

India, since the opening up of the economy and subsequent economic and political reforms, has made tremendous strides in the global equity markets and also been impinged on by the recent happenings. Though the consequences of the global financial crisis are difficult to quantify, however, the impacts are multi-fold. Some of them include volatility in exchange rates, outflow of foreign institutional investments, slump in demand of the real estate sector, erosion in the value of overall investment by the investors and less than average performance of some prominent sectors and an overall under-performance of the equity markets in comparison to other emerging markets. The global uncertainties in recent times have also added to the market's woes and the downgrade by the global rating agencies has proved sadistic to unnerve the investor's confidence. With the apprehension that some of the European countries may default on their debt obligations, the probability of slowdown looms large on India as the country has several issues of its own to deal with which are largely impacting the equity markets. The present paper aims to study whether there is any contagion effect of the recent crisis on Indian stock market. The rest of the paper is organized as follows: Section two sketches a brief overview of the literature on integration of equity markets and the contagion effects of the recent US subprime crisis. Section three narrates the research methodology to estimate the causal relation based on Granger causality test. Section four analyses the data and observe the empirical results and finally, section five concludes.

## 2. Review of literature

A number of studies has been undertaken on integration of Asian stock markets within themselves and with the developed markets as well (Nath and Verma, 2003; Lamba, 2005; Raj and Dhal, 2008; Auzairy and Ahmed, 2009; Korajazyk, 1995; Chittedi, 2009; Wong, Agarwal and Du, 2005; Abas, 2009; Aktan, Mandaci, Kopurla and Ersener, 2009 and Chattopadhyay and Behera 2008). Most of these literatures have used similar methodology to analyze the interaction among the stock markets. They begin their studies with unit root test and then observe whether the variables are cointegrated or not using cointegration test followed by Vector Error Correction (VEC) model to show the existence of short run or long run relationships among the variables.

Arshanapalli and Kulkarni (2001) studied the interdependence between India and the US stock market and the results showed that the former was not dependent on the later market. Kumar (2002a, 2002b), in his study, has confirmed that stock index of Indian stock market was not co-integrated with the developed markets. Bose (2005) identified that the Indian stock market did not function in relative isolation from the rest of Asia and the US as stock returns in India were highly correlated with returns in the US, Japan, as well as other Asian markets during the post-Asian crisis and up to mid-2004. The paper by Wong, Agarwal and Du (2005) empirically investigated the long-run equilibrium relationship and short-run dynamic linkage between India and the stock markets in major developed countries (US, UK and Japan) and concluded that Indian stock market was integrated with mature markets and was susceptible to the dynamics in these markets in the long run. Lamba (2005) performs a comprehensive large sample analysis to investigate the presence of long run relationships among South Asian equity markets and the developed equity markets. The results reveal that Indian markets are influenced by developed equity market of US, UK and Japan.

Mishra (2006) investigated the international integration of Indian stock market and found no long-run relationship between BSE and NASDAQ indices. Mallick (2006) used the dynamic conditional correlation (DCC) and multivariate GARCH model of Engle (1982) to measure the degree of co-movement of BSE and NASDAQ. Empirical findings confirmed that there had been a significant increase in the mean of correlation coefficient between the markets in the crisis periods compared to the pre-crisis period. Chen, Lobo and Wong (2006) examined the relation between India-US, US-China and India-China using Fractionally Integrated VECM to study co-integration between them. By supplementing the model with a multivariate GARCH model, it was observed that all these pairs are fractionally co-integrated. The US market played a dominant role while there remained an interactive relationship between US and Chinese stock markets. Raj and Dhal

(2008) observe that the Indian market's dependence on global markets, such as the US and the UK, is substantially higher than on regional markets such as Singapore and Hong Kong. Majid et al. (2008) find long-run relationships for five ASEAN countries with the US and Japan only in the post-crisis period, while Awokuse et al. (2009) evidenced that the number of cointegrating vectors increases in the post-crisis period among 11 Asian economies.

