

# Cointegration of Asian Stock Markets: Empirical Evidence from India

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## Abstract

At present stock return is significantly related to other global stock markets. The present paper empirically investigates the short run and long run equilibrium relationship between the stock market of India, Japan Hong Kong, Singapore, Malaysia, China, and Australia monthly data during January 1995 to December 2013. Researcher employs correlation test, multivariate cointegration framework, Vector Auto Regressive error-correction model and Granger causality test with reference to financial up evils in Asia and world viz., Asian crisis (1997/98), financial crisis (2008) Inflation conditions, Natural disasters, financial up evils etc. of long run relationship. Results find that the Indian stock market return is significantly cointegrated with long run and short run situations/causalities in Asian Stock returns.

**Keywords:** Stock Return, Stock market, Integration, VAR, Error Correction Model, Granger Causality and Long run Relation

## 1. Introduction

Asian financial market development in past decades has been influenced their government policy changes regarding about foreign portfolio investment, foreign financial investments, trade relations exchange control, ease of financial restrictions, implement of innovative technologies in trading activities, LPG etc. Many restrictions were removed to flow of international capital movement and counties capital market gave the important places of diversification of investment activities and portfolios. If markets are more integrated we would expect to see their indices display common trends. Since stock market indices are no stationary, testing for cointegration is a natural procedure (Dickinson, 2001). Integration is one of the important elements in financial analysis it describes the relationship between other countries particularly in financial economics. Before existence of financial reforms bank-dominated and highly directed lending have left financial markets relatively

underdeveloped, while the 1997/98 financial crisis has left an understandable wariness of the risks of open capital markets. Unsurprisingly, then, this study finds that Asia's trade-and hence its trade-related bank claims-is much more integrated than equity markets. The economic and financial turmoil that struck Asia in mid-1997 was representative of both crisis and panic. Asia's financial systems had continued to rely upon what Professor Merton Miller has called '19th century technology'. Capital markets were poorly developed and, on the upside of the business cycle, banks extended credit excessively, misallocated capital and employed weak credit controls. The Thailand Baht was devalued on July 2, 1997, panic spread among both foreign and domestic creditors and investors. In the following months, this was transmitted to other Asian Countries. Eventually, a group of countries (Thailand, Korea, Indonesia, Malaysia, Japan, and the Philippines) suffered severe collapse of currencies and stock markets. Other countries (China, India, Hong Kong, Taiwan, and Singapore) have, so far, suffered only the indirect consequences of the crisis (Tu & Hsiao-Ching, 2000)

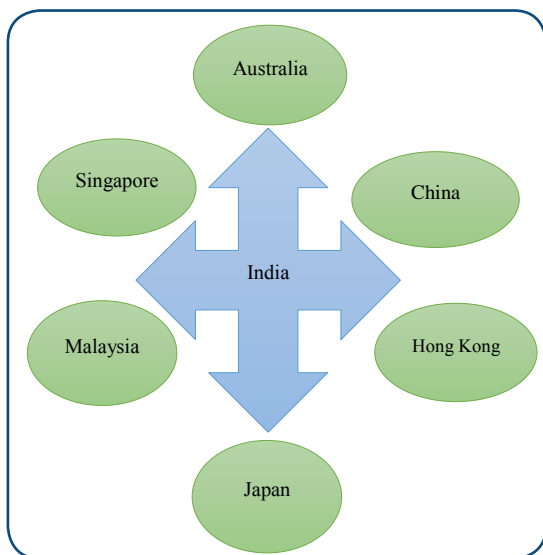
In view of financial liberalisation scenario, market has declined. Crisis or financial upheavals in Asian stock market change investor psychology due to financial shocks but as compared to other markets, stagnant growth is common in Asia and the main cause was decline of American stock market to investor psyche.

However, the possibility still exists that the inter dependence of the Indian market on other markets has been increasing, because of the recent financial liberalisation in India due to the SEBI (Security and Exchange Board of India) Act (1992) and changes in the world economic environments. Considering this possibility, this paper investigates the degree of interdependence between the stock markets of India and other major Asian markets,

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and analyses whether this interdependence has changed over the past decade. Though the Indian stock market was not among the emerging markets affected by the Asian financial crisis, India, as an Asian country, also experienced a similar financial crisis in the mid-1990; the Indian rupee depreciated 23 percent in value, against the U.S. dollar (Bahng, 2003).

The study analyses the causal relation between the Indian stock market Asian stock markets. The importance of cointegration of capital markets for the operation of free market economy is well-known. However, the influence of Asian markets on the global markets is a new problem. The growing importance of economic powerhouses like China and India poses a serious challenge to the global economy; even to the extent of challenging the US economic dominance. How does this affect India? A very important question that needs to be answered is that whether the Indian market is prepared to face the challenges these Asian markets bring and how can it benefit from them? This study will look at one aspect of the problem that is the cointegration of the Asian markets with the Indian stock market. It can provide a good understanding of the current relationship between markets and provide a preliminary framework for future studies with regard to risk diversification of foreign portfolio securities.



**Fig. 1: Co-integration Relationships with India and Asian Stock Market Index**

The rest of the paper is organised as follows. Second section discusses existing literature on the integration.

Third section deliberates the research methodology. Fourth section provides empirical Evidence. Fifth section presents suggestions and concluding remarks on the topic.

## 2. Review of Literature

The prior studies connect to stock market integration provides to inter linkages to other markets around the global and also Asian stock market integration and casual relationship to other markets. The market interdependency of global market strengthened after great stock market crash i.e., October 1987. Some literature review in this regard are briefly discussed as follows.

Tonks (1989) measured the impact of the abolition of U.K. exchange control in the degree of integration of U.K. and overseas stock markets used cointegration techniques and results find that there is no significant increase in the correlation of short-run stock market returns for the United Kingdom and certain overseas markets post 1979. There does appear to be a marked increase in the degree to which these markets move together in the long run after this date-there appears to be no long-run gain from diversifications.

In the research by Gallagher (1995), interdependencies between the Irish stock market and two other stock markets viz., the United Kingdom and Germany, are assessed. The application of cointegration techniques suggests that a long-run relationship does not exist between either the stock markets' price levels or their rates of return. He finds significant increase in the correlation between short-run returns across the markets after the 1987 stock market crash. Greater stock market integration has coincided with greater financial and economic integration. No lead-lag relationships are found for the pre-crash period in applying Granger causality tests.

The study by Bekaert (1995) develops return-based measure of market integration for nineteen emerging equity markets. It then examines (i) global factors account for a small fraction of the time variation in expected returns in most markets, and global predictability has declined over time, (ii) the emerging markets exhibit differing degrees of market integration with the U.S. market, and the differences are not necessarily associated with direct barriers to investment, (iii) the most important de facto barriers to global equity-market integration are poor credit ratings, high and variable inflation, exchange rate controls, the lack of a high-quality regulatory and

accounting framework, the lack of sufficient country funds or cross-listed securities, and the limited size of some stock markets.

Stijn Claessens (1995) investigates the behaviour of stock returns in the twenty stock markets represented in the International Finance Corporation's Emerging Markets Database. Using statistical methodologies that have identified seasonal and size-based return differences, as well as general return predictability in industrial markets, we find that these emerging markets display few of the same anomalies. In particular, we find limited evidence of turn-of-the-tax-year effects and small-firm effects. We do find, however, evidence of return predictability.

