A STUDY OF INTER-LINKAGES AMONG THE STOCK MARKETS OF INDIA, CHINA AND USA

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ABSTRACT
The present study aims to study the interlinkages among the select markets of India, China and USA, using the daily closing stock prices from January 1, 2006 through December 31, 2016. The Augmented Dickey Fuller Unit Root Test, Johansen Cointegration, Granger Causality Test and Vector Auto Regression tests are conducted using Eviews6. The co movement of the stock market indices in different countries posed a big challenge as they reduce the benefit of diversification of investment. The present study concludes that the markets are not cointegrated. The dynamics at each of the market are reflected in the prices changes at lag 1. For each of the market under study the impulse response at own market is significant and the innovations at other markets poses least threat. Thus, the investors can reap the benefits of portfolio diversification.

Keywords: Stock market, Capital market, Portfolio diversification

INTRODUCTION
International capital market relationships, not only have implications for portfolio diversification, but also have important implications for macroeconomic policies that influence trade and fiscal balances of the countries and the financial policies of different agents within the capital importing economy. In a country like India where the stock market has undergone significant transformation with the liberalization measures, there are also concerns regarding its exposure to risk in case of a global/regional crisis, i.e. a need to know how far cointegration can affect the Indian stock market in a more and more globally connected environment. Hence, the analysis of inter-linkages among the three major markets under the present study would not only give an idea of the possible gains out of portfolio diversification to be reaped from the Indian market but also may give some indication of the vulnerability of the country’s stock market in case of a crisis.

The growing international integration of financial markets has led several empirical studies to study the mechanism through which stock market movements are transmitted around the world. These studies examine how stock returns in one stock market influence the returns of other stock markets. These studies also evaluate their implications for pricing securities, hedging, other trading strategies, and framing regulatory policies. These issues have been of interests to all the participants in the stock markets in the wake of October 1987 international crash of stock markets that saw large correlated price movements across most of the stock markets of the world. It has resulted in introduction of
various regulations and institutional rules to dampen the cross-market impact of large stock movements.

The extent of the global linkage of emerging markets improves access to the international capital markets. Strong global linkage reduces the insulation of the emerging stock markets from external shocks, hence limiting the scope for independent monetary policy. From the perspective of the global investors, weak stock market linkage in the form of less than perfect correlation between their returns offers potential gains from international portfolio diversification, whereas, strong market linkage or co-movement in returns eliminates the potential benefits of diversification.

It is commonly believed that international capital inflows have huge contribution in influencing the economic behaviour of the countries positively. FIIs have gained a significant role in Indian capital markets also. With the increasing integration of Indian Stock Market with the rest of the world, more and more foreign companies are allowed to enter the domestic markets. Indian companies have been allowed to issue ADR’s (American Depository Receipts), FCCBs (Foreign currency convertible Bonds) and ECBs (External Commercial Borrowings). FIIs have been permitted to invest in all types of securities including government securities and they enjoy full capital account convertibility. The Indian stock market has witnessed unprecedented buoyancy in recent years. Strong macro-economic fundamental, positive investment climate, sound business outlook and continued foreign institutional investment supplemented by the active participation of domestic financial institutions have driven the bullish trend. They have brought quantitative and qualitative developments in Indian stock market viz., increased depth and breadth of market, expansion of securities business, removal of restrictions on foreign capital inflows, reflect market information faster than other investors due to their professional knowledge and training. Not only India, but most of the emerging economies of world are watching the similar trend.

LITERATURE REVIEW

The study on the presence of interlinkages among international capital markets has serious implications for the macroeconomic policies of countries as well as the portfolio diversification. Investors typically wish to hold securities from a variety of firms because such diversification reduces portfolio risk, similarly, investors who buy shares in foreign as well as domestic companies seek to avoid some market risk and reap rewards through global diversification. Diversification pays since stock indices of different countries do not move together exactly so that stock returns in different markets are less than perfectly correlated. International capital market relationships, not only have implications for portfolio diversification, but also have important implications for macroeconomic policies that influence trade and fiscal balances of countries and the financial policies of different agents within the capital importing economy. This section presents the studies conducted on interlinkages among the different stock markets.

Shachmurove (2006) studied the dynamic interrelationships among the stock exchanges of the US and the four emerging markets, namely Brazil, China, India, and Russia. Using daily data from May 1995 to October 2005, the dynamic linkages among these markets were analysed using VAR Models. It was found that the Brazilian stock market returns are affected to a large extent by other stock markets and the Russian stock market is affected to a lesser extent. The Chinese stock exchange seems the most isolated from exogenous disturbances and is least influenced by the US stock market. This result seems to provide for a larger extent of US purchases activities in the Chinese stock markets in order to improve diversification.

Choudhry et. al. (2007) studied the changes in the long run relationship between eight Far East countries namely Thailand, Malaysia, Indonesia, Hong Kong, Singapore, the Philippines, South Korea and Taiwan around the Asian financial crisis of 1997-98. They observed the change in the influence of the U.S. and Japanese stock markets in the Far East region before, during and after the Asian financial crisis using daily stock price indices from January 1, 1998 to January 1, 2003. The Correlation coefficients, multivariate co-integration, causality test and regression ests were used. Results showed significant long-run relationship and linkages between the Far East stock markets before, during and
after the crisis. It was also found larger U.S. influence in all periods and some evidence of increasing 
Japanese influence to the eight Far East countries were also found.

In the current context of globalization and the subsequent integration of the global markets, this paper 
examined the trends, similarities and patterns in the movements of the Indian Stock Market in 
comparison to its international counterparts. This study explored New York Stock Exchange (NYSE), 
Hong Kong Stock exchange (HSE), Tokyo Stock Exchange (TSE), Russian Stock exchange 
(RSE), Korean Stock exchange (KSE) from various socio-politico-economic backgrounds. Both 
the Bombay Stock exchange (BSE) and the National Stock Exchange of Indian Limited (NSE) have 
been used in the study as a proxy of Indian Stock Market. The time period has been divided into 
various phases to test the correlation between the various exchanges so as to prove that the Indian 
markets have become more integrated with its global counterparts and its reaction are in tandem with 
that are seen globally.

Valadkhani et al.(2008) examined the relationships between stock market returns of 13 countries based 
upon monthly data from December 1987 to April 2007. The principal component (PC) and maximum 
likelihood (ML) methods were used to examine any patterns of stock market co-movements. Factor 
analysis provides evidence that stock returns in a number of Asian countries are highly correlated and, 
based on the robust factor loadings, they form the first well-defined common factor. The paper also 
found consistent results (based on both the PC and ML methods) suggesting that the stock market 
returns of developed countries are also highly correlated.

Singh and Singh (2010) examined the linkages of the two leading emerging markets i.e. Chinese and 
Indian market with developed markets, using the correlation test, Granger causality and the co-
integration test applying error correction model. They used daily data from January 2000 to December 
2009 for the stock market indices of China, India, United States, United Kingdom, Japan and Hong 
Kong. It was found that Chinese and Indian markets are both correlated with all four major markets. 
Both markets have at least had a unilateral causality with all four developed markets. This suggests 
that the benefits of any short-term diversification, or speculative activities, are limited between them.

Majid and Kassim (2009) explored empirically the effects of the current financial crisis on the 
integration and co-movements of selected stock markets of the emerging economies, namely Indonesia 
and Malaysia. The results of this paper support the general view that stock markets tend to show 
greater degree of integration or increased co-movements during the crisis period, resulting in lesser 
benefit of diversification that can be gained by investors participating in these markets.