Ismail and Rahman (2009) investigated the relationship between the US and four leading Asian emerging stock markets namely Hong Kong, India, South Korea and Malaysia and found that there were possibilities of relationship between all the stock markets. Longstaff's (2010) empirical investigation into the pricing of subprime asset-backed collateralized debt obligations (CDOs) and their contagion effects on other markets find strong evidence of contagion in the financial markets. Kim *et al.* (2010) studied the turmoil of 2007–2009 and found how the troubles in a small segment of the US mortgage market became escalated into a crisis of global proportions. Yilmaz (2010) examines the extent of contagion and interdependence across the East Asian equity markets since early 1990s and compares the ongoing crisis with earlier episodes. They show that there is substantial difference between the behaviour of the East Asian return and volatility spillover indices over time. While the return spillover index reveals increased integration among the East Asian equity markets, the volatility spillover index experiences significant bursts during major market crises, including the East Asian crisis. Fidrmuc and Korhonen (2010) analyze the transmission of global financial crisis to business cycles in China and India. They find wide differences for different frequencies of cyclical development. More specifically, at business cycle frequencies, dynamic correlations are typically low or negative, but they are influenced most by the global financial crisis. Finally, they find a significant link between trade ties and dynamic correlations of GDP growth rates in emerging Asian countries and OECD countries. Iqbal, Khalid and Rafiq (2011) attempted to find out dynamic relationship using Johansen (1988) and Juselius and Jones (1990) co-integration procedure for long run relationship and Granger Causality test based on Toda and Yamamoto (1995). No integration was found among US, Pakistan and India. However, the Granger Causality test showed the evidence of unidirectional causality running from NYSE to Bombay and Karachi stock exchange.

Though there are many studies in respect to identifying the existence of co-integration and the contagion effect of recent crises on different stock markets in the world using different methodologies, there is no exclusive and extensive study with respect to co-integration between the Indian (BSE and NSE) and the US (DJIA, NASDAQ, NYSE and S&P) markets and the aftermath contagion impact of the crisis.

## 3. Materials and Methods

The present study deals with the secondary data obtained from the Ministry of Finance (Government of India), NSE and BSE database for the Indian markets. The data for the US markets are collected from the online source of Yahoo finance and the Bloomberg database. The sample period spans from January 2, 2008 to February 16, 2012 after matching daily stock prices of the selected six stock exchanges with 963 observations. Eviews 7 package program has been used for arranging the data and conducting econometric analyses using Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) Unit Root Test, Johansen's (1995) Co-integration Test and Granger (1969) Causality Test. For the purpose of analysis, linear deterministic trend and lags interval in first differences have been used. The Augmented Dickey-Fuller unit root test has been used to observe the stationarity of the time series data used for the study and to find the order of integration between them. The ADF unit root test has been performed by estimating the regression:

$$\Delta y_t = a_0 + \gamma y_{t-1} + \Sigma b_i y_{t-1} + e_t$$

The ADF unit root test is based on the null hypothesis ($H_0$): $Y_t$ is not I(0). Accordingly, if the calculated ADF statistic is found less than the critical value, then the null hypothesis is to be rejected; or otherwise accepted. If the variable is observed stationary at level, the variable is said to be integrated of order zero, I(0). If the variable is found non-stationary at level, the ADF test is to be conducted and the first difference of the variable can be used for testing a unit root. In this case, the variable is said to be co-integrated of order one, I(1).

In the second step, the Johansen's co-integration test has been applied to test out whether there exists any short run equilibrium relation between the variables. The Johansen approach to co-integration test is based on two test statistics, viz., the trace test statistic, and the maximum eigenvalue test statistic. The trace test statistic can be specified as: $\lambda_{trace}(r) = -T\Sigma\log(1 - \lambda_i)$ where $\lambda_i$ is the $i^{th}$ largest eigenvalue of matrix $\Pi$, and T is the number of observations. In the trace test, the null hypothesis ($H_0$) is that the number of distinct co-integrating vector(s) is less than or equal to the number of co-integration relations (r). The maximum eigenvalue test examines the null hypothesis of exactly '*r*' co-integrating relations against the alternative of '*r* + 1' co-integrating relations with the test statistic: $\lambda_{max} = -T\log(1 - \lambda_{r+1})$ where $\lambda_{r+1}$ is the $(r+1)^{th}$ largest squared eigenvalue. In the trace test, the null hypothesis of $r = 0$ is tested against the alternative of '*r* +1' co-integrating vectors.

At the end, the Granger Causality test has been used to determine whether one time series is useful in forecasting another thereby finding out the direction of relationship between the variables of the study. In the Granger Causality test, the vector of endogenous variables is divided in two sub-vectors, $Y_{1t}$ and $Y_{2t,}$ with dimensions $K_1$ and $K_2$ respectively, so that $K = K_1 + K_2$. The sub-vector $Y_{1t}$ is said to be Granger-causal for $Y_{2t}$ if it contains useful information for predicting the latter set of variables. For testing this property, the levels VAR following form without exogenous variables of the model is considered.

$$A_0Y_t= A_1Y_{t-1} + \ldots\ldots..+A_{p+1}Y_{t-p-1}+B_0X_t+\ldots..+B_qX_{t-q}+C^*D^*_t+ u_t$$

If that model contains p+1 lags of the endogenous variables as in the above model, the test is then based on a model with p+2 lags of the endogenous variables proposed by Dolado and Lütkepohl (1996). The null hypothesis that 1t Y is not Granger-causal for 2t Y is tested by checking the null hypothesis i $\alpha = 0$, i =1, 2... p +1.

A Wald test statistic, divided by the number of restrictions $pK_1 K_2$, is used in conjunction with an F ($pK_1 K_2$, KT − n *) distribution for testing the restrictions. Here n* is the total number of parameters in the system (Lütkepohl, 1991), including the parameters of the deterministic term. Of course, the role of $Y_{1t}$ and $Y_{2t}$ can be reversed to test Granger-causality from $Y_{1t}$ to $Y_{2t}$.

## 4. Empirical Results

### 4.1 Descriptive Statistics

Table 1 shows statistical movements of daily stock indices comprising 5 days in a week. For the whole sample period, the BSE provides the highest mean and standard deviation than that of the other markets under study. It is observed that all the selected series have non-symmetric distributions. Skewness and kurtosis measures provide insights about the underlying statistical distribution of stock indices. It is evidenced that skewness is negative and kurtosis is positive for all six markets during the period under study. However, both the skewness and kurtosis measures pertaining to the Indian stock market are significantly different from those of US markets. On the other hand, it exhibits more or less a similar pattern of statistical distribution. The Jarque-Bera statistic, defined over skewness and kurtosis measures, is very high for all six stock markets, implying that stock indices differ significantly from the normal distribution. Alternatively, this implies that in each stock market there exists opportunities for investors to benefit from these markets.

**Table-1**
**Descriptive Statistics**

| | BSE | DJIA | NASDAQ | NSE | NYSE | S&P |
|---|---|---|---|---|---|---|
| Mean | 16062.68 | 10745.10 | 2273.932 | 4818.967 | 7328.088 | 1149.246 |
| Median | 16852.91 | 11019.42 | 2326.200 | 5037.500 | 7356.790 | 1176.190 |
| Maximum | 21004.96 | 13056.72 | 2873.540 | 6312.450 | 9656.000 | 1447.160 |
| Minimum | 8160.400 | 6547.050 | 1268.640 | 2524.200 | 4226.310 | 676.5300 |
| Std. Dev. | 3100.286 | 1508.695 | 388.5276 | 912.9252 | 1153.573 | 170.2439 |
| Skewness | -0.994971 | -0.600435 | -0.660159 | -0.939301 | -0.314658 | -0.580262 |
| Kurtosis | 3.243552 | 2.401881 | 2.605039 | 3.191959 | 2.571879 | 2.435214 |
| Jarque-Bera | 161.2698 | 72.21837 | 76.20684 | 143.0856 | 23.24545 | 66.84012 |
| Probability | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000009 | 0.000000 |
| Observations | 963 | 963 | 963 | 963 | 963 | 963 |

### 4.2 Correlation Statistics

An analysis of stock index correlation is important since correlation of stock price indices could be elevated owing to the presence of an underlying time trend and the persistence of prices in level form. The pair-wise correlations of daily stock indices (the first difference of logarithm-transformed stock prices in the six markets) in Table- 2 show that the correlation of the Indian markets with other markets has strengthened during recent times. A strikingly important result is that the Indian markets have an edge over the US markets in respect of sharp increase in stock price correlation among the selected markets. Nevertheless, the stock index correlation of the Indian markets has been found lower than that of the other US markets.

**Table-2**
**Correlation Statistics**

| | BSE | DJIA | NASDAQ | NSE | NYSE | S&P |
|---|---|---|---|---|---|---|
| BSE | 1.00000 | 0.722629 | 0.83951 | 0.99912 | 0.67790 | 0.719612 |
| DJIA | 0.72263 | 1.000000 | 0.91997 | 0.71887 | 0.94695 | 0.990548 |
| NASDAQ | 0.83951 | 0.919969 | 1.00000 | 0.84069 | 0.81269 | 0.900690 |
| NSE | 0.99912 | 0.718872 | 0.84069 | 1.00000 | 0.67001 | 0.714447 |
| NYSE | 0.67790 | 0.946954 | 0.81268 | 0.67001 | 1.00000 | 0.978389 |
| S&P | 0.71961 | 0.990548 | 0.90069 | 0.71445 | 0.97839 | 1.000000 |

### 4.3 Unit Root Test Result

Two or more non-stationary time series are said to be co-integrated if a linear combination of the variables is found stationary. The test of non-stationarity is regarded as the precondition for analysing co-integration. As such, the first step in the analysis is to identify the presence of unit roots in each selected series and to verify whether the index series are non-stationary. The other assumption is that, all the series should compulsorily be integrated in the same order. For this, the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) tests are applied to the levels and first differences of each series; the null hypothesis is that a series is non-stationary and so, rejection of the unit root hypothesis supports stationarity. Lag lengths and model were chosen according to the Schwartz Information Criterion (SIC) and Bartlett Kernel & Newey-West Bandwidth. The critical values are based on MacKinnon (1996); an asterisk indicates significant at the 5 percent level.

**Table-3**
**Unit Root Tests Results**

| Index | Index level | | | | First difference | | | |
|---|---|---|---|---|---|---|---|---|
| | ADF | | PP | | ADF | | PP | |
| | Intercept | Intercept + Trend | Intercept | Intercept + Trend | Intercept | Intercept + Trend | Intercept | Intercept + Trend |
| BSE | -1.78 [0] | -2.67 [0] | -1.76 [11] | -2.66 [12] | -29.74* [0] | -29.76* [0] | -29.72*[ 13] | -29.74*[14] |
| | (0.3930) | (0.2489) | (0.3984) | (0.2542) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| DJIA | -1.60 [1] | -2.21 [1] | -1.60 [20] | -2.18 [21] | -36.24* [0] | -36.31* [0] | -36.23* [16] | -36.91*[18] |
| | (0.4806) | (0.4835) | (0.4844) | (0.5023) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| NASDAQ | -1.17 [1] | -2.50 [1] | -1.19 [13] | -2.51 [13] | -34.82* [0] | -34.86* [0] | -34.92* [11] | -35.00*[12] |
| | (0.6895) | (0.3298) | (0.6819) | (0.3230) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| NSE | -1.83 [0] | -2.80 [0] | -1.82 [11] | -2.79 [11] | -30.49* [0] | -30.51 [0] | -30.49* [12] | -30.51*[12] |
| | (0.3681) | (0.1974) | (0.3715) | (0.2011) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| NYSE | -2.18 [1] | -2.23 [1] | -2.17 [17] | -2.20 [18] | -34.93* [0] | -34.97 [0] | -35.25* [14] | -35.33*[15] |
| | (0.2127) | (0.4721) | (0.2189) | (0.4890) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| S&P | -1.87 [1] | -2.26 [1] | -1.87 [17] | -2.24 [19] | -36.28* [0] | -36.34 [0] | -36.65* [14] | -36.79*[15] |
| | (0.3457) | (0.4560) | (0.3454) | (0.4664) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |

* represent the statistical significance level of 1%, 5 % and 10%; ( ) MacKinnon (1996) one-sided p-values; [ ] Lag lengths for ADF and PP.