Korajczyk (1996) measures the deviations of asset returns from an equilibrium model of returns constructed assuming market integration. Applying the measure to stock returns from 24 national markets indicates that market segmentation tends to be much larger for emerging markets than for developed markets, and it tends to decrease over time.

Yuhn (1997) investigated whether the globalisation of financial markets enhances the efficiency of national stock markets. Empirical analysis indicates that the U.S. and Canadian stock markets obey the long-run equilibrium path implied by our dynamic cointegration model, but the Japanese, British, and German markets do not exhibit such characteristics. Thus, it can be claimed that the stock markets of the United States and Canada are efficient, whereas those of Japan, the United Kingdom, and Germany are not.

Kanas (1998) employs the multivariate trace statistic, the Johansen method, and the recently proposed Bierens nonparametric approach to test pairwise cointegration between the US and each of the six largest European equity markets, namely UK, Germany, France, Switzerland, Italy, and the Netherlands. The results from these tests are robust and consistent in suggesting that the US market is not pairwise cointegrated with any of the European markets, which is in contrast to previous evidence on the linkages between the US and European markets.

Tu and Hsiao-Ching (2000) used a cointegration and variance decomposition analysis to examine the linkages among the stock markets of 12 Asia-Pacific countries, before and during the period of the Asian financial crisis. The variance decomposition reveals that the 'degree of

exogeneity' for all indices has been reduced, implying that no countries are 'exogenous' to the financial crisis. The Granger's causality test suggested that the US market still 'causes' some Asian countries during the period of crisis, reflecting the US market's persisting dominant role.

Bahng (2003) investigated existence of inter-dependence between the Indian stock market and Asia's emerging markets since 1990 and analysed whether the MSCI Asian Index has significantly influenced the Bombay Stock Exchange Index before, during, and after the Asian financial crisis. He conducted uni-directional and bi-directional causality tests using the Granger causality test and then examines the impulse response functions and variance decompositions of forecast errors based on a VAR model. Results provide evidence that the influence of the Asian market on the Indian market has increased during and after the Asian financial crisis.

Ray (2003) showed that strong correlation between prices of the dual-listed stocks is corroborated by the finding of a bidirectional causality in a vector auto regression model. The competing domestic stock exchange, viz, National Stock Exchange (NSE) too is found to share the same bidirectional relation scrip-wise with the Nasdaq/New York Stock Exchange. The impulse responses pattern indicates that a positive shock in the domestic (international) price of a scrip gets transmitted in terms of a strong positive movement in the international (domestic) price the very next day. Thus, the quotes of both the markets share not only a stock-wise bidirectional causality, but markets also are efficient in processing and incorporating the pricing information.

Ray (2003) looked into the nature of relationship between the daily share price in BSE and NSE on one hand and Nasdaq and New York Stock Exchange on the other, for 1999-2000 through 2000-2001 and found a unidirectional causality from Nasdaq to BSE or NSE. The direction of causation also holds good for the technology segment of the New York Stock Exchange and BSE or NSE. Domestic prices of technology stocks and overall domestic share prices were found to be independent of each other.

Verma (2003) examined the interdependence of the three major stock markets in South Asia. He used daily stock market data from January 1994 to November 2002 of stock market indices of India (NSE NIFTY), Singapore (STI), and Taiwan (Taiex) and employed bi-variate and multivariate cointegration analysis to the linkages among

these stock markets. Results find cointegration between the stock market indices for the entire period and hence no long run equilibrium. It found mild causality for some years in the study though most of the time these markets have not been interlinked.

Wing-Keung Wong (2004) studies the issue of co-movement between stock markets in major developed countries and those in Asian emerging markets using the concept of cointegration. Results find that there is co-movement between some of the developed and emerging markets, but some emerging markets do differ from the developed markets with which they share a long-run equilibrium relationship. Furthermore, it has been observed that there has been increasing interdependence between most of the developed and emerging markets since the 1987 Stock Market Crash. This interdependence intensified after the 1997 Asian Financial Crisis and this phenomenon of increasing co-movement between developed and emerging stock markets, the benefits of international diversification become limited.

Binswanger (2004) shows that a substantial fraction of the changes in growth rates of real activity can be explained by lagged aggregate stock return variations in the U.S. as well as in other G-7 countries from the 1950s to the 1990s. The study shows that similar breakdown occurred in Canada, Japan and in an aggregate economy consisting of the four European G-7 countries.

The paper by Wing-Keung Wong (2005) empirically investigates the long-run equilibrium relationship and short-run dynamic linkage between the Indian stock market and the stock markets in major developed countries (United States, United Kingdom, and Japan) after 1990 by examining the Granger causality relationship and the pairwise, multiple and fractional cointegrations between the Indian stock market and the stock markets from these three developed markets. It concluded that Indian stock market is integrated with mature markets and sensitive to the dynamics in these markets in a long run. In a short run, both U.S and Japan Granger cause the Indian stock market but not vice versa

Lambda (2005) conducted detailed, large sample analysis of the short- and long-run relationships between the South Asian markets of India, Pakistan and Sri Lanka and the major developed markets using data from July 1997 - December 2003. Tested multivariate cointegration framework and vector error-correction modeling and

results find that the Indian market is influenced by the US, UK, and Japan and that this influence has persisted following the September 11, 2001 terrorist attacks on the US. Pakistan and Sri Lanka are relatively isolated from the major developed markets during the entire sample period. It finds that the three South Asian equity markets are becoming more integrated with each other but at a relatively slow pace.

Maneschiöld (2006) analyses the existence of long-run relationships among Baltic stock markets and major international stock markets, of United States, Japan, Germany, the United Kingdom, and France. Evidence indicates that the German market dominates this long-run relationship. In general, short-term Granger causality indicates causality running from the European markets to the Baltic markets, as well as among the Baltic States, excepting Latvian and Lithuanian short term effects on the Estonian market. Overall results suggested that international investors can obtain diversification benefits given a long-term investment horizon because of the low degree of integration between the Baltic and international capital markets.

Hunter (2006) used ADRs to examine the equity markets and concluded that markets of Argentina, Chile, and Mexico have become internationally integrated in the post-liberalisation period or direct/indirect barriers are the cause of segmentation. Researcher finds that these markets have not become integrated. There is no secular trend towards greater integration. In fact, the Brazilian and Mexican currency crises temporarily increased the level of segmentation of Argentina and Chile, and appear to have had a more persistent effect on the level of integration of Mexico, as this market has become increasingly segmented in the post-crisis period.

Otero (2007) examined the linkage between two parallel stock exchanges trading the same shares in Colombia, viz., Bogota' and Medellin' Stock Exchange. He provided empirical evidence to support the hypothesis that these two markets can be best described as fully integrated over a period of almost four decades, which is consistent with the view that arbitrage opportunities are only possible in the short but not in the long-run.

Singh (2010) examines the linkages of the two leading emerging markets i.e. Chinese and Indian market with developed markets. Author used daily data from January 2000 to December 2009, and the stock market indices of

China, India, United States, United Kingdom, Japan, and Hong Kong were examined. The linkages are modelled using the correlation test, Granger causality and the cointegration test applying error correction model. He found that Chinese and Indian markets are both correlated with all four major markets. Both markets have at least a unilateral causality with all four developed markets. It suggested that the benefits of any short-term diversification, or speculative activities, are limited between them.