Majid et al (2009) empirically explored market integration among five selected Association of 
Southeast Asian Nations (ASEAN) emerging markets (Malaysia, Thailand, Indonesia, the Philippines 
and Singapore) during the pre- and post-1997 financial crisis periods. The study finds that the stock 
markets in the ASEAN region are cointegrated both during the pre- and post-1997 financial crisis. 
However, the markets are moving towards a greater integration, particularly during the post-1997 
financial crisis. Finally, as measured by the error correction terms, except the emerging market of 
Indonesia, all other ASEAN markets appear to be the important bearers of short-run adjustment to a 
shock in the long-run equilibrium relationships in the region both during the pre- and post-crisis 
periods.

Singh et. al. (2009) applied the open and closed price volatility testing the interdependence of fifteen 
world indices including an Indian market index in terms of return and volatility spillover effect. Vector 
autoregressive model (VAR) was used to estimate the conditional return spillover among these indices 
in which all fifteen indices are considered together. It is found that there is greater regional influence 
among Asian markets in return and volatility than with European and US. Japanese market, which is 
first to open, is affected by US and European markets only and affects most of the Asian Markets. US 
market is influenced by both Asian and European markets.

Modi et al. (2010) found that the correlation of BSE (India) with BVSP (Brazil), MXX (Mexico), 
FTSE100 (UK), DJIA and NASDAQ (USA) is low. Hence, these combinations provide attractive 
portfolio diversification opportunities for Indian investors.

An and Brown (2010) examined the co movements of the weekly and monthly index returns of the US,
Brazil, Russia, India, and China stock markets during October 13 1995-October 13 2009. As expected, unit-root tests for the overall period indicated that stock prices are non-stationary, but stock returns are generally stationary for all indexes. Their findings indicated that there is some cointegration between the US and China, while there is no cointegration between the US and the other emerging markets by themselves. Therefore, all the BRIC stock markets with the exception of China provide attractive portfolio diversification opportunities for global investors.

Sharma and Bodla (2011) studied the inter-linkages between stock markets of India, Pakistan and Sri Lanka. Daily closing levels of the benchmark indices in the three countries are taken for a period of January 2003-June 2010. While line charts, correlogram and unit-root test are applied to check the stationary nature of the series; Granger's causality model, vector auto regression (VAR) model and variance decomposition analysis are performed to find out the linkages between the markets under study. The paper concluded that while the National Stock Exchange (India) Granger causes Karachi Stock Exchange (Pakistan) and Colombo Stock Exchange (Sri Lanka), the vice versa is not true. These results of Granger's causality model are also confirmed by the VAR models.

Sharma et al (2011) studied the inter-linkages between stock markets of Brazil, Russia, India, and China using daily closing levels of the benchmark indices for a period of 1 April 2005 to 31 March 2010 using Granger’s causality model, Vector Auto Regression (VAR) model and Variance Decomposition Analysis. They concluded that the Indian stock exchange has shown visible impact on the Brazil and the Russia stock exchange. On the other hand, the Russia stock exchange affects none of the stock exchange but the China stock exchange affect the Indian stock exchange and Russian stock exchange, the Brazil stock exchange has the visible impact on all the stock exchange.

Ali et al (2011) investigated the co movement of Pakistan’s Equity Market with the markets of India, China, Indonesia, Singapore, Taiwan, Malaysia, Japan, USA and UK by applying cointegration test on monthly stock prices from July 1998 to June 2008. The results reveal that there is no co movement of Pakistan’s equity market with the markets of UK, USA, Taiwan, Malaysia and Singapore. Therefore, investors can reduce risk through investment in these countries. Whereas, the stock prices of Pakistan equity market move together with the stock prices of India, China, Japan and Indonesia so there is no chance of risk minimization for investors through international portfolio in these countries. Also the role of stock exchange structure is not found in the co movement of Pakistan stock market with the selected stock markets.

It seems that former empirical studies on the relationship between world stock markets do not provide consistent results. There are many reasons for the varying results including the select markets, different sample periods, different frequency of observations, and the different methodologies employed.