The results of the Augmented Dickey-Fuller (ADF) test and Philips-Perron (PP) test in Table-3 suggest that all the representative stock price indices in their natural logarithm level are non-stationary series, with the linear trend including both the intercept and the time trend. In first difference form, however, these stock price indices are stationary, plausibly with an intercept and time trend component. Thus, the chosen stock price indicators are first-order integrated series, or I(1) processes. Unit root tests are conducted using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. The results, using the Schwartz Information Criterion (SIC), are presented in Table-3. For all the level series under study the null hypothesis of a unit root is not rejected. However, when the tests are applied to the first differences of the series, the null is rejected indicating that they are stationary. Consequently all the three level series are found integrated of order one, that is, I(1).

### 4.4 Johansen Co-integration Test Result

Empirical results of the co-integration rank test are derived from Johansen's multivariate VECM involving the six stock prices chosen in the study where linear deterministic trends (restricted) are also allowed. This test determines the rank (r) of the coefficient matrix based on Vector Auto Regression (VAR) model of the series, with the rank indicates existence of any co-integration, as well as the number of co-integrating relationships. Two likelihood ratio tests are conducted, namely, the Trace Test (TT) and the Maximum Eigen Value test (MEV), to determine the number of co-integrating vectors.

**Table-4**
**Results of Johansen's Co-integration Test**
**[Unrestricted Co-integration Rank Test] (Trace)**

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Probability** |
|---|---|---|---|---|
| None * | 0.058768 | 164.4102 | 150.5585 | 0.0065 |
| At most 1 | 0.042663 | 106.3883 | 117.7082 | 0.2082 |
| At most 2 | 0.029611 | 64.61990 | 88.80380 | 0.7129 |
| At most 3 | 0.015528 | 35.82429 | 63.87610 | 0.9490 |
| At most 4 | 0.010774 | 20.83148 | 42.91525 | 0.9436 |
| At most 5 | 0.007522 | 10.45406 | 25.87211 | 0.9042 |
| At most 6 | 0.003356 | 3.220324 | 12.51798 | 0.8494 |
| Trace test indicates 1 cointegrating eqn(s) at the 0.05 level; Lags interval: 1 to 4 | | | | |

* denotes rejection of the hypothesis at the 0.05 level
** MacKinnon-Haug-Michelis (1999) p-values

**Table 4A**
**Results of Johansen's Co-integration Test**
**[Unrestricted Co-integration Rank Test] (Maximum Eigenvalue)**

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.058768 | 58.02185 | 50.59985 | 0.0072 |
| At most 1 | 0.042663 | 41.76845 | 44.49720 | 0.0961 |
| At most 2 | 0.029611 | 28.79561 | 38.33101 | 0.4016 |

| | | | | |
|---|---|---|---|---|
| At most 3 | 0.015528 | 14.99281 | 32.11832 | 0.9483 |
| At most 4 | 0.010774 | 10.37742 | 25.82321 | 0.9511 |
| At most 5 | 0.007522 | 7.233731 | 19.38704 | 0.8842 |
| At most 6 | 0.003356 | 3.220324 | 12.51798 | 0.8494 |
| Trace test indicates 1 cointegrating eqn(s) at the 0.05 level; Lags interval: 1 to 4 | | | | |

* denotes rejection of the hypothesis at the 0.05 level

** MacKinnon-Haug-Michelis (1999) p-values

The results based on those tests are shown in Table 4 and 4A where the Trace test indicates the existence of one co-integrating equations at 5% level of significance, the maximum eigenvalue test, on the other, makes the confirmation of this result. Thus, the selected variables of the study have a long-run or equilibrium relationship.

### 4.5 Pair wise Granger Causality Test Results

Results of Granger Causality Wald test performed based on Vector Error Correction Model (VECM) with the objective of revealing any causality relationship between variables in each model as are shown in Table 5. The test is also performed in determining the direction of causation between these six variables using the Vector Error Correction Model.

**Table 5**
**Results of Pair wise Granger Causality Test**

| Null Hypothesis | F-Statistic | Probability | Decision |
|---|---|---|---|
| DJIA does not Granger Cause BSE<br>BSE does not Granger Cause DJIA | 22.1222<br>2.63715 | 4.E-10<br>0.0721 | Reject |
| NASDAQ does not Granger Cause BSE<br>BSE does not Granger Cause NASDAQ | 27.3010<br>2.26184 | 3.E-12<br>0.1047 | Reject |
| NSE does not Granger Cause BSE<br>BSE does not Granger Cause NSE | 5.83169<br>9.35471 | 0.0030<br>9.E-05 | Reject |
| NYSE does not Granger Cause BSE<br>BSE does not Granger Cause NYSE | 21.9315<br>3.26433 | 5.E-10<br>0.0386 | Reject |
| S&P does not Granger Cause BSE<br>BSE does not Granger Cause S&P | 23.1327<br>3.13380 | 2.E-10<br>0.0440 | Reject |
| NASDAQ does not Granger Cause DJIA<br>DJIA does not Granger Cause NASDAQ | 3.41852<br>5.96877 | 0.0332<br>0.0027 | Reject |
| NSE does not Granger Cause DJIA<br>DJIA does not Granger Cause NSE | 2.58274<br>20.3037 | 0.0761<br>2.E-09 | Reject |
| NYSE does not Granger Cause DJIA<br>DJIA does not Granger Cause NYSE | 0.85461<br>0.63322 | 0.4258<br>0.5311 | Reject |
| S&P does not Granger Cause DJIA<br>DJIA does not Granger Cause S&P | 0.64167<br>2.55080 | 0.5266<br>0.0785 | Reject |
| NSE does not Granger Cause NASDAQ<br>Nasdaq does not Granger Cause NSE | 2.44270<br>25.1876 | 0.0875<br>2.E-11 | Reject |
| NYSE does not Granger Cause NASDAQ<br>NASDAQ does not Granger Cause NYSE | 2.97587<br>4.85404 | 0.0515<br>0.0080 | Reject |
| S&P does not Granger Cause NASDAQ<br>NASDAQ does not Granger Cause S&P | 4.58699<br>9.30931 | 0.0104<br>0.0001 | Reject |
| NYSE does not Granger Cause NSE | 20.6894 | 2.E-09 | Reject |

| | | | |
|---|---|---|---|
| NSE does not Granger Cause NYSE | 3.15220 | 0.0432 | |
| S&P does not Granger Cause NSE<br>NSE does not Granger Cause S&P | 21.3922<br>3.08743 | 8.E-10<br>0.0461 | Reject |
| S&P does not Granger Cause NYSE<br>NYSE does not Granger Cause S&P | 0.87016<br>0.81961 | 0.4192<br>0.4409 | Reject |

The results confirm rejection of the null hypothesis that any individual market of the selected six markets does not Granger Cause the other markets individually. For example, 'DJIA does not Granger Cause BSE' and also 'BSE does not Granger cause DJIA'. And in this way, the entire pair-wise Granger causality test results validate the hypothesis that any of the selected individual stock exchange does not Granger cause the other stock markets under the study. Therefore, it may be inferred that both the variables contain some significant information such that they do cause each other.