Joshi (2011) tries to explore the dynamics of co-movement of stock markets of USA, Brazil, Mexico, China, and India using daily closing price data from January, 1996 to July, 2007. The long-term relationships among the markets are analysed using the Johansen and Juselius multivariate cointegration approach. Short-run dynamics are captured through vector error correction models. This enquiry revealed that there is an evidence of cointegration among the markets demonstrating that stock prices in the countries studied here share a common trend. The analysis of speed of adjustment coefficient reveals that there are significant under reaction and overreaction along with full adjustment are observed at both shorter as well as longer differencing.

Mahajan (2013) empirically investigates the long run equilibrium relationship between the stock market of India, U.S., China, Singapore, and Germany with special emphasis on evaluating the influence of U.S. based global financial crisis (2008) on this long run relationship. This exercise is based on the monthly closing data of the stock market indices for all the selected countries. Single equation Engle-Granger co-integration approach has been applied to examine one to one relationship of Indian stock market with the stock markets of other countries. The single equation analysis and approach called multivariate approach given by Johansen and Juselius (1988, 1991) is employed to study long run relationship among all the stock markets which suggested that co-movements of stock prices among the selected countries has increased after the 2008 financial crisis.

Srinivasan Palamalai (2013) examined the stock market integration among major stock markets of emerging Asia-Pacific economies, viz. India, Malaysia, Hong Kong, Singapore, South Korea, Taiwan, Japan, China, and Indonesia. The results of Granger causality/Block exogeneity Wald test based on VECM and variance decomposition analysis revealed the stock market

interdependencies and dynamic interactions among the selected emerging Asia-Pacific economies. The result suggests that investors can gain feasible benefits from international portfolio diversification in the short run. On the whole results suggest that although long-term diversification benefits from exposure to these markets might be limited, short-run benefits might exist due to substantial transitory fluctuations.

Fuerstb (2014) focuses on the relationship between stock and direct real estate markets in nine Asian countries from the period 1980 to 2012 through both linear and nonlinear cointegration techniques. He proved that there is empirical evidence of linear cointegration of stock and property markets in Taiwan, fractional cointegration in Singapore and Hong Kong and no evidence of cointegration in China, Japan, Thailand, Malaysia, Indonesia, and South Korea. He concluded that segmentation of property markets from stock markets does not appear to be linked to the differences in the maturity of national financial markets and that the differing degrees of integration across Asia may instead be reflective of a range of factors impacting upon the underlying economic structures in each country.

### 3. Research Methodology

#### 3.1 Data Set

The study includes monthly stock market indices closing values collected from the [www.yahoo.finance.com](http://www.yahoo.finance.com) and also checked the data for validity purpose to respected stock exchange websites. The data series consists of index values of India (BSE), Japan (NIKKEI), Hong Kong (HANG), Singapore (STI), Malaysia (FTSE), China (SSE), and Australia (AOI). The data encompasses the period from January 1995 to December 2013.

**Table 1: Major Asian Countries Indices**

S.No	Country	Index
1	India	S&P BSE Sensex
2	Japan NIKKEI	Nikkei 225
3	Hong Kong HSI	Hang Seng
4	Singapore STI	Straits Times
5	Malaysia	FTSE Bursa Malaysia KLCI
6	China	Shanghai SE Composite IX
7	Australia	All Ordinaries

### 3.2 Asset Return Calculation

We have converted asset price into log return value,  $R_t$  given by below equation

$$R_t = 100 \ln \left( \frac{n_t}{n_{t-1}} \right) \quad (1)$$

### 3.3 Econometric Approach

Econometric analysis is very important in financial time analysis. It finds robust measurement. We used several tests for the purpose of stock market integration and the theoretical background of selected statistics as below.

### 3.4 Stationarity Test

The time model is considered very important and it generates data and its statistical features especially conditional mean and variance, both of which are invariant data. Data which do not possess this property is called non-stationary, in random walk process. Most of the macroeconomics time series data are followed by shocks which are known to be non-stationary. Time series models are weekly stationary or assets return series is weekly stationary (Ruey, 2010). Since econometrics models use non-stationary data, they are likely to violate some important statistical properties of the estimators and give misleading inferences.

Now a simple first order autoregressive process can be written as:

$$Y_t = \mu_0 + \mu_1 t + \alpha Y_{t-1} + \varepsilon_t \quad (2)$$

Where  $Y_t$  is the stochastic process, and  $\mu_0$ ,  $\mu_1$  and  $\alpha$  are parameters. Here,  $t$  is the time period and  $\varepsilon_t$  is a random error term, with white noise properties of zero mean, constant variance and the zero covariance. Here  $\mu_0$  is called the drift parameter or constant or intercept term and the nature of the time series in the equation (2) depends on the parameter values. If  $\mu_1 \neq 0$  and  $|\alpha| < 1$ , then  $Y_t$  follows a deterministic trend. The autoregressive component,  $\alpha Y_{t-1}$ , means that there may be short run deviations, but the series will return to trend eventually. This series is called a trend stationary (TS) process, as the residuals from the regression  $Y_t$  on a constant and a trend will be stationary. If  $\mu_0 = 0$ ,  $\mu_1 = 0$  and  $\alpha = 1$ , then the series is called a simple random walk, a unit root process. And if  $\mu_0 \neq 0$ ,  $\mu_1 = 0$  and  $\alpha = 1$ , the series is said to follow a random walk with drift parameter.

Several tests have been developed for testing non-stationarity, more popularly known as unit root, in time series. These include the Dickey-Fuller, Augmented Dickey-Fuller and Phillips Perron tests to check the presence of unit root in the time series. These tests are necessitated when a time series is non-stationary because the usual t-test is inappropriate to test the null hypothesis,  $\alpha = 1$  in equation (2). Now we will discuss each type of unit root test in the following sections.<sup>1</sup>

### 3.5 Dickey-Fuller and Augmented Dickey-Fuller Tests

The Dickey-Fuller test says that in the equation (2), the first order difference equation has a unit root. Specifically, assuming the absence of trend term in equation (1), the modified form as;

$$\Delta Y_t = \mu_0 + \delta Y_{t-1} + \varepsilon_t \quad (3)$$

Where  $\Delta Y_t = Y_t - Y_{t-1}$ . Here the null hypothesis is the  $\{Y_t\}$  process has a unit root, i.e.  $H_0: \delta = \alpha - 1$ . Since  $-1 \leq \alpha \leq 0$ , it follows that  $-2 \leq \delta \leq 0$ .

More generally, if the above equation follows a  $p^{\text{th}}$  order autoregressive process, then it is called Dickey-Fuller test. But if it follows both  $p^{\text{th}}$  and  $q^{\text{th}}$  order of both autoregressive and moving average process [ARIMA (p,q)], this extended Dickey-Fuller test is called augmented Dickey-Fuller test. Specifically, if the time series follows AR(p), it can be represented as,

$$Y_t = \mu_0 + \sum_{i=1}^p \alpha_i Y_{t-i} + \varepsilon_t \quad (4)$$

After the mathematical manipulation, equation (3) can be written as,

$$\Delta Y_t = \mu_0 + \delta y_{t-1} + \sum_{i=2}^p \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (5)$$

Where  $\delta = -1(1 - \sum_{i=1}^p \alpha_i)$  and  $\beta_i = \sum_{j=i}^p \alpha_j$ .