OBJECTIVES

The objective of the present study is to find the linkages between the stock exchanges under study and to analyse whether there exist opportunities for diversification among these stock exchanges. The objectives can be sub-classified as follows

1. Whether there exists any short term or long term relationship among the markets under study? This would bring an insight into the possibilities of diversification while investing into these markets.

2. How rapidly the shocks get transmitted among the select markets under study? This would throw light on the speed and efficiency of price adjustments in the select markets under study.

SCOPE OF THE STUDY

The present study aims to study to the inter-linkages among the stock markets of India, China and United States. The daily closing prices of the stock indices of the stock exchanges of the select countries are taken from January 1, 2006 through December 31, 2016. The Bombay BSE Sensex (BSE_IND) is the select stock exchange for India. Standard & Poor 500 Composite (SP_USA) is taken for USA and Shanghai Se Composite (SSE_CHI) is taken for China The closing prices for each of
these market is collected from yahoo finance and econometric tests are conducted using Eviews6.

**RESEARCH METHODOLOGY**

In order to analyse the linkages among the select markets the data need to be statistically analyzed. The analysis of econometrics can be performed on a series of stationary nature. In order to check whether or not the series are stationary, the line graph for each of the series is prepared. In order to further confirm the (stationary) nature of the series, the Augmented Dickey-Fuller test under the unit root test is conducted to confirm whether or not the series are stationary.

This study adopts three methods available in the literature as follows:

**Granger Causality Test**

The equation for the pairwise Granger causality test is as follows:

\[ Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \ldots + \alpha_i Y_{t-1} + \beta_1 X_{t-1} + \ldots + \beta_i X_{t-1} + \mu_t \]

Where,

\( X_t \) and \( Y_t \) = daily stock market index for country X and Y respectively
\( \mu_t \) = error term at time t

The F test is used to test the hypotheses of the Granger Causality as follow: H0: \( \beta_1 = \beta_2 = 0 \) (X does not Granger cause Y)

H1: At least one of the \( \beta_1 \neq 0 \)

The null hypothesis is rejected if the computed F-value exceeds the critical F value at the chosen level of significance. This implies that X does Granger cause Y. The test will be performed in pairs form between Sensex and other Asian stock markets.

**Unit Root Test**

This study employs Augmented Dickey-Fuller (ADF) test to determine the unit root property of the stock market indices.

This requires regressing \( \Delta Y_i \) on a constant, a time trend \( \Delta Y_{t-1} \) and several lags of dependent terms as follows:

\[ \Delta Y_t = \gamma_0 + \gamma_1 Y_{t-1} + \beta_1 \sum Y_{t-1} + \epsilon_t \]

Where,

\( \Delta = \) first difference operator
\( \gamma_0, \gamma_1 \) and \( \beta_i \) = coefficients to be estimated
\( Y_t \) = non-stationary time series
\( \epsilon_t \) = error term at time t

The following hypotheses are tested:

H0: \( \gamma = 0 \) (series contain a unit root)
H1: \( \gamma \neq 0 \) (series is stationary)

After getting the order of integration using ADF test, the presence of co-movement between the stock market indices is testing using co-integration test.

**COINTEGRATION TEST**

Thus, this study employs Augmented Dickey Fuller (ADF) tests to determine the order of integration for every stock return.

If both the variables are integrated of same order, the co-integrating regression will be estimated using OLS.

\[ Y_t = \beta_0 + \beta_1 X_t + \mu_t \]
Where \( Y \) and \( X \) are non-stationary series. The residuals, denotes as \( \mu_t \) are then tested to ensure that they are I (0) by running Augmented Dickey-Fuller (ADF) test. The time series is said to be co-integrated if the residual is itself stationary, I (0). The residual will still be non-stationary if the time series are not co-integrated. In effect the non-stationary I (1) series have cancelled each other out to produce a stationary I (0) residual.

The following hypotheses are tested:

\[ \text{H}_0: \mu_t \sim I(1) \quad \text{error term or residuals contain unit root} \]
\[ \text{H}_1: \mu_t \sim I(0) \quad \text{error term or residuals is stationary} \]

The test statistics against the critical values are checked. If t-statistics is smaller (more negative) than the critical value, null hypothesis of residuals contain unit root is rejected and conclude that the residuals or the error term is stationary. This would imply that the two stock indices are co-integrated.

**VECTOR AUTOREGRESSIVE (VAR) MODEL**

VAR models represent a system of regression equations and are actually expanded from Autoregressive (AR) models and Sims (1980) was the one of those who made these models popular in econometrics.

Generally, if a dependent variable \( Y_t \) depends on different combinations of the previous \( Y_t \) values \( (Y_t - p) \), then a general \( \text{VAR}(p) \) model can be written a

\[
Y_t = \sum_{i=1}^{p} B_i Y_{t-i} + Z_t
\]

where \( C_i \) is an intercept, a column vector of coefficients and \( B_i = B_1, \ldots, B_p \) are the \( k \times k \) matrices of coefficients, \( Z_t \sim \text{IID}(0, \Sigma) \) is a column vector of forecast errors, \( Y_{t-p} \) are fixed values and \( p \) is a lag length.

**DATA ANALYSIS**

The daily closing prices of the three stock markets taken in the study are collected from yahoo finance for a period starting from January 1, 2006 through December 31, 2016. The days when any of the markets were closed the last closing value was taken. Since the closed market did not generate new information, the information of previous day is used for the succeeding day. Taking BSE (India) as base, the missing values were filled taking the last closing price. The daily closing prices used in the present study were, then, transformed to the series of return by taking natural logarithm of the series using Eviews6. This generated a continuously compounded series with 2716 observations for further analysis.

**Table 1 Descriptive Statistics.**

<table>
<thead>
<tr>
<th></th>
<th>LOGBSE_IND</th>
<th>LOGSSE_CHI</th>
<th>LOGSP_USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>9.6827</td>
<td>7.7973</td>
<td>7.2298</td>
</tr>
<tr>
<td>Median</td>
<td>9.7555</td>
<td>7.7884</td>
<td>7.1986</td>
</tr>
<tr>
<td>Maximum</td>
<td>10.2983</td>
<td>8.7147</td>
<td>7.6643</td>
</tr>
</tbody>
</table>
Table 1 presents the summary statistics of the log transformed value of the closing value of the indices under study. The descriptive statistics for the indices under study presents the Mean, Median, Maximum, Minimum and standard deviation. Kurtosis measures the peakedness of the distribution. Greater than 3 value of kurtosis points that it is Leptokurtic distribution, with values concentrated around mean and thicker tails. Less than 3 indicates Platykurtic distribution where the values are wide spread around the mean. China and USA have platykurtic distribution and India have Leptokurtic distribution. The Jarque-Bera test statistic measures the difference of the skewness and kurtosis of the data series with those from the normal distribution. It rejects the null hypothesis that the data come from a normal distribution as the p-value is much less than 0.01 for all BSE_IND and SSE_CHI but for SP_USA. This implies that in each of the markets there exists opportunities for investors in the form of abnormal returns except for the SP_USA, where the returns do not significantly differ from the normal distribution.

Then, the log series were checked for presence of unit root using Line graphs for the log series at level and at first difference and Augmented Dickey Fuller Unit Root Test.

Graph 1 three series at level and reveals that the series are non-stationary.
Graph 2 three series at first difference and the series are found to be stationary.

The table 2 presents the result of Augmented Dickey Fuller Unit Root Test. The Critical values and the results of the different markets under study are shown below.

<table>
<thead>
<tr>
<th>Stock markets</th>
<th>level lags</th>
<th>first Difference lags</th>
<th>ADF</th>
<th>ADF</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSE_IND</td>
<td>20</td>
<td>19</td>
<td>-0.386</td>
<td>11.1088</td>
</tr>
<tr>
<td>SSE_CHI</td>
<td>14</td>
<td>13</td>
<td>-1.033</td>
<td>12.7583</td>
</tr>
<tr>
<td>DJ_USA</td>
<td>24</td>
<td>27</td>
<td>-1.717</td>
<td>9.56143</td>
</tr>
</tbody>
</table>

The Augmented Dickey Fuller Unit Root Test and the line graphs confirmed that all the series are non-stationary at level and become stationary at first difference. The three series representing the closing prices of the stock markets of different countries are stationary at first difference at 5% level of significance, that is, all the indices are integrated of order 1, i.e., I(1).

The Johansen Cointegration test is conducted to confirm the long run association or cointegration among the select stock markets. This test takes two statistics into consideration, one the trace statistics and the other is Max Eigen value. The null hypothesis under Johansen Cointegration is the number of cointegrated equations. The first null hypothesis shows the statistics for none, i.e, no cointegration. As a general rule, if the p value is less than 0.05, we reject the null hypothesis but for the p-value more than 0.05, null cannot be rejected.
Table 3
Johansen Cointegration Test

<table>
<thead>
<tr>
<th>Hypothesized</th>
<th>No. of CE(s)</th>
<th>Trace</th>
<th>0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigenvalue</td>
<td>Statistic</td>
<td>Critical Value</td>
<td>Prob.*</td>
</tr>
<tr>
<td>None</td>
<td>0.002103</td>
<td>10.90068</td>
<td>29.79707</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.001843</td>
<td>5.19291</td>
<td>15.49471</td>
</tr>
<tr>
<td>At most 2</td>
<td>7.11E-05</td>
<td>0.192759</td>
<td>3.841466</td>
</tr>
</tbody>
</table>

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

<table>
<thead>
<tr>
<th>Hypothesized</th>
<th>No. of CE(s)</th>
<th>Max-Eigen</th>
<th>0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigenvalue</td>
<td>Statistic</td>
<td>Critical Value</td>
<td>Prob.*</td>
</tr>
<tr>
<td>None</td>
<td>0.002103</td>
<td>5.707772</td>
<td>21.13162</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.001843</td>
<td>5.000151</td>
<td>14.2646</td>
</tr>
<tr>
<td>At most 2</td>
<td>7.11E-05</td>
<td>0.192759</td>
<td>3.841466</td>
</tr>
</tbody>
</table>

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The Johansen Cointegration Test result shows that there is no long run association between the stock indices under study at significance level of 5%. This indicates that there exists opportunities for portfolio diversification, as the markets under study have no co-movement in the long run.

Pairwise Granger Causality Test is conducted to confirm the causality among the select stock indices. Assuming the null hypothesis is that the variables does not Granger cause and vice versa, a rejection of the null hypothesis shows a presence of Granger causality. The Granger causality test was performed for each pair of stock indices. For all the pairs, the F-statistic and its probability is given in test result. As a general rule, for 5% significance level, if the probability value is less than 0.05, the null hypothesis cannot be accepted. In the Granger Causality test, a probability of less than 0.05 implies that there is a causality relationship.
Table 4

Pairwise Granger Causality Tests

<table>
<thead>
<tr>
<th>Lags: 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Hypothesis</td>
<td>Obs</td>
<td>F-Statistic</td>
</tr>
<tr>
<td>DLOGSSE_CHI does not Granger Cause DLOGBSE_IND</td>
<td>2713</td>
<td>5.93857</td>
</tr>
<tr>
<td>DLOGBSE_IND does not Granger Cause DLOGSSE_CHI</td>
<td>1.46638</td>
<td>0.2309</td>
</tr>
<tr>
<td>DLOGSP_USA does not Granger Cause DLOGBSE_IND</td>
<td>2713</td>
<td>4.66118</td>
</tr>
<tr>
<td>DLOGBSE_IND does not Granger Cause DLOGSP_USA</td>
<td>162.619</td>
<td>2.00E-67</td>
</tr>
<tr>
<td>DLOGSSE_CHI does not Granger Cause DLOGSP_USA</td>
<td>2713</td>
<td>0.61712</td>
</tr>
<tr>
<td>DLOGSP_USA does not Granger Cause DLOGSSE_CHI</td>
<td>41.2518</td>
<td>2.00E-18</td>
</tr>
</tbody>
</table>

The results of Granger Causality test reveal that there exists bi-directional causality among the stock markets India and the USA. The Chinese market Granger Causes Indian market under study but is not Granger caused by the same. Whereas the USA market Granger Causes the Chinese market but is not Granger Caused by the same.

The lag order selection criteria indicates lag 1 based on Schwarz information criterion and lag 2 based on Akaike information criterion.

The VAR is used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach circumvents the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. Following the AIC criterion, the optimal lag order 2 is selected. The standard error is shown in () and the t-statistics in [ ]. For the confidence level of 5%, the critical value is 1.96. The VAR estimates at Lag 2 are presented in the following section.

Table 5

Vector Autoregression Estimates

<table>
<thead>
<tr>
<th>Sample (adjusted): 4 2716</th>
</tr>
</thead>
<tbody>
<tr>
<td>Included observations: 2713 after adjustments</td>
</tr>
<tr>
<td>Standard errors in () &amp; t-statistics in [ ]</td>
</tr>
<tr>
<td>DLOGBSE_IND</td>
</tr>
<tr>
<td>DLOGBSE_IND(-1)       0.079441</td>
</tr>
<tr>
<td>-0.02053</td>
</tr>
<tr>
<td>[ 3.86932]</td>
</tr>
<tr>
<td>DLOGBSE_IND(-2)       -0.014903</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>DLOGSSE_CHI (-1)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>DLOGSSE_CHI (-2)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>DLOGSP_USA (-1)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>DLOGSP_USA (-2)</td>
</tr>
<tr>
<td></td>
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<td>C</td>
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</tbody>
</table>

The above table presents the Vector Regression Estimates (VAR) for the three markets under study at lag 1 and lag 2. The changes in BSE_IND at Lag 1 are significant to explain the changes in the closing prices of BSE_IND and SP_USA. The second Lag is significant only to explain the changes at SP_USA. The dynamics at SSE_CHI are significant to explain the price variation in BSE_IND and SP_USA at lag 1. The innovations in SP_USA are significant for the price variations in BSE_IND and SP_USA at lag 1. At lag 2 it could only capture its own dynamics.

The following section shows the Impulse response for the three markets under study.
Markets reveals that the own shocks are more important than the foreign shocks. The impulse response exhibits that the markets capture the shocks quickly and have major impact of their own innovations than that of the other markets.

CONCLUSION

The present study has taken the closing prices at the select markets of India, China and USA from January 1, 2006 through December 31, 2016. The econometric evaluation of the data is done using Eviews6. Based on the test results of Augmented Dickey Fuller Unit Root Test, Johansen Cointegration, Granger Causality Test and Vector Auto regression Test, the study concludes that

1. The markets are not cointegrated, thus there exists possibilities of portfolio diversification.
2. The price changes at BSE_IND and SP_USA are significant for each other at lag1. SSE_CHI is found to be the most alienated market and is not influenced by the dynamics at other markets under study.
3. The lag 2 is significant only for the markets own changes. The information flow from other markets gets adjusted the same day and does not have significant impact on the prices of other markets.
4. The impulse response from each of the three markets reveals that the own shocks are more important than the foreign shocks.
5. Both the Asian markets under study have higher volatility (standard deviation). This indicates that these markets are high risk investment destinations for portfolio investors.
The US market is found to be responsive to the changes at both the Indian and Chinese market. The Chinese market is least affected by other markets.

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