**5. Conclusion**

The particular study aspires to find out any causal relationship among the leading stock exchanges of India (BSE and NSE) and the US (DJIA, NASDAQ, NYSE and S&P) over a period from January 2008 to February 2012 and especially after the subprime mortgage crisis. Some well-versed Econometric models are being executed to examine any significant long-run affiliation among the series. The Augmented Dickey-Fuller test shows that the time series data used for the study are stationary and integrated of order one. The Johansen's co-integration test reveals that there exists long run equilibrium relation between the selected variables. The Granger causality test in the vector error correction model suggests the evidence of feedback causality running between the six stock exchanges. Thus, each variable contains some significant information so that one can be used to predict the other. Moreover, the results are found consistent with the claims by the financial analysts and also provide evidence of contagion effects on the Indian equity markets. The market suffered huge outflow of foreign capital, lesser demand for Indian exports hence thrashing export earnings, loss of confidence of the domestic financial institutions and retail investors which ultimately impacted the market to near collapse and increase in the rupee-dollar exchange rates. In a rapidly globalizing world where India's integration with other economies has been increasing, the decoupling theory was never totally persuasive; given the evidence recently - capital flow reversals, sharp widening of spreads on sovereign and corporate debt, and abrupt currency depreciations - the decoupling theory has almost completely lost credibility (Subbarao, 2008).

The present work is restricted exclusively in identifying the causal relationship among the leading stock exchanges in India and the US and has not ventured to study the assimilation with other emerging and developed markets that may help to rationalize the impacts of such shocks, thereby strengthening or weakening co-movements between India and the other economies. Finally, it has analysed only the fluctuations in return between two countries to study co-movement. Future endeavours can be made taking other areas of concern to analyse other countries and other variables as well to study the co-movements.

## References


Abas, M. (2009). Analysis of Stock Market Linkages: Chinese, Indian and Major Markets. *Unpublished Dissertation.*

Aktan, B., Mandaci, P. V., Kopurla. B. S. and Ersener. B. (2009). Behaviour of Emerging Stock Markets in the Global Financial Meltdown: Evidence from BRIC-A. *African Journal of Business Management.* Vol. 3 (9).

Arshanapalli, B. and M.S. Kulkarni. (2001). Interrelationship between Indian and US Stock Markets. *Journal of Management Research.* 1.

Auzairy, N. A. and Ahmed. R. (2009). The Impact of Subsequent Stock Market Liberalization on the Integration of Stock Market in ASEAN-4+South Korea. *World Academy of Science Engineering and Technology*. 58.

Awokuse, T. O., Chopra, A., and Bessler, D.A. (2009). Structural change and international stock market interdependence: Evidence from Asian emerging markets. *Economic Modeling.* 26.

Bose, S. (2005). Securities Market Regulations: Lessons from US and Indian Experience. *The ICRA Bulletin. Money & Finance.* Vol. 2. No. 20-21.

Chattopadhyay, S. and Behera. S. K. (2008). Financial Integration for Indian Stock Market. *Working Paper.* 12th Annual Conference on Money and Finance in the Indian Economy.

Chen, H., Lobo, J. B. and Wong, W-K. (2006). Links between the Indian, US and Chinese Stock Markets. *Working Paper No. 0602*.

Chittedi, K.R. (2009). Global Stock Markets Development and Integration: with Special Reference to BRIC Countries. *Unpublished*.

Dickey, D. and Fuller, W. (1979). Distribution of the Estimates for Autoregressive Time Series with a Unit Root. *Journal of American Statistical Association.* 74.

Dickey, D. and Fuller, W. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica. 49*.

Dolado, J.J., Lütkepohl, H. (1996). Making Wald tests work for cointegrated VAR systems. Econometric Review. 15.

Engle, R. F. (1982). Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica.* Vol. 50.

Engle, R. F. and Granger, C. W. J. (1987). Co-Integration, Error Correction: Representation, Estimation and Testing. *Econometrica.* Vol. 55(2).

Fidrmuc, J. and I. Korhonen. (2010). The Impact of the Global Financial Crisis on Business Cycles in the Emerging Economies in Asia. *Journal of Asian Economics.* Vol. 21.

Granger, C. W. J. (1986). Developments in the Study of Cointegrated Economic Variables. *Oxford Bulletin of Economics and Statistics.* Vol. 48.

Granger, C. W. J. (1988). Some Recent Developments in a Concept of Causality. *Journal of Econometrics.* Vol. 39 (1/2).

Ismail, M. T. and Rahman, R. A. (2009). Modelling the Relationships between US and Selected Asian Stock Markets, *World Applied Sciences Journal.* 7 (11).

Iqbal, A., Khalid. N. and Rafiq. S. (2011). Dynamic Interrelationship among the Stock Markets of India, Pakistan and United States. *International Journal of Human and Social Sciences.* 6:1.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control.* Vol. 12(2-3).

S. Johansen and K. Juselius (1990). Maximum likelihood estimation and inference on cointegration–with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*. Vol. 52(2).

Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models. *Econometrica.* Vol. 59.

Kearney, C. & Lucey, B.M. (2004). International Equity Market Integration: Theory, Evidence and Implications. *International Review of Financial Analysis.* Vol.13. no. 5.

Kim S.J, Moshirian F, Wu E (2005). Dynamic Stock Market Integration Driven by the European Monetary Union: An Empirical Analysis. *J. Bank. Financ*. 29.

Korajczyk, A. R. (1995). Stock Market Integration for Developed and Emerging Markets. *The World Bank Policy Research Department.* Policy Research World Paper No. 1482

Kumar, N. (2002a). Towards an Asian Economic Community- Vision of Closer Economic Cooperation in Asia: An Overview. *Research and Information System for Non-Aligned and other Developing countries (RIS).* Discussion Paper 32. New Delhi.

Kumar, N. (2002b). Towards an Asian Economic Community: The Relevance of India. *Research and Information System for Non-Aligned and other Developing countries (RIS)*. Discussion Paper 34. New Delhi.

Lamba, A.S. (2005). An Analysis of the Short- and Long-Run Relationships between South Asian and Developed Equity Markets. *International Journal of Business*. Vol. 10(4).

Longstaff, F.A.(2010). The subprime credit crisis and contagion in Financial markets. *Journal of Financial Economics.* 97. 436-450.

Longstaff, F. A., J. Pan, L. H. Pedersen, and K. J. Singleton. (2011). How sovereign is sovereign credit risk? *American Economic Journal: Macroeconomics.* 3.

MacKinnon, James G. (1996). Numerical Distribution Functions for United Root and Cointegration Tests. *Journal of Applied Econometrics*. Vol. 11, No. 6.

MacKinnon, James G., Alfred A. Haug, and Leo Michelis. (1999). Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration. *Journal of Applied Econometrics*, Vol. 14, No. 5.

Majid, M. S. A., Meera, A. K. M., Omar, M. A. and Aziz, H. A. (2009). Dynamic Linkages Among ASEAN-5 Emerging Stock Markets. *International Journal of Emerging Markets*, 4(2).

Mallik, G. (2006). Has the Stock Market Integration between the Asian and OECD Countries Improved after the Asian Crisis? *Frontiers in Finance and Economics*. Vol. 3(2).

Mishra, D. (2006). Financing India's Rapid Growth and its Implications for the Global Economy. *Mimeo*, World Bank.

Nath, G. C and Verma, S. (2003). Study of Common Stochastic Trend and Co-integration in the Emerging Markets: A Case Study of India, Singapore and Taiwan. *Research paper. NSE India.*

Phillips, P. C. B. and Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika.* Vol. 75. No. 2.

Raj, J. and Dhal, S. (2008). Integration of India's Stock Market with Global and Major Regional Markets. *BIS Papers.* No. 42.

Subbarao, D, (2008). The global financial turmoil and challenges for the Indian economy, BIS Review, Speech by Dr Duvvuri Subbarao, Governor of the Reserve Bank of India, at the Bankers' Club, Kolkata, 10 December 2008.

Toda, H.Y.and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics* 66.

Wong, W-K., Agarwal, A. and Du, J. (2005). Financial Integration for Indian Stock Market: A Fractional Cointegration Approach. *Working Paper No. 0501*. Department of Economics. National University of Singapore.

Yilmaz, K. (2010). Return and Volatility Spillovers among the East Asian Equity Markets, *Journal of Asian Economics*, Vol. 21(3).