Equation (4) is also recommended if the residuals sequence,  $\{\varepsilon_t\}$  in equation (3.2), is not a white noise, for e.g. when  $\varepsilon_t$ s are auto correlated. There are different forms of DF and ADF tests, which are possible by including trend terms in equation (2) and (4), and also excluding drift (intercept or constant) term,  $\mu_0$  from these equations. DF test is a special case of ADF test when  $p=1$ . To test the significance of  $\delta$  in equations (3.2) and (3.4), the usual Student's  $\tau$ -statistics critical values cannot be

<sup>1</sup> This is drawn from Enders (2004) and Brooks (2002).

used but  $\tau$ -statistics are made available under alternative assumption of drift, trend, sample size, and level of significance. They are abbreviated as  $\tau$  (no drift and no trend),  $\tau_\mu$  (only drift), and  $\tau_\tau$  (with both drift and trend). DF test has also provided the critical F-test values, known as  $\Phi_1$ ,  $\Phi_2$ , and  $\Phi_3$  for pair-wise joint tests of significance for  $\mu_0$  and  $\mu_1$ . Thus, the null hypothesis that  $\delta=0$  can be rejected if the computed t value for the coefficient  $\delta$  is greater than the critical  $\tau$ -value in absolute magnitude. It has been shown that the same DF test critical values are valid for the ADF test as well.

### 3.6 Phillips-Perron Test

One of the important assumptions of DF test is that the error terms are uncorrelated, homoscedastic as well as identically and independently distributed (iid). Phillip and Perron (1988) have modified the DF test, known as PP test, which can be applied when the above properties are not valid. The PP test has been shown to follow the same critical values as that of DF test; but has greater power to reject the null hypothesis of unit root. However, it cannot reject the null hypothesis when the error series follows a negative moving average process. In such situation, it is recommended to use the DF test rather than the PP test.

### 3.7 Engle-Granger Cointegration Test

If two non-stationary time series variables are integrated with I(1), then the combination is unchanged. That means if variables with different orders of integration are combined, then the combination will be integration of higher order. Cointegration between the variables ensures that long-run relationship exists between variables (Engle & Granger, 1987). For example, there exists correlation between current price and prior to price. Let see in the following equation;

$$z_t = S_t - a - bF_{t-1} \quad (1.6)$$

where,  $S_t$  is the current price at time  $F_{t-1}$  and is the past price taken at I periods before the contract matures at time t and i is the number of periods. If  $a = 0$  and  $b = 1$ , then it can be said that the two variables are cointegrated with order I(1) in the equation (5).

The Engle-Granger cointegration test has two step methods; in first step, we look the variables whether they are I(1) or not. If variables are I(1), then directly we apply OLS to measure the coefficient value and save the residuals value. Then we will test this residuals value

to ensure that they are I(0). In the second step, there is linear transformation of cointegrating vector, so any linear transformation of the cointegrating vector will be cointegrating vector.

### 3.8 Johansen Cointegration Test

In equation (5), if both variables are I(1), Johansen cointegration test is conducted. Consider a VAR with  $k^{\text{th}}$  lags containing these variables could be written as;

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + B_{xt} + \varepsilon_t \quad (7)$$

Where  $y_t$  is a k-vector of non-stationary I(1) variables,  $x_t$  is a d-vector of deterministic variables, and  $\varepsilon_t$  a vector of innovations. We can rewrite this VAR as

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \dots + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t \quad (8)$$

where,  $\Pi = \left( \sum_{j=1}^k \beta_j \right) - I_g$  and  $\sum_{j=1}^i \beta_j - I_g$

Here,  $Y_t$  is an  $(n \times 1)$  vector and  $\Delta Y_t = Y_t - Y_{t-1}$ , and  $\Pi$  and  $\Gamma$  are matrices of coefficients. If the variables are not cointegrated, then the rank of  $\Pi$  will not be significantly different from zero. Particularly, if the rank  $\Pi = 0$ , it implies no cointegration but there will be cointegration if the  $\Pi = 1$ . According to Johansen approach, there are two test statistics for cointegration;

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^g \ln(1 - \lambda_i) \quad (9)$$

$$\lambda_{\text{max}}(r, \bar{\alpha} + 1) = \bar{\alpha} T \ln(1 - \lambda_{r+1}) \quad (10)$$

where r is the number of cointegrated vectors,  $\hat{\lambda}_i$  is the estimated value for the ith order eigenvalue from the  $\Pi$  matrix, and T is the total time period. The null hypothesis should be tested for  $r=0$  and  $r=1$ . The null hypothesis cannot be rejected if  $r=0$ , that means there is no cointegration vector and there is no cointegration. On the other hand, if  $r=0$  is rejected, we conclude that there is cointegration between the variables. Thus the value of r is continually increased until the null is no longer rejected.

### 3.9 Vector Error Correction (VEC) Model

The Vector Error Correction Model (VECM) allows the short-run dynamic adjustment of variables to the long-run behaviour of the endogenous variables. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. Take a simple example of VECM model with more than

two variables as:

$$\Delta RBSE_t = \alpha_1 + \sum_{i=1}^m \beta_i \Delta RBSE_{t-i} + \sum_{j=1}^m \phi_j \Delta RAOI_{t-j} + \sum_{j=1}^m \eta_j RFTSE_{t-j} + \sum_{j=1}^m \varphi_j RHANG_{t-j} + \sum_{j=1}^m \theta_j RNIKKEI_{t-j} + \sum_{j=1}^m \gamma_j RSSE_{t-j} + \sum_{j=1}^m \zeta_j RSTI_{t-j} + Z_{t-1} + \mu_{1t} \rightarrow 1$$

$$RAOI_t = \alpha_2 + \sum_{n=1}^m \varphi_n RAOI_{t-n} + \sum_{n=1}^m \gamma_n RBSE_{t-n} + \sum_{n=1}^m \Gamma_n RFTSE_{t-n} + \sum_{n=1}^m \Lambda_n RHANG_{t-n} + \sum_{n=1}^m \theta_n RNIKKEI_{t-n} + \sum_{n=1}^m \lambda_n RSSE_{t-n} + \sum_{n=1}^m \xi_n RSTI_{t-n} + Z_{t-2} + \nu_{2t} \rightarrow 2$$

$$RFTSE_t = \alpha_3 + \sum_{l=1}^m \iota_l RFTSE_{t-l} + \sum_{l=1}^m \xi_l RBSE_{t-l} + \sum_{l=1}^m \varpi_l RAOI_{t-l} + \sum_{l=1}^m \theta_l RHANG_{t-l} + \sum_{l=1}^m \lambda_l RNIKKEI_{t-l} + \sum_{l=1}^m \vartheta_l RSSE_{t-l} + \sum_{l=1}^m \delta_l RSTI_{t-l} + Z_{t-3} + \varepsilon_{3t} \rightarrow 3$$

$$RHANG_t = \alpha_4 + \sum_{q=1}^m \xi_q RHANG_{t-q} + \sum_{q=1}^m \psi_q RBSE_{t-q} + \sum_{q=1}^m \varpi_q RAOI_{t-q} + \sum_{q=1}^m \delta_q RFTSE_{t-q} + \sum_{q=1}^m \vartheta_q RNIKKEI_{t-q} + \sum_{q=1}^m \gamma_q RSSE_{t-q} + \sum_{q=1}^m \omega_q RSTI_{t-q} + Z_{t-4} + \nu_{4t} \rightarrow 4$$

$$RSTI_t = \alpha_5 + \sum_{k=1}^m \pi_k RSTI_{t-k} + \sum_{k=1}^m \delta_k RBSE_{t-k} + \sum_{k=1}^m \theta_k RAOI_{t-k} + \sum_{k=1}^m \lambda_k RFTSE_{t-k} + \sum_{k=1}^m \phi_k RHANG_{t-k} + \sum_{k=1}^m \varphi_k RNIKKEI_{t-k} + \sum_{k=1}^m \vartheta_k RSSE_{t-k} + Z_{t-5} + \varepsilon_{5t} \rightarrow 5$$

$$RFTSE_t = \alpha_6 + \sum_{r=1}^m \lambda_r RFTSE_{t-r} + \sum_{r=1}^m \delta_r RBSE_{t-r} + \sum_{r=1}^m \theta_r RAOI_{t-r} + \sum_{r=1}^m \phi_r RHANG_{t-r} + \sum_{r=1}^m \varphi_r RNIKKEI_{t-r} + \sum_{r=1}^m \vartheta_r RSSE_{t-r} + \sum_{r=1}^m \pi_r RSTI_{t-r} + Z_{t-6} + \varepsilon_{6t} \rightarrow 6$$

$$RSSE_t = \alpha_7 + \sum_{i=1}^m \varsigma_i RSSE_{t-i} + \sum_{i=1}^m \beta_i RBSE_{t-i} + \sum_{i=1}^m \phi_i RAOI_{t-i} + \sum_{i=1}^m \vartheta_i RFTSE_{t-i} + \sum_{i=1}^m \pi_i RHANG_{t-i} + \sum_{i=1}^m \rho_i RNIKKEI_{t-i} + \sum_{i=1}^m \gamma_i RSTI_{t-i} + Z_{t-7} + \nu_{7t} \rightarrow 7$$

In this model, the right hand side is the error correction term. In long run equilibrium, this term becomes zero.  $Z_{t-1}$  to  $Z_{t-7}$  shows the Error correction term. If  $a_1$  and  $a_7$  deviate from the long run equilibrium, this term will be non-zero and each variable adjusts partially to restore equilibrium. The coefficient  $\alpha_i$  measures the speed of adjustment of the  $i^{th}$  endogenous variable towards the equilibrium.

### 4. Empirical Evidence

Before going to further analysis, descriptive statistics gives the appropriate picture of return analysis. First we show the graphical picture of major Asian stock market values over the period of the study as given in Fig. 2. The

graph shows ups and down situation for entire sample period. In 1998 and 2008 market declined financial upheavals in Asian nations. Table 2 gives the descriptive picture of Asian stock market index return statistics. It is evident from the table that the RBSE, RHANG, RSTI, RFTSE, RSSE, and RAOI have given positive mean return except RNIKKEI i.e., -0.013728. Highest mean log returns is RBSE (0.778214) and least was given RSTI i.e., 0.187112. However, as volatility concern, where there is highest return there volatility is implied. Highest volatility return is RSSE (8.337629), RBSE (7.417548) and least was RAOI i.e., 3.771411. Overall table results show that data is normally distributed it shows the Jarque-Bera test statistics.

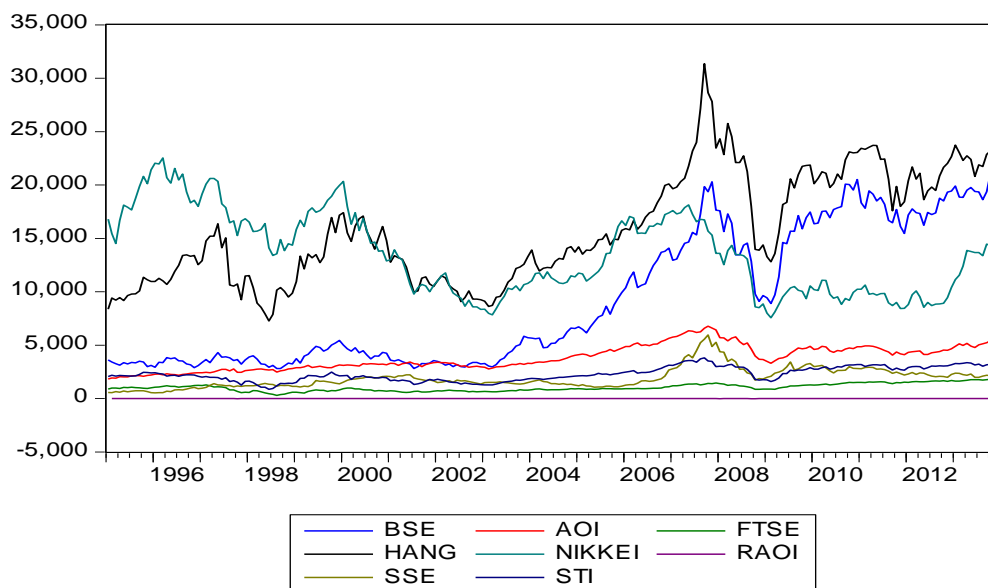


Fig. 2: Price Movement of Asian Stock Indices

**Table 2: Descriptive Statistics of Monthly Log Returns**

Descriptive	RBSE	RNIKKEI	RHANGSENG	RSTI	RFTSE	RSSE	RAOI
Mean	0.778214	-0.013728	0.451608	0.187112	0.329697	0.583586	0.472701
Median	0.750180	0.276598	1.040383	0.932448	0.918605	0.636894	1.172159
Maximum	24.88511	13.87701	25.31934	24.85503	29.44212	27.80547	7.364287
Minimum	-27.29919	-27.21623	-34.82347	-27.36404	-28.46320	-28.27794	-15.08776
Std. Dev.	7.417548	5.889194	7.345386	6.940787	6.922706	8.337629	3.771411
Skewness	-0.291166	-0.612571	-0.527075	-0.360803	-0.096310	-0.090777	-1.001261
Kurtosis	3.584853	4.188133	5.862137	6.229350	6.990095	4.203166	4.551334
Jarque-Bera	6.442660	27.54868	87.99145	103.5632	150.9357	14.00372	60.69160
Probability	0.039902	0.000001	0.000000	0.000000	0.000000	0.000910	0.000000
Sum	176.6547	-3.116363	102.5150	42.47441	74.84131	132.4740	107.3032
Sum Sq. Dev.	12434.52	7838.269	12193.76	10887.44	10830.79	15710.63	3214.520

Source: Authors Calculation

**Table 3: Correlation Analysis among Asian Log Return Indices**

	RBSE	RNIKKEI	RHANGSENG	RSTI	RFTSE	RSSE	RAOI
RBSE	1	.450**	.472**	.490**	.196**	.185**	.271**
RDJINDEX	.401**	.536**	.664**	.668**	0.12	.170*	.337**
RNIKKEI	.450**	1	.494**	.503**	.164*	0.084	.336**
RHANGSENG	.472**	.494**	1	.785**	0.118	0.106	.249**
RSTI	.490**	.503**	.785**	1	.194**	0.112	.333**
RFTSE	.196**	.164*	0.118	.194**	1	.212**	.400**
RSSE	.185**	0.084	0.106	0.112	.212**	1	.222**
RAOI	.271**	.336**	.249**	.333**	.400**	.222**	1

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

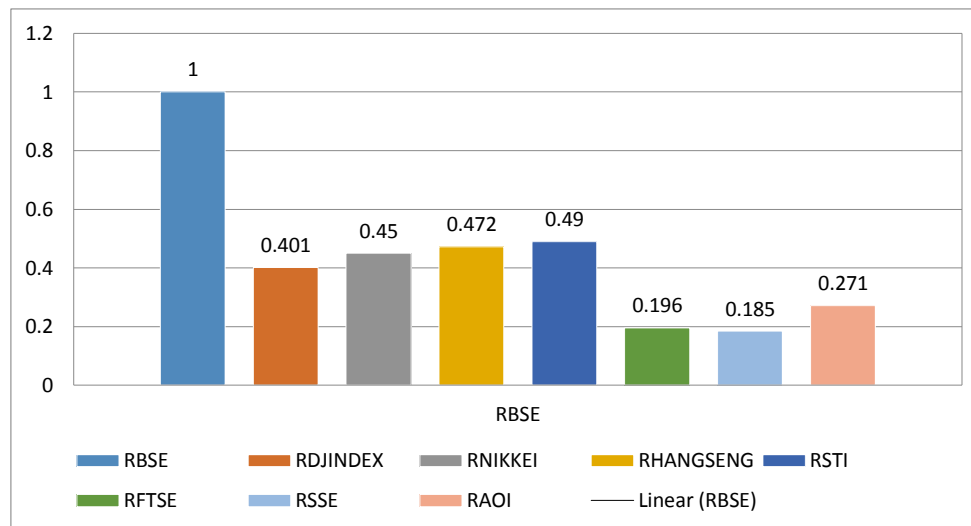
**Fig. 3: Correlation of Asian Stock Returns in Integrating BSE**

Table 3 and Fig. 3 demonstrate the Karl Pearson correlation matrix of all Asian stock market index log returns. The correlation matrixes show the correlation coefficient between RBSE and other Asian indices. RBSE is highly correlated with RSTI with correlation coefficient of 0.49 percent and it indicates strong relationship between indices. The least correlation coefficient value is found with RSSE (0.185). Other log return series are also correlated in low value but all variables are significant at 1% and 5% level.

## 5. Unit Root Test

To examine the stationary property of all the variables used in our study, we have carried out the ADF and PP unit root tests. All the tests have been conducted level and first difference, with intercept. Stock market integration between India and other Asian countries (Japan, Hong Kong, Singapore, Malaysia, China, and Australia) is explained here with the help of co-integration techniques. Hence, it is a necessary condition that the variables that appear in the stock market integration should not be integrated of order zero i.e. I(1).

**Table 4: Unit Root Test of Asian Indices**

Variable	ADF		PP	
	Level	FD	Level	FD
RBSE	-14.49747***	-12.28996***	-14.51198***	-108.9671***
RAOI	-13.82510***	-7.515446***	-13.95787***	-61.66081***
RFTSE	-4.394101***	-10.13215***	-12.51864***	-95.41108***
RHANG	-14.14060***	-8.942425***	-14.13886***	-122.2350***
RNIKKEI	-13.27630***	-9.164153***	-13.40535***	-66.60497***
RSSE	-4.991797***	-8.703042***	-14.97173***	-70.39481***
RSTI	-13.56989***	-9.922131***	-13.59549***	-106.7288***

\*\*\* 1% level \*\*5% level, \*10% level of significance \*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1) \*MacKinnon (1996) one-sided p-values.ADF: Augmented Dickey-Fuller test statistic, PP: Phillips-Perron test statistic,

Source: Author Calculation

### 5.1 Lag Length Determination

Table 5 shows the results of the lag length selection test. This paper uses numerous criteria to determine the maximum lag length. In particular, the Akaike Information Criteria (AIC), the sequential modified LR test statistic, Final Prediction Error (FPE) and the Schwarz Information Criterion (SIC) are used in order to determine

the appropriate maximum lag length to use for each of the endogenous variables. All these criteria are in accord that the maximum lag length for the endogenous variables is two (2). This implies that one should estimate the vector auto regression for this study using the lag length of two (2) for each endogenous variable.

**Table 5: VAR Lag Order Selection Criteria for Asian Stock Indices**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4806.030	NA	2.90e+10	43.95461	<b>44.06294*</b>	<b>43.99836*</b>
1	-4751.646	104.7944	2.76e+10	43.90544	44.77206	44.25544
2	-4682.387	<b>129.0310*</b>	<b>2.30e+10*</b>	43.72043*	45.34533	44.37668
3	-4655.736	47.94779	2.82e+10	43.92453	46.30771	44.88702
4	-4622.993	56.81291	3.30e+10	44.07300	47.21447	45.34175
5	-4585.334	62.93787	3.69e+10	44.17657	48.07632	45.75156
6	-4550.668	55.71804	4.27e+10	44.30747	48.96551	46.18872
7	-4511.415	60.58274	4.77e+10	44.39649	49.81281	46.58398
8	-4476.417	51.77853	5.58e+10	44.52435	50.69896	47.01810

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)  
 FPE: Final prediction error  
 AIC: Akaike information criterion  
 SC: Schwarz information criterion  
 HQ: Hannan-Quinn information criterion

After confirming the lag length and ensuring that the variables are not cointegrated, the next step is to estimate equations. The estimation is done using the variables in their stationary levels of integration. Equation one to seven VAR equation that author estimate which are explained by lagged values of D(RBSE), D(RAOI), D(RFTSE), D(RHANG), D(RNIKKEI), D(RSSE) and D(RSTI). The results also show that lagged values of each endogenous variable are significant in explaining the endogenous variable.

## 5.2 Cointegration Test

The null hypothesis of no cointegration between stock returns and variables of interest against at least one available cointegrating vector is tested using both the Engle and Granger (1987) two-step procedure and Johansen's (1988) method of maximum likelihood estimation of multi-cointegrated VAR systems (Yaz, 1996).

Author used Engle Engle-Granger test and Johansen to check the whether there is any statistical long run association between Indian stock markets and other markets. If the two time series are found to be co-integrated it means that they have a long run equilibrium relationship among them and they are cointegrated (Vanita, 2010). It is reported from Table 6.

**Table 6: Johansen Maximum Likelihood Cointegration Test**

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5% Critical Value	1% Critical Value	Max Eigen statistics	5% Critical Value	1% Critical Value
H0: $r = 0$	H1: $r = 1$	522.1744*	125.6154	135.9732	131.0978*	46.23142	52.30821
H0: $r \leq 1$	H1: $r = 2$	391.0766*	95.75366	104.9615	92.77585*	40.07757	45.86900
H0: $r \leq 2$	H1: $r = 3$	298.3008*	69.81889	77.81884	83.88851*	33.87687	39.37013
H0: $r \leq 3$	H1: $r = 4$	214.4123*	47.85613	54.68150	77.16341*	27.58434	32.71527
H0: $r \leq 4$	H1: $r = 5$	137.2488*	29.79707	35.45817	59.48107*	21.13162	25.86121
H0: $r \leq 5$	H1: $r = 6$	77.76778*	15.49471	19.93711	43.87523*	14.26460	18.52001
H0: $r \leq 6$	H1: $r = 7$	33.89255*	3.841466	6.634897	33.89255*	3.841466	6.634897

Max-eigenvalue test indicates 7 cointegratingeqn(s) at the 0.01 level

\* denotes rejection of the hypothesis at the 0.01 level

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

Both Trace and Maximum Eigen value indicate the presence of single cointegrating vector among all the stock markets at 0.01percent significant level. This implies that there is a well-defined long-run equilibrium relationship among the major stock markets, which suggests the stock market indexes move together and have high correlation in the long run, so there are limited benefits from portfolio diversification across the stock markets in the long run. By and large, the cointegrated stock markets imply that there is a common force, such as arbitrage activity, which brings the stock markets together in the long run. The Eigen-value is more considerable to test the cointegrating relation. It is because in co integration test, the Eigen values test is more noteworthy than the trace test. The maximal Eigen-values test tends to give better results than the trace tests which are either large or small (Chen, 2000).

These findings are consistent with the results of Tuand Hsiao-Ching (2000), Koh (2000) who found a significant long-run relationship between the Asian markets returns.

## 5.3 Vector Error Correction Model of Asian Log Stock Returns

Authors already proved by cointegration test that the stock market prices are cointegrated or long run relationship exists between major Asian stock markets. The long-run dynamics was examined through the effect of the lagged error correction term in the VEC model. Results of Table 7 clearly show significant error correction terms with negative sign for all the major stock market returns. Lagged  $\Delta$ RAOI and  $\Delta$ RFTSE cause the lagged  $\Delta$ RBSE. This implies that these major stock markets are

significantly adjusted to disequilibrium from the long-run relationship or the response with which the previous period's deviations from the long-run relationship are corrected is found to be significant in these major stock markets. The empirical results reveal that all the major

stock market returns of Asian economies are significantly influenced by each other, suggesting a stronger long-run bilateral relationship between major stock markets of India, Japan, Hong Kong, Singapore, Malaysia, China, and Australia.

**Table 7: Short-run Causality Results Based on based on VEC Granger Causality/Block Exogeneity Wald  $\chi^2$  test**

DP	$\Delta$ RBSE	$\Delta$ RAOI	$\Delta$ RFTSE	$\Delta$ RHANG	$\Delta$ RNIKKEI	$\Delta$ RSSE	$\Delta$ RSTI
$\Delta$ RBSE	---	5.741545*	5.984583**	0.149233	1.225859	3.952171	3.092688
$\Delta$ RAOI	25.4622***	--	2.069104	10.44458**	1.401305	2.88395	11.83034***
$\Delta$ RFTSE	45.74855***	16.94922***	---	52.08752***	5.946918*	3.517349	15.97245***
$\Delta$ RHANG	1.360304	7.409842*	13.95103***	---	0.915124	3.138582	0.920873
$\Delta$ RNIKKEI	2.162493	0.499903	0.565978	6.320541*	---	0.88255	4.230188
$\Delta$ RSSE	1.630165	4.743536*	4.340715	3.459571	2.689802	---	1.909424
$\Delta$ RSTI	0.343663	3.67423	10.2802***	11.25399***	2.426967	0.802444	---

Note:  $\Delta$  shows first difference. DP: Dependent variable

2 lag length was determined by Final prediction error criterion (FPE) and Akaike information criterion (AIC). \*, \*\* and \*\*\* significance at ten, five and one percent level, respectively.

**Table 8: VAR Estimation for Monthly Return of Asian Stock Returns**

Error Correction:	D(RBSE)	D(RAOI)	D(RFTSE)	D(RHANG)	D(RNIKKEI)	D(RSSE)	D(RSTI)
$Z_{t-1}$	-0.089203 (-1.50949)	-0.145385*** (-5.56933)	-0.358388*** (-8.34624)	0.218292*** ( 3.9374)	0.041675 (0.90976)	-0.069635 (-1.12099)	0.064690 (1.23246)
D(RBSE(-1))	-0.661621*** (-8.01421)	0.182229*** (4.99688)	0.405201*** ( 6.75470)	-0.088189 (-1.13864)	-0.041868 (-0.65423)	-0.028393 (-0.32718)	-0.042709 (-0.58244)
D(RBSE(-2))	-0.336823*** (-4.22920)	0.082269** (2.33843)	0.211138*** (3.64845)	-0.034193 (-0.45763)	-0.089621 (-1.45165)	0.068051 (0.81286)	-0.027815 (-0.39320)
D(RAOI(-1))	0.103601 ( 0.67673)	-0.536119** (-7.92760)	0.457404*** ( 4.11184)	-0.155476 (-1.08252)	0.032308 ( 0.27224)	-0.118964 (-0.73925)	-0.012540 (-0.09222)
D(RAOI(-2))	-0.234859 (-1.63191)	-0.356631*** (-5.60968)	0.200900** ( 1.92112)	-0.364603*** (-2.70042)	-0.047122 (-0.42239)	-0.323622** (-2.13919)	-0.216522* (-1.69385)
D(RFTSE(-1))	0.209302* ( 2.39834)	0.055145 ( 1.43044)	-0.325359*** (-5.13080)	-0.305683*** (-3.73363)	-0.049343 (-0.72940)	0.078608 ( 0.85690)	-0.212832*** (-2.74574)
D(RFTSE(-2))	0.062291 ( 0.75745)	0.020722 ( 0.57041)	-0.084151 (-1.40822)	-0.134364* (-1.74153)	-0.033065 (-0.51867)	0.179389** ( 2.07513)	-0.203830*** (-2.79046)
D(RHANG(-1))	0.044984 ( 0.35764)	-0.178399*** (-3.21077)	-0.649278*** (-7.10400)	-0.234880** (-1.99047)	0.245128* ( 2.51407)	0.242982* ( 1.83773)	0.340932*** ( 3.05168)
D(RHANG(-2))	0.037362 ( 0.33070)	-0.080945 (-1.62193)	-0.264408*** (-3.22086)	-0.001013 (-0.00955)	0.131675 ( 1.50353)	0.102994 ( 0.86726)	0.295007*** ( 2.93988)
D(RNIKKEI(-1))	0.103351 ( 1.03904)	0.051939 ( 1.18206)	0.125553* ( 1.73711)	0.089264 ( 0.95656)	-0.596864*** (-7.74083)	0.167508 ( 1.60203)	0.112481 ( 1.27315)
D(RNIKKEI(-2))	0.019173 ( 0.18872)	0.024075 ( 0.53644)	-0.045239 (-0.61282)	0.044749 ( 0.46951)	-0.263218*** (-3.34230)	0.053130 ( 0.49750)	-0.012668 (-0.14039)
D(RSSE(-1))	-0.092750 (-1.44723)	0.030715 ( 1.08493)	-0.071030 (-1.52527)	-0.076481 (-1.27204)	-0.037340 (-0.75162)	-0.700093*** (-10.3920)	-0.044042 (-0.77371)

Error Correction:	D(RBSE)	D(RAOI)	D(RFTSE)	D(RHANG)	D(RNIKKEI)	D(RSSE)	D(RSTI)
D(RSSE(-2))	0.023866 (0.38313)	0.046326*** (1.68355)	0.005052 (0.11161)	-0.100578* (-1.72106)	-0.042360 (-0.87724)	-0.237383*** (-3.62529)	-0.001649 (-0.02981)
D(RSTI(-1))	-0.155269 (-1.18021)	-0.168806*** (-2.90465)	-0.309518*** (-3.23777)	-0.008617 (-0.06981)	-0.173267* (-1.69898)	-0.187904 (-1.35873)	-0.808569*** (-6.91952)
D(RSTI(-2))	0.035931 (0.27570)	-0.022227 (-0.38609)	-0.019394 (-0.20480)	-0.096512 (-0.78937)	-0.016387 (-0.16221)	-0.143553 (-1.04788)	-0.377931*** (-3.26492)
C	0.048730 (0.08677)	-0.041469 (-0.16716)	0.003948 (0.00967)	-0.034416 (-0.06532)	0.010337 (0.02374)	-0.024793 (-0.04200)	-0.020110 (-0.04031)
R-squared	0.387823	0.504715	0.559782	0.426160	0.334310	0.453783	0.404846
Adj. R-squared	0.343675	0.468998	0.528035	0.384777	0.286304	0.414392	0.361927
F-statistic	8.784717	14.13071	17.63286	10.29803	6.963857	11.52006	9.432641
Log likelihood	-786.3600	-603.3465	-714.8294	-772.0615	-729.3167	-797.5412	-759.8060
Akaike AIC	7.163929	5.529879	6.525263	7.036264	6.654613	7.263761	6.926839
Schwarz SC	7.407618	5.773568	6.768952	7.279953	6.898302	7.507450	7.170528

Notes:\*\*\* Significant at the 1 percent level

\*\*Significant at the 5percent significance level.

\* Significant at the 10 percent significance level.

Figures in parentheses are t-statistics. The ordering of the variables in the VAR systems is Indian and Asia

The VAR-VECM model identify the whether market returns are long run or short run causality in equilibrium situations. Results are shown in Table 8. The tested results confirmed that Australia and Malaysia stock markets' bench market returns have long run equilibrium or long run association with Indian stock market, and Japan, Hong Kong, Singapore, and China have short run equilibrium

error correction models in proved major stock market returns equilibrium in only short term period. But, jointly influence the stock return of lag BSE stock return.

#### 5.4 Granger Causality Test

Granger Causality test determines the casual relationship between India and major Asian markets in this present study. The lags are statistically fixed at 8.

**Table 9: Granger Causality Test of Asian Indices**

Null Hypothesis	Lag 2		Lag 4		Lag 6		Lag 8	
	F- Value	$\alpha$ -value	F- Value	$\alpha$ -value	F- Value	$\alpha$ -value	F- Value	$\alpha$ -value
RAOI does not Granger Cause RBSE	1.80246	Do not Re-ject	0.95208	Do not Re-ject	0.95208	Do not Re-ject	1.53749	Do not Re-ject
RBSE does not Granger Cause RAOI	8.71458	Reject (At 1%)	5.12359	Reject (At 1%)	5.12359	Reject (At 1%)	2.80035	Reject (At 1%)
RFTSE does not Granger Cause RBSE	2.15086	Do not Re-ject	1.61205	Do not Re-ject	1.40654	Do not Re-ject	1.09915	Do not Re-ject
RBSE does not Granger Cause RFTSE	6.46407	Reject (At 1%)	4.29489	Reject (At 1%)	3.32633	Reject (At 1%)	2.63082	Reject (At 1%)
RHANG does not Granger Cause RBSE	4.74920	Reject (At 5%)	3.32558	Reject (At 5%)	2.43387	Reject (At 5%)	1.85800	Reject (At 10%)
RBSE does not Granger Cause RHANG	0.72723	Do not Re-ject	0.51835	Do not Re-ject	1.19410	Do not Re-ject	1.13944	Do not Re-ject
RNIKKEI does not Granger Cause RBSE	2.11385	Do not Re-ject	0.99404	Do not Re-ject	0.68341	Do not Re-ject	1.55455	Do not Re-ject

Null Hypothesis	Lag 2		Lag 4		Lag 6		Lag 8	
	F- Value	$\alpha$ -value	F- Value	$\alpha$ -value	F- Value	$\alpha$ -value	F- Value	$\alpha$ -value
RBSE does not Granger Cause RNIKKEI	0.02756	Do not Reject	0.62788	Do not Reject	0.45546	Do not Reject	0.77859	Do not Reject
RSSE does not Granger Cause RBSE	1.02427	Do not Reject	0.63480	Do not Reject	0.57012	Do not Reject	0.47123	Do not Reject
RBSE does not Granger Cause RSSE	2.34133	0.0986 (At 10%)	1.35181	Do not Reject	1.48539	Do not Reject	1.10097	Do not Reject
RSTI does not Granger Cause RBSE	3.76268	Reject (At 5%)	2.20048	Reject (At 10%)	2.15668	Reject (At 5%)	1.95749	Reject (At 5%)
RBSE does not Granger Cause RSTI	0.10498	Do not Reject	0.28067	Do not Reject	0.66685	Do not Reject	0.59815	Do not Reject

Notes:  $\alpha$  indicates Probability value

Source: Author Calculation

Table 9 presents the result of Granger causality test. Results find that in most cases of log stock returns unidirectional relation is a common phenomenon (Mukherjee & Mishra, 2005). RBSE Granger causes RAOI up to 8 lags at 1% level of significance. RBSE also Granger causes RFTSE overall lags at 1% significance. RBSE also causes bi-directional relation of RHANG at 5% level of significance up to 8 lags. RBSE unidirectional causality of RSSE at 1 lag period is at 10% significance level. Again RBSE directional causes of RST up to 8 lags at 5% and 10% level of significance. Results suggest that the developments in the Indian stock market do impact the Australia, Malaysia, and China stock markets. Overall results show bidirectional and unidirectional relation of constructed return series in Asian stock market. The strength of causality is more in India to Hong Kong and Malaysia.

## 6. Concluding Remarks

This study examines the stock market integration among major Asian stock markets viz. India, Japan, Hong Kong, Singapore, Malaysia, China, and Australia. Correlation and Descriptive statistics, Unit root test, ADF, PP test, Johansen and Juselius (1990) multivariate cointegration test, Granger causality/Block exogeneity Wald test based on VECM approach, and VAR-VECM were employed to investigate the dynamic linkages between markets over the period of January 1995 to December 2013 using monthly data. The results show that RBSE movements are highly correlated with RST and least with RFTSE and volatility situation is highest in RSSE log returns. The Indian stock market is integrated in long run as well as short run also. Unidirectional causality is related in Australia and

Malaysia for the reason that (i) increased financial tie ups of Asian countries, (ii) financial crisis and upheavals, (iii) directional causality in RSTI, and (iv) natural calamities also have impact on investor returns. So in all mentioned cases, it implies the development in Asian stock market and spreads to the Indian stock market. Further Indian stock market is integrated to Asian stock market and investors diversify their securities in Asian stock market and hedge the inflation situations.

These findings are consistent with the results of Choudhry and Lin (2004), Asjeet (2005), Mukherjee and Mishra (2005), Bose and Mukherjee (2006), Vanita and Shruti (2010), Srinivasan Palamalai (2013), who found a significant short run and long run relationship between the Asian stock markets.

The present study's implication is that in short run and long run equilibrium in stock market, investors automatically diversify their funds into international portfolio market. It shows the upheavals of market turmoil and the volatility situations. International integration of financial markets and exchanges of investor speculative decision of international markets. There is integration in world market in short run and long run which automatically increases their financial stability conditions. This result implies that investors can diversify the international portfolio diversification in short-run. The study results suggest that although long-term diversification benefits from exposure to these markets might be limited, short-run benefits might exist due to substantial transitory fluctuations.

For investors, the above results do suggest that there is no way to hedge against a deterioration of financial

conditions in any area during a crisis time. Although the 1998 Asian financial crisis had affected negatively major stock exchanges in the region as confirmed by former studies, the recent 2008 crisis has shown some new trends in the integration of Asian capital markets to the international financial marketplace. The author concludes that influence of stock market integration of Asian stock market to Indian stock market is very close to one and it is moving towards the financial integration with Asian economy.

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