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The 2007-09 US Crisis Impact on Asian Stock Markets Integration and Dynamic Linkages-An Introspect

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Abstract: Post-liberalization in 1980s many Asian markets have become an attractive portfolio diversification destination to the international and US investors. This raised research interest on these markets specifically in issues of co-integration and dynamic linkages. Here, I have taken sixteen Asian stock markets including representatives from SAARC, ASEAN and MENA and both developed and emerging ones under one panel along with the US market to investigate long-run co-integration and short-run dynamic relationships for the overall study period (January, 2005-June, 2012) and in pre-, during and post-crisis sub-periods. To fulfill my objectives, I have used graphical presentations, descriptive statistics results, ADF and PP tests, Johansen and Juselius's co-integration technique and sign and size of vector coefficients, Granger's causality and impulse response function analysis to investigate long-run integration and short-run dynamic linkages and variance decomposition analysis to examine volatility transmission impact. Results show time-variant degrees of co-integration in between the Asian and US markets. India is undoubtedly one of the strongest contenders to attract most of the foreign inflows as it shows positive market returns overall and during-the-crisis period also. This study would support the international investors, especiall, the Indian and US ones and their investment consultants and others to prioritize their portfolio diversification strategies in similar future periods.

Key words: Co-integration and dynamic linkages, portfolio diversification, India and US, Asian markets, JJ co-integration, sign and size coefficients, Granger causality

INTRODUCTION

Integration and dynamic linkages of international stock markets all over the world is a well-investigated topic in empirical literature. However, it never loses its importance to the academic researchers for the regulators, policy-makers, individual and institutional investors both domestic and Foreign because of immense importance in international investment scenario. Especially, international investors always look for profitable portfolio diversification opportunities in the developing markets to reap maximum gains through portfolio diversification process. However, there are many obstacles for adopting such a strategy. One of them is the integrated and dynamically linked international stock markets in which investors can't gain anything above average returns. This is because such markets rise and fall simultaneously with other co-integrated and interlinked markets. So, irrespective of their distinguishing theoretical features, the 'law of one price' (Cournot and Fisher, 1927; Marshall, 1930); portfolio diversification with risky and risk-free assets (Markowitz, 1952); Capital Asset Pricing Models (CAPM) (Lintner, 1965; Sharpe, 1964) and Arbitrage Pricing Theory (APT) (Ross, 1976) are the basis of such co-integration when risks command the same price.

Choudhry *et al*. (2007), Kearney and Lucey (2004) suggest that co-integrated stock markets reduce the benefits of international portfolio diversification in the long-run. This is so because the existence of common factors limits the amount of independent variation in stock prices (Chen *et al*., 2002). Hassan and Naka (1996) also prove that gains from portfolio diversification continue to accrue although in the short-run but not in the long-run. So, it is indispensable to investigate whether markets are co-integrated in the long-run to find out whether there is any available opportunity for the international investors to gain from portfolio diversification process outside their borders.

As the United States of America (USA) (I have used US here) is the most influential market all over the world (Morales and Andresso-O'Callaghan, 2009) especially has strong integration impact on Asia-Pacific markets (Atmadja *et al*., 2014), here I have selected US S&P 500 benchmark Index to study selected Asian stock markets co-integration in relation to the US market. However, the most important consideration for selection of the US S&P

500 Index here is that I am investigating the Asian markets co-integration and dynamic linkages amidst very recent sub-prime financial crisis which was also originated in the US financial sector in July, 2007 (Dasgupta, 2013) and caused a serious collapse in international stock markets in January, 2008 (Gokay, 2009). The serious consequences were present till mid-2009 and in the last half of the same year the world more specifically Asian stock markets begun to revive (Anonymous, 2009). Selection of most of the Asian markets including the middle-East ones along with the US and Indian markets under a study for the first time is also relevant and timely. This is so, because post-liberalization of equity markets in many Asian emerging markets during the 1980s, there has been a rising interest among international investors to invest in these markets to gain from portfolio diversification process. Their interest in the Asian emerging markets is justified based on the growth potential of these developing markets and thereby diversification of portfolio risks with above average returns.

So, here, I want to find how stock markets co-integration and short-run relationships were evident in between the US and sixteen selected Asian stock markets including India during the overall study period (i.e., January, 2005-June, 2012). Theoretically, the data would preferably be in a longer time-interval and over a long period of time for co-integration analysis (Hooker, 1993; Lahiri and Mamingi, 1995). So, I have taken monthly returns data for all the periods. This has also avoided its noisy nature. However, Click and Plummer (2005), Gerlach *et al.* (2006), Hakkio and Rush (1991) conclude that data frequency does not have a significant impact on co-integration analysis.

The existing literature is also unanimous in validating that in during the crisis periods generally a stronger short and long-run relationship is found than that of before and after such crises globally (Dasgupta, 2013; Yang *et al.*, 2003). However, in comparison to pre-crisis period, post-crisis co-integration is more prominent in empirical studies (Cheng and Glascock, 2006). So, it is necessary to examine the truth behind this observation in relation to the selected Asian markets and the corresponding US influence in different study-periods. Thereby, I have also investigated these relationships by following a balanced time-period approach for pre-crisis (January, 2005-June, 2007), during the crisis (July, 2007-December, 2009) and post-crisis (January, 2010-June, 2012) period. This is also in line with suggestions of many past empirical studies (Bekaert *et al.*, 2002; Forbes and Rigobon, 2002; Karolyi and Stultz, 1996; Lee and Kim, 1993; Lin *et al.*, 1994; Longin and Solnik, 1995, 2001) that integration and dynamic linkages of international stock markets is a time-varying concept. So, longitudinal studies should be undertaken to get authentic results. However, in between these sub-periods I have put special emphasis on the results of during-the-crisis period. This gives a precise knowledge for investment decision making to international investors to adopt their respective portfolio diversification strategies during different crisis sub-periods especially during-the-crisis period in the future. I have also given special emphasis to the Indian stock market's relationships with its Asian peers along with the US market in the overall study-period and in all sub-periods to find which of these markets was being the most favourable portfolio diversification destination to international and especially to Indian and US investors. To validate my results or find out the contradictions if any, I have compared my results with few similar and relevant past studies from earlier time-periods especially that of 1997 Asian financial crisis and also current US crisis.

Stock market integration is defined differently by various researchers in the past. Here, I have followed Kearney and Lucey (2004)'s idea of equalization of the rates of returns to define it as it is a direct approach based on the law of one price which implies that stock market indices having same risk characteristics should command similar returns under the condition of unrestricted international capital flows. The Reserve Bank of India observes in this regard that the unification of various stock markets leads to convergence of risk-adjusted returns.

Many prominent empirical studies such as Choudhry *et al.* (2007), Kasa (1992), Taylor and Tonks (1989) have used the co-integration hypothesis to investigate the integration of international financial markets in continuation with the seminal works of Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990). A co-integration model is most useful in this regard since not only it distinguishes between the nature of long-run and short-run linkages among these markets but also captures the interaction between them as well. However, Byers and Peel (1993) argue that co-integration among stock prices does not preclude the benefits of diversification. Similarly, Hakkio and Rush (1991), Sephton and Larsen (1991) have also questioned the reliability of using the co-integration hypothesis to test market efficiency and gains from portfolio diversification. This is because the extent of gains from portfolio diversification process in co-integrated markets would depend on the size of the coefficients of the long-run co-integrating vector relating to various

stock price indices or their returns (Verchenko, 2000). Therefore, portfolio diversification in the long-run would depend on the size and sign condition of the coefficients of the co-integration vector relating to various stock prices or indices returns.

Thus, to fulfill my overall objectives here I have used graphical presentations, descriptive statistics results (to verify the nature and normality of the data series), correlation test results, Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979, 1981) tests and Phillips and Perron (1988) tests (to find out the unit-roots if any), Johansen and Juselius (1990)'s co-integration technique and Granger (1969)'s pair wise causality test. I have also conducted Impulse Response Function (IRF) analysis to find the information transmission (i.e., dynamic linkages) in between studied markets and Variance Decomposition Analysis (VDA) to investigate the volatility transmission (i.e., innovation impact) within them.

This study contributes to the existing literature in several ways. First, my data is comprehensive in its time and country-coverage. It covers most of the Asian stock markets (all significant ones are included) along with the US and India. Regional markets such as the SAARC (South Asian Association of Regional Cooperation); ASEAN (Association of South-East Asian Nations) and MENA (Middle East North Africa) are also well-represented. Also, I have included the regional developed markets such as Japan and Singapore and the developing ones such as India and China under one panel. Secondly, my findings provide useful information for the Indian and US investors primarily in formulating their international portfolio diversification strategies in different periods especially during-the-crisis period. This would also help the international investment managers, brokers and fund houses irrespective of their country-origin. India is chosen as the focal point to represent an Asian emerging market which is also a departure from most of the previous empirical studies that tend to focus on developed Asian markets like Japan and Singapore. Thirdly, this study examines the impact of the recent US subprime financial crisis on the integration and dynamic linkages of Asian markets under balanced time-period and overall. It is interesting and new to analyze the impact of the crisis that starts in the developed US market on the Asian markets. Most earlier studies have worked on the impact of 1997 Asian crisis on the developed Asian markets.

Literature review: Though there are many studies investigating stock markets integration and dynamic linkages both in the short and long-run but here I have taken into consideration only the relevant ones.

Studies undertaking 1997 Asian crisis: Empirical studies such as, Cheung and Ho (1991) and DeFusco *et al.* (1996) on Asian stock markets integration in pre-Asian crisis period indicate non-existence of co-integration. They therefore suggest that international diversification across these markets is justified and desirable. However, Cheung and Mak (1992) by using weekly data from eight Asia-Pacific markets and two developed markets (i.e., US and Japan) find that the US market leads most of the Asia-Pacific markets during the years 1978-1988, except Korea, Taiwan and Thailand. This implies that US investors might not be getting much diversification benefits by investing in these Asia-Pacific markets. Masih and Masih (1999) also suggest the important role of the US market in leading the emerging Asian markets in the short as well as in the long-run.

The 1997 Asian financial crisis for the first time create a sudden and overwhelming interest among researchers to study the nature of market co-integration involving Asian markets. The main research issue was the impact of the crisis on such co-integration. Most of such studies including. Click and Plummer (2005), Ng (2002), Sheng and Tu (2000) and Yang *et al.* (2003) with the exception of Goh *et al.* (2005) and Ibrahim (2006) find evidence of strengthened integration in stock markets among the Asian peers and among US and such Asian markets during and after-crisis. These studies are also indicative that the US market is becoming more influential in leading the Asian markets. Later studies of Chen *et al.* (2009) and Ozdemir *et al.* (2009) also find enough evidential support for the increased integration. However, Goh *et al.* (2005); Ibrahim (2006) and Huyghebaert and Wang (2010) contradict with the above findings as they prove lack of co-integration among the Asian markets post-Asian financial crisis.

Thus, most of the previous studies on co-integration of Asian markets indicate that during the 1997 Asian financial crisis, market integration became stronger. However, once the financial crisis was over, the results become inconsistent.

Studies undertaking 2007-09 US crisis: Recent empirical studies on Asian stock markets integration have had the objective to capture the impact of the US sub-prime crisis of 2007-2009. Cheung *et al.* (2010) examine the impact of this crisis on the inter-relationships among global stock markets. They find a significant spillover effect from the US market to other global stock markets (i.e., UK, Hong Kong, Japan, Australia and China). The results indicate that the linkages among these markets, both the short-run causal relationships and long-run co-integration are strengthen during-the-crisis. Thus, they suggest that

international portfolio managers need to consider these increasing international linkages when constructing their client's portfolio to maximize diversification returns. Gupta and Guidi (2012) investigate the co-integration of the Indian stock market and three developed Asian markets (namely, Hong Kong, Japan and Singapore) and the US market by using daily data over the period 1999-2009. Their results show no long-run relationships between India and these Asian developed markets. The impact of the crisis is allowed when they use the Gregory-Hansen test with structural breaks but find no evidence of co-integration among these markets.

In another recent study, Graham *et al*. (2012) examine the co-movements of twenty two emerging stock markets located in America, Asia, Europe and Middle-East/Africa with the US Stock Market by employing the wavelet analysis method. The study findings indicate that the US and these emerging markets have had higher degree of co-movements. Their results also show that the strength of such co-movement varies by country. They further suggest that international investors could obtain significant diversification benefits by investing selectively in these markets, though it all depends on the investment horizon.

Dasgupta (2013) aims at investigating the relative integration and dynamic linkages of the emerging economies all over the world and the US with India to find the most attractive international portfolio diversification opportunities between 2003-12 for the overall study period and for pre-, during-and post-US 2007-09 financial crisis periods. It undertakes pair-wise Granger causality test, Johansen and Juselius's and Engle-Granger's co-integration techniques and Vector auto regressions to fulfill its objectives. The results show many unidirectional but no bidirectional causal relationships and some long-run co-integration in between these markets. He concludes that these emerging economies stock markets are the most favourable investment destinations for the US and global investors, especially, China, Brazil and India. In another recent study, Dasgupta (2016a, b) while investigating the short-run dynamic linkages and long-run integration of 27 countries all over the world under trade-agreement or economic-status based selected panels (regional mostly) find similar results. Dasgupta (2016) also provides evidence that the Indian stock market is found to have short-run granger relationships with most of its BRIC counterparts and some others. However, emerging economies stock markets and Russia don't provide any portfolio diversification opportunity for the US and other international investors.

In a very recent study, Lee and Isa (2014) find that the US sub-prime crisis has resulted in a temporary co-integration in the undertaken market groups during the peak of the crisis but it is weak or absent in the pre and post-crisis periods. They also observe that co-integration is strongest in the Malaysian and European market groups and surprisingly weak in the group involving Malaysia and its neighbouring emerging markets. The results of the causality and variance decomposition analysis strongly indicate that Malaysia is largely unrelated with other markets. Overall, their evidence points towards the possibility for diversification benefits to local Malaysian investors.

However, contradicting the idea of long-run association, Islam *et al*. (2013) investigate the transmission of volatility and financial contagion among fifteen countries from both Asia-Pacific and Europe. It is suggested that the Asia-Pacific region is co-integrated, more through real linkage than financial linkage and thus less vulnerable to persistent global shocks.

Studies comparing both 1997 Asian and 2007-09 US crises: While comparing the impact of sub-prime crisis on Asian economies with that of 1997 Asian crisis, Yoshida (2010) observes stark differences. He points out more pervasive decline in volatility spillovers during the period of financial turmoil of the Asian financial crisis. Also, he indicates the market participants' awareness during recent 2007-09 crisis which was not evident during earlier 1997 Asian crisis. Atmadja *et al*. (2014), Huyghebaert and Wang (2006) and Yang *et al*. (2003) in line with Masih and Masih (1999) and Bessler and Yang (2003) prove that the US substantially influenced the Asian markets in pre, during and post-1997 crisis periods but was almost unaffected by the Asian markets. However, Glick and Hutchison (2013) contradict by saying that the transmission of US equity returns to Asian countries decreases after the crisis. Yoshida (2010) also observes that the causality from the epicenter of crises is intensified and regional integration of Asian markets is strengthened during-crisis in the recent one. According to him such co-integration was not evident during 1997 crisis. Atmadja *et al*. (2014) by using block causality tests and the accounting innovation analysis indicate that the short-run dynamic interactions among the stock indices become more intense during the current financial crisis. However, they find that there is no indication of co-integration relationships among the Asian equity indices in the 1997 financial crisis. But, Huyghebaert and

Wang (2010) suggest that the integration of East Asian stock markets was strengthened during as well as after the 1997 Asian financial crisis.

The Singapore (Huyghebaert and Wang, 2010; Yang *et al*., 2003) and Hong Kong (Huyghebaert and Wang, 2010) market appears to be a market leader in the Asian region in terms of integration and influence while Japan doesn't take any active role. Islam (2014) observes that the Singapore market was less affected by the 1997 Asian crisis and reduces its interdependence even more in the post-crisis phase after the recent US financial crisis. In the period after the recent US crisis, the interdependence of South Korea and Malaysia with other economies is significantly low (Islam, 2014). However, South Korea has been discussed as strong conduits in both the Asian and US financial crises (Islam *et al*., 2013). Islam (2014) also suggest that although the Indian market is experiencing significant shock from the crisis among Asian economies in the post-US financial crisis period, India never had significant interdependence during the 1997 Asian crisis. While developed 'conduits' through fundamental association (Singapore) and financial association (Japan) are significant in transmitting the crisis from the US to Asia, India is turning into an 'ideal' future 'conduit' with better association, albeit with a declining magnitude of outside shock and increasing speed of adjustment. Indian stock market is therefore recently evidencing strong co-integration and emerging as a concrete evidence of pure contagion due to its rapid growth after the Asian crisis and during the US financial crisis. However, India has not yet become embroiled during crises because of its strong domestic fundamentals and international investor's interest and I find this to be a hopeful sign as other emerging Asian economies show signs of following the example of India in the coming few years. Thus, India is also an ideal candidate to attract more and more foreign inflows to provide maximum gains from portfolio diversification process. Huyghebaert and Wang (2010) has fueled this thought by pointing out that India's strongest competitor the Chinese stock market remains an isolated market despite its increased importance in the world economy.

Thus, overall I have found no such study which investigates most of the Asian stock markets under one panel like this study in terms of short- and long-run co-integration and dynamic linkages with the US and Indian market takes the centre-stage.

MATERIALS AND METHODS

I have used the monthly closing values (to calculate returns) of the bellwether indices of these sixteen Asian stock markets and the US market for the overall study period and all sub-periods. The data descriptions are shown in Table 1.

Here, I have investigated stock markets co-integration and dynamic linkages from the Indian and US perspectives. Monthly returns are identified as the difference in the natural logarithm of the closing index value for the two consecutive trading months. It is presented as:

$$R_t = \log(P_t/P_{t-1}) \quad (1)$$

Where:

R_t = Logarithmic monthly return at time t

P_{t-1} and P_t = Monthly prices of the indices at two successive months, t-1 and t, respectively

For examining short-run dynamic linkages and integration in between selected Asian and US stock markets, I have applied correlation analysis and Granger causality test. This is so because Leong and Felmingham (2003) find that correlation test results don't provide a reliable basis for empirical studies investigating integration as correlation coefficients are known to be upward-biased if the stock indices have heteroskedastic elements. Therefore, investigation should be extended by employing Granger (1969)'s pair wise causality test. Granger (1969) observes that a time series X_t Granger-causes another time series Y_t if the latter can be predicted with better accuracy by using past values of X_t rather than by not doing so, other information being identical. Thus, testing causal relations between two stationary series ΔX_t and ΔY_t is based on the following two equations:

$$\Delta Y_t = \alpha_0 + \sum_{k=1}^{p} \alpha_k \Delta Y_{t-k} + \sum_{k=1}^{p} \beta_k \Delta X_{t-k} + \mu_t \quad (2)$$

$$\Delta X_t = \varphi_0 + \sum_{k=1}^{p} \varphi_k \Delta X_{t-k} + \sum_{k=1}^{p} \phi \Delta Y_{t-k} + \upsilon_t \quad (3)$$

Where:

Δ = The difference operator

Y_{t-k} and X_{t-k} = The lagged value of Y_t and X_t, μ_t

υ_t = Disturbance terms assumed to be white noise

The lag length (k = 1, 2, ..., p) is chosen by using the Akaike Information Criterion (AIC) and/or Schwarz Information Criteria (SIC). The null hypothesis that X_t does not Granger cause Y_t is not accepted if the β_k's (k>0) are significantly different from zero using standard F test

Table 1: Asian and US stock indices information

Countris	Index	Abbreviation used in this study	Data collected from
India	S&P CNX NIFTY	NIFTY	www.econstats.com
Pakistan	Karachi 100	K100	www.econstats.com
Sri Lanka	CSE All Share	CSEALL	www.econstats.com
Japan	Nikkei 225	N225	www.econstats.com
Hong Kong	Hang Seng	HS	www.econstats.com
China	Shanghai Composite	SHCO	www.econstats.com
Korea	Korea Composite	KOSPI	www.econstats.com
Indonesia	Jakarta Composite	JACO	www.econstats.com
Malaysia	Kuala Lumpur Composite	KLCO	www.econstats.com
Philippines	PSE Composite	PSECO	www.econstats.com
Singapore	Straits Times	ST	www.econstats.com
Taiwan	Taiwan Weighted	TW	www.econstats.com
Saudi Arabia	Tadawul All Share	TASI	www.tadawul.com
UAE	Abu Dhabi General	ADG	www.adx.com
Iran	TSE 50	T50	www.tse.ir
Kuwait	Kuwait Price Index	KPI	www.kuwaitse.com
USA	S&P 500	SP500	www.econstats.com

(the statistic is for the joint hypothesis $\beta_1 = \beta_2 = ... = \beta_k = 0$). Similarly, Y_t Granger-causes X_t if the Φ_k's, k>0 are jointly different from zero.

Then, ADF (Dickey and Fuller, 1979, 1981) tests are employed to test the validity of market co-integration hypothesis by detecting the presence of stationarity in the returns data series. If a time series is non-stationary, one can study its behaviour only for the time-period under consideration. It is not possible to generalize it to other time-periods. Therefore, it will not be useful for future forecasting purposes. So, testing of unit-roots in the time series data has to be done. I have used the following equation to test for unit-roots through ADF tests:

$$\Delta y_t = \alpha_0 + \lambda y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \quad (4)$$

Where:

α_0 = A constant
λ = The coefficient of y_{t-1}
p = The lag order of autoregressive process
Δy_t = y_t-y_{t-1} are first differences of y_t, y_{t-1} are lagged values of order one of y_t, Δy_{t-i} are changes in lagged values
u_t = White noise

Thus, here I have tested the null hypothesis of $\lambda = 0$ against the alternative hypothesis of $\lambda < 0$. The null hypothesis of non-stationarity is rejected if λ is negative and significantly different from zero. I have also used the following equation to test for unit-roots through (Phillips and Perron, 1988) tests which is the AR(1) process:

$$\Delta Y_t = b_0 + \beta Y_{t-1} + e_t \quad (5)$$

Where:

Y_t = A stock price series (in logarithmic form)
b_0 = A constant
e_t = Error terms. The PP test statistics are based on the Phillips Z-test

After judging the stationarity, I have performed Johansen and Juselius (1990)'s co-integration tests to find out long-run integration of these markets most reliably. The objective of the co-integration tests is to determine whether a group of non-stationary data series is co-integrated or not. The presence of co-integrating relations forms the basis of the Vector Error Correction Model (VECM) specification. The tests for the presence of co-integration is performed when all the returns series are non-stationary and integrated of the same order.

In this study, the Johansen and Juselius (1990)'s Trace and Maximum Eigenvalue tests have been employed to test the long-run relationships among the Asian and US stock market's monthly returns series. To fulfill the above objectives the following VECM-specific equation is used:

$$\Delta y_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + \varepsilon_t \quad (6)$$

Where:

$$\Gamma_i = -\sum_{j=i+1}^{p} A_j \text{ and } \Pi = -I + \sum_{i=1}^{p} A_i$$

Here, I have also used the trace and maximum Eigenvalue tests to find the number of co-integrating vectors. The equations for these tests are as follows:

$$J_{trace} = -T \sum_{i=1+r}^{n} \ln(1-\hat{\lambda}_i) \quad (8)$$

$$J_{max} = -T\ln(1-\lambda_{r+1}) \quad (9)$$

Where:

T = The sample size
λ_i = The ith largest canonical correlation

The trace test tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of n co-integrating vectors. The maximum Eigenvalue test

on the other hand, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of r+1 co-integrating vectors. If the test statistic is greater than the critical value from the Johansens's tables, I reject the null hypothesis that there are r co-integrating vectors in favour of the alternative hypothesis under the said tests in line with Brooks (2002).

I have also applied here the Variance Decomposition Analysis (VDA) to quantify the extent up to which these seventeen stock market indices returns are influenced by each and also how the Indian and US market shock are having impact on the Asian markets. While IRF traces the effects of a shock to one endogenous variable on to the other variables in the VAR, VDA separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the VDA provides information about the relative importance of each random innovation in affecting the variables in the VAR. More specifically, it is useful for gauging the importance of innovations in one market (India and US here) to other markets and the nature of volatility transmission across markets (Chen *et al*., 2002). Thus, to support VDA I have undertaken the IRF analysis to obtain additional insights into the transmitting (of information) mechanism of the stock market movements in the Indian and US stock markets to the other Asian stock markets. The pattern of dynamic responses of each of the seventeen stock markets to a shock, i.e., positive residuals of one standard deviation unit in the Indian and US stock market have been examined during the overall period and only during-the-crisis period.

RESULTS AND DISCUSSION

Graphical and descriptive statistics results: Here, I have used graphical presentations and descriptive statistics results to disclose the normality or volatility of the selected Asian and US indices returns series. Volatility is strongly evident in all these stock market's returns throughout the overall study period and especially, during-the-crisis period. An interesting fact is that the Pakistani Stock Market does not follow the US or Indian stock markets at all. The Sri Lankan market also shows similar trends quite often. However, all other Asian markets have shown influence from the US and they had done better or worse than it during these periods. The Indian market is also mostly in line with its Asian peers but it suffers most and gains most during bad and good times.

Table 2 and 3 presents descriptive statistics results for the overall study period and all sub-periods. It is found that for the overall study period US and all Asian indices except Japan, Saudi Arabia and UAE are giving positive average returns. However, during-the-crisis period most of these markets including the US had provided negative returns. The positive returns from the Indian market along with the Sri Lankan, Hong Kong and Indonesian markets during this US crisis period imply their internal market strength, attractiveness to foreign investors and lower influence from the US and other Asian peers. It is also observed that during the pre-crisis period most Asian markets except Saudi Arabia and Iran had provided positive returns, however, in the post-crisis period the SAARC and ASEAN markets in line with the US had recovered and were giving positive returns. The SD results also imply higher volatility for these markets during-the-crisis period. The skewness value has also pointed out that except few indices returns the others have higher values (and mostly negatively skewed) during the pre, during and post crisis periods. It is also mostly true for the overall study period. It implies a deviation from normal distribution of the returns data series and asymmetry and volatility in them. The value of kurtosis has suggested that during-the-crisis most of these indices returns had leptokurtic distribution (i.e., >3) with values concentrated around the mean and thicker tails. This is in line with the overall study period. This means high probability for extreme values which is observed from the above tables. The kurtosis value of some others during other periods also indicates platykurtic distribution (i.e., <3) and the values are wider spread around the mean. The Jarque-Bera test statistics also reject (as p = 0) the null-hypothesis of normal distribution for the overall study period but not so for other periods. All these imply non-normality and volatility in most of the indices returns series during the overall study period and sometimes in sub-periods. This also implies that in each of these stock markets there exist opportunities for international investors to benefit from

Table 2: Descriptive Statistics (Overall study period (January, 2005-June, 2012)

Indices	Mean	SD	Skewness	Kurtosis	Jarque-Bera
NIFTY	0.004493	0.034690	-0.655019	5.329004	26.77672***
K100	0.003847	0.036988	-1.942397	11.311070	315.6206***
CSEALL	0.005755	0.032254	0.135792	3.307678	0.631588
N225	-0.001175	0.027121	-1.027242	5.731225	43.80185***
HS	0.001506	0.030551	-0.732111	4.596465	17.59741***
SHCO	0.002720	0.041505	-0.648865	3.883699	9.243843***
KOSPI	0.003509	0.028291	-0.864575	5.232237	29.89816***
JACO	0.006635	0.031977	-1.812338	10.740890	273.9739***
KLCO	0.002734	0.017859	-0.687516	6.086337	42.81071***
PSECO	0.005101	0.026842	-1.177251	7.002946	80.87722***
ST	0.001600	0.026865	-1.040138	7.463675	90.94480***
TW	0.000833	0.028531	-0.451206	3.516009	4.052296
TASI	-0.001062	0.040564	-0.569624	3.256845	5.114455*
ADG	-0.001095	0.034621	0.927030	7.326735	83.09316***
T50	0.001404	0.024505	0.121458	2.656217	0.664481
KPI	2.80E-05	0.026535	-1.147497	6.753123	72.57349***
SP500	0.000564	0.020698	-0.893677	4.798346	24.10756***

*, ** and *** denote significance at 1, 5 and 10% levels, respectively

Table 3: Descriptive statistics (sub-periods)

Indices	Mean	SD	Skewness	Kurtosis	Jarque-Bera
Pre-crisis period (January 2005-June 2007 (30 months))					
NIFTY	0.010571	0.024355	-0.720021	2.862401	2.615817
K100	0.011511	0.031678	-0.150651	3.059587	0.117917
CSEALL	0.007741	0.029588	-0.853219	3.872198	4.590824*
N225	0.006611	0.016736	-0.274652	3.820878	1.219470
HS	0.006157	0.014398	-0.894298	3.089542	4.008864
SHCO	0.015985	0.034094	0.460329	3.269423	1.150248
KOSPI	0.009639	0.022785	0.018266	2.224718	0.752997
JACO	0.011006	0.021769	-1.182472	4.324299	9.183414***
KLCO	0.005798	0.013059	0.704494	3.453570	2.738717
PSECO	0.010112	0.020339	-0.198691	2.233501	0.931792
ST	0.007828	0.013446	-1.650132	6.508184	28.99887***
TW	0.005347	0.017233	0.099647	2.229358	0.792010
TASI	-0.002302	0.048491	-0.321517	2.151941	1.415871
ADG	0.002077	0.045142	1.354962	5.998789	20.42053***
T50	-0.003578	0.019730	0.104518	2.219073	0.816929
KPI	0.009160	0.026369	-0.540784	4.084391	2.932116
SP500	0.003119	0.008949	-0.215969	1.984659	1.521859
During the crisis period (July 2007-December 2009 (30 months))					
NIFTY	0.002693	0.002693	-0.572187	3.797974	2.432942
K100	-0.005550	-0.005550	-1.891660	8.007720	49.23846***
CSEALL	0.003977	0.003977	0.410353	2.978812	0.842510
N225	-0.007850	-0.007850	-0.874321	4.590387	6.983846**
HS	6.62E-05	6.62E-05	-0.507783	3.000228	1.289218
SHCO	-0.002222	-0.002222	-0.825524	2.388339	3.875111
KOSPI	-0.000514	-0.000514	-0.901312	4.258919	6.042910**
JACO	0.002453	0.002453	-1.504841	6.964337	30.99781***
KLCO	-0.000900	-0.000900	-0.513719	4.115285	2.874361
PSECO	-0.002647	-0.002647	-1.136998	5.652153	15.25622***
ST	-0.002932	-0.002932	-0.577740	4.435434	4.244507
TW	-0.001180	-0.001180	-0.309329	2.297094	1.096019
TASI	-0.001940	-0.001940	-0.647403	3.027661	2.096607
ADG	-0.003708	-0.003708	-0.311292	3.162983	0.517718
T50	-0.005909	-0.005909	0.589319	3.455848	1.996233
KPI	-0.007873	-0.007873	-1.230853	5.028956	12.72083***
SP500	-0.004325	-0.004325	-0.729942	3.248550	2.741294
Post-crisis period (January 2010-June 2012 (30 months))					
NIFTY	0.000215	0.025434	0.177952	2.479775	0.496627
K100	0.005580	0.022303	-0.956012	3.209274	4.624543*
CSEALL	0.005545	0.030962	0.623002	3.401364	2.142021
N225	-0.002284	0.025131	-0.244324	2.409447	0.734413
HS	-0.001706	0.027787	-0.421808	2.962656	0.891353
SHCO	-0.005603	0.024737	0.334967	2.317483	1.143302
KOSPI	0.001403	0.022168	-0.386020	2.772278	0.809879
JACO	0.006445	0.022740	-0.416236	2.791115	0.920803
KLCO	0.003305	0.013022	-0.425695	3.221288	0.967292
PSECO	0.007839	0.022105	-0.218219	3.001545	0.238100
ST	-9.62E-05	0.020350	-0.364241	2.531196	0.938080
TW	-0.001670	0.022897	-0.204447	2.173263	1.063360
TASI	0.001057	0.022108	-0.258723	2.722300	0.431085
ADG	-0.001653	0.015592	0.632366	2.618810	2.181068
T50	0.013698	0.025134	-0.613177	3.423457	2.104076
KPI	0.001203	0.013368	-0.518077	3.195904	1.389994
SP500	0.002897	0.020842	-0.142992	2.310830	0.695928

*, ** and *** denote significance at 1, 5 and 10% levels, respectively

above average returns in case of portfolio diversification. However, it is significant to note that in the post-crisis period most of these Asian stock markets and the US have become normal and less volatile than other periods.

ADF and PP tests results: As there is strong evidence of volatility and non-stationarity in these returns data series, I have used the ADF and PP tests to find out whether they contain any unit-roots or not.

The results have not indicated the presence of unit-roots under PP tests results and except in one case (under ADF tests result for KLCO) in the selected US and Asian indices returns series for the overall study period and during all sub-periods. Hence, changes in them are mostly stationary. In other words, all stock market indices returns series are integrated of order zero (i.e., I (0)).

Short-run results: The correlation test results and pair wise Granger causality relationships along with IRF analysis results are analyzed here to find out whether these Asian markets have any short-run relationships and dynamic linkages with the US market in the overall study period and during sub-periods (during-the-crisis period is strongly emphasized). Also, their relationships with the Indian NIFTY Index have been especially examined.

It is found that the Indian Stock Market have had close association with thirteen others (except Pakistan, Iran and Kuwait) selected international stock markets in the short-run in during-the-crisis period. However, in the pre and post-crisis periods less short-run relationships are observed with the Indian NIFTY Index. Especially, the ASEAN stock markets had short-run relationships. Also, the US market was always correlated with the Indian stock market in all periods. The results also point out that the US market had been showing more short-run relationships with the Asian markets in during and post-crisis periods. However, in the pre-crisis period it was only interrelated with the Indian, Hong Kong, Korean and Indonesian markets.

It is also an interesting fact that the Pakistani, Sri Lankan and Iranian stock markets were not correlated in the short-run during the overall study period with any of their Asian peers or the US. In the pre-crisis period also, they had shown a similar trend. During-the-crisis results indicate an overwhelming presence of short-run relationships in Asia and with the US than any other sub-periods. In line with this, although the Sri Lankan and Iranian (only with Kuwait) markets show correlation but Pakistani market still didn't show any short-run relationships. However, in the post-crisis period although Pakistani market has had relationships with some other Asian peers but the Sri Lankan and Iranian markets again didn't show any correlations with others.

Table 4 and 5 presents Granger causality test results for the overall study period and sub-periods for all these indices returns series to make my study more in-depth.

It is found that the Indian stock market had only one (i.e., Iranian stock market Granger causes it) and the US market had only two (i.e., Pakistan and Iranian stock markets Granger cause the SP500) significant short-run causal relationships with any other selected markets here. However, these results are contradictory with the earlier

Table 4: Pair wise Granger causality test results (Overall study period (January, 2005-June, 2012))

Causal effect	F-statistic	Probability
NIFTY→CSEALL	4.49223	0.0369
T50→NIFTY	9.14444	0.0033
K100→N225	6.32930	0.0137
K100→HS	5.00703	0.0278
K100→KOSPI	3.82360	0.0538
K100→JACO	3.76760	0.0555
K100→TW	6.17360	0.0149
K100→SP500	9.04538	0.0035
JACO→CSEALL	5.78357	0.0183
KLCO→CSEALL	5.09603	0.0265
ST→CSEALL	8.12142	0.0055
TW→CSEALL	6.77919	0.0109
TASI→CSEALL	3.99075	0.0489
CSEALL→ADG	4.89808	0.0295
T50→CSEALL	4.72704	0.0324
CSEALL→T50	4.30105	0.0411
SP500→CSEALL	3.87867	0.0521
N225→KOSPI	5.73161	0.0188
N225→JACO	3.79115	0.0548
N225→PSECO	4.27383	0.0417
HS→PSECO	4.67370	0.0334
TW→HS	3.67238	0.0586
T50→HS	9.06612	0.0034
SHCO→PSECO	3.77745	0.0552
ADG→SHCO	8.93588	0.0036
TW→KOSPI	8.25093	0.0051
JACO→PSECO	5.75939	0.0186
T50→JACO	7.43150	0.0078
KLCO→PSECO	9.47142	0.0028
ST→KLCO	3.83462	0.0534
T50→KLCO	6.72724	0.0112
ST→PSECO	6.26051	0.0142
TW→PSECO	4.53809	0.0360
TASI→PSECO	5.98336	0.0165
T50→PSECO	13.33600	0.0004
TW→ST	3.66426	0.0589
T50→ST	9.60201	0.0026
T50→TW	5.90853	0.0171
TW→SP500	4.71649	0.0326
ADG→T50	6.05746	0.0158
KPI→ADG	4.88021	0.0298
T50→SP500	13.40760	0.0004
KPI→SP500	6.27553	0.0141

*, ** and *** denote significance at 1, 5 and 10% levels, respectively

Table 5: Pair wise Granger causality test results (sub-periods)

Causal effect	F-statistic	Probability
Pre-crisis period (January 2005-June 2007 (30 months))		
JACO→SHCO	6.52112	0.0169
KLCO→SHCO	6.15498	0.0199
TASI→SHCO	7.50561	0.0110
ADG→SHCO	10.89700	0.0028
KPI→SHCO	5.12133	0.0322
KOSPI→KPI	4.91360	0.0356
JACO→PSECO	4.29588	0.0483
T50→KLCO	3.92210	0.0583
During the crisis period (July 2007-December 2009 (30 months))		
NIFTY→CSEALL	4.46135	0.0444
HS→NIFTY	6.92084	0.0141
NIFTY→HS	5.89542	0.0224
T50→NIFTY	6.03502	0.0210
K100→SP500	7.10736	0.0130
N225→CSEALL	5.88008	0.0226
HS→CSEALL	4.73869	0.0388
KOSPI→CSEALL	4.49957	0.0436
JACO→CSEALL	12.39600	0.0016
KLCO→CSEALL	4.13731	0.0523
CSEALL→PSECO	6.03985	0.0210
ST→CSEALL	9.05449	0.0058
TW→CSEALL	8.99452	0.0059
TASI→CSEALL	4.19059	0.0509
KPI→CSEALL	4.79010	0.0378
SP500→CSEALL	13.81390	0.0010
N225→KOSPI	4.56359	0.0422
HS→PSECO	5.78591	0.0236
T50→HS	6.92171	0.0141
SHCO→T50	4.51056	0.0434
TW→KOSPI	9.33299	0.0051
T50→KOSPI	4.87829	0.0362
KOSPI→T50	5.50218	0.0269
JACO→TASI	11.51180	0.0022
T50→JACO	5.44085	0.0277
T50→KLCO	4.80261	0.0376
T50→PSECO	5.98477	0.0215
T50→ST	7.52961	0.0109
T50→TW	6.70628	0.0155
TW→T50	5.35855	0.0288
TASI→T50	4.97360	0.0346
ADG→T50	9.92048	0.0041
KPI→ADG	4.82534	0.0372
T50→SP500	7.16841	0.0127
Post-crisis period (January 2010-June 2012 (30 months))		
KOSPI→NIFTY	8.35882	0.0077
NIFTY→KOSPI	6.00754	0.0213
JACO→NIFTY	3.99142	0.0563
ST→NIFTY	4.74710	0.0386
NIFTY→ST	7.64945	0.0103
SP500→NIFTY	3.97883	0.0567
K100→TASI	4.16003	0.0517
ADG→K100	4.93169	0.0353
CSEALL→SHCO	5.07311	0.0330
T50→CSEALL	4.00596	0.0559
JACO→N225	4.03326	0.0551
KLCO→JACO	4.89156	0.0360
TASI→SP500	5.73185	0.0242
KPI→SP500	5.69602	0.0246

*, ** and *** denote significance at 1, 5 and 10% levels, respectively

correlation results. It is also observed that the Korean stock market had significantly Granger caused the Indian stock market in the post-crisis period. The US stock market on the other hand Granger caused the Sri Lankan market significantly during-the-crisis period. No other significant short-run unidirectional or bidirectional causal relationships were found in between the US and Indian stock markets with other Asian markets during any other period. However, NIFTY and HS in during-the-crisis period and NIFTY and KOSPI in post-crisis period had bidirectional causal relationships (though mostly not fully significant) in the short-run.

The Iranian stock market had also shown many short-run significant causal relationships with mainly the ASEAN markets. Along with NIFTY and SP500, it also Granger caused Hong Kong, Indonesian, Philippines and Thailand stock markets. All these results are however in contradiction with earlier correlation results. The Sri Lankan stock market had been Granger caused by most Asian peers in during-the-crisis period but not in other periods.

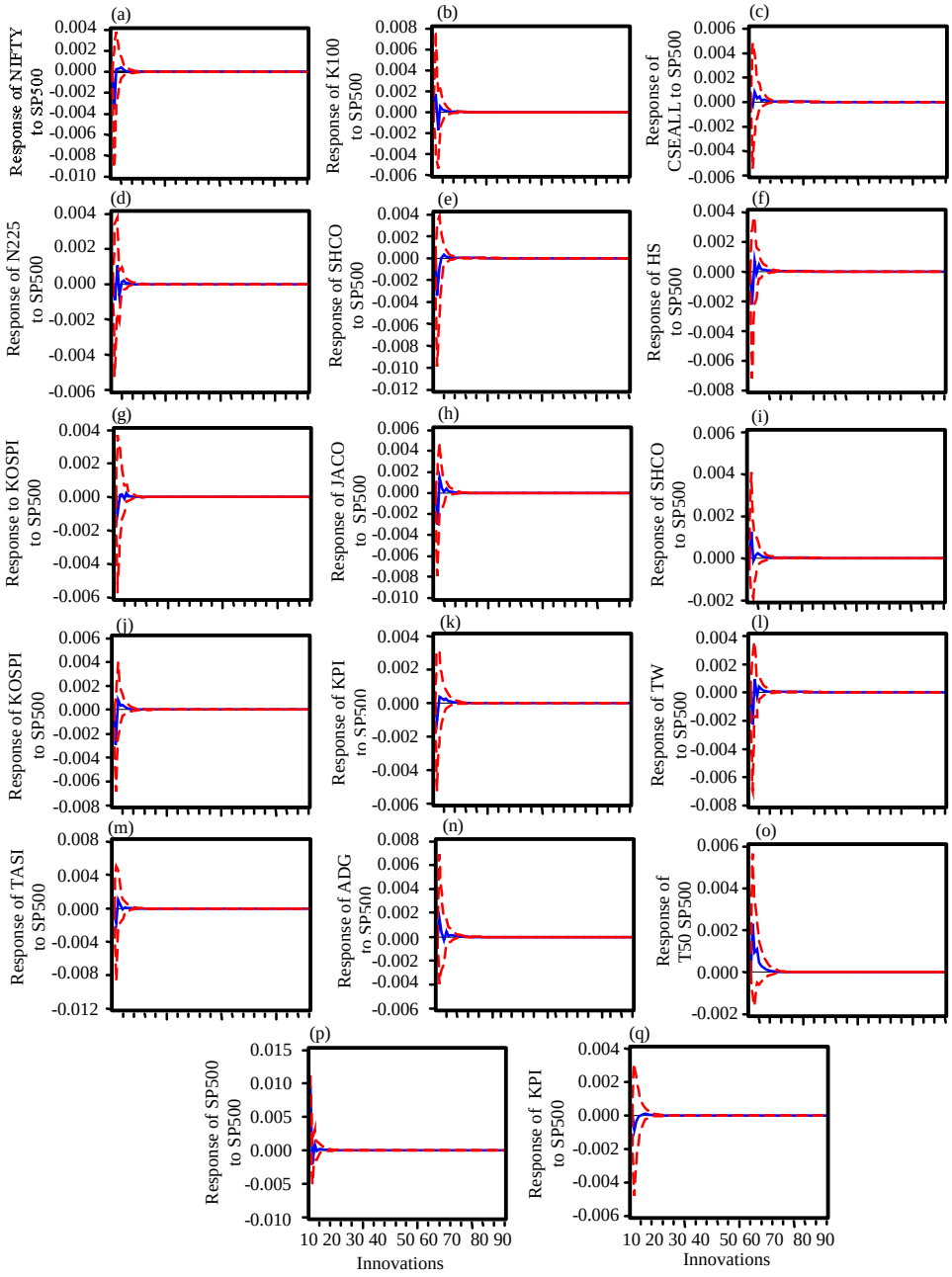

Fig. 1: Response to one SD innovations ±2 SE (to SP500) (Overall study period (January, 2005-June, 2012))

The pattern of dynamic responses of each of the other Asian markets to a shock, i.e., positive residuals of one standard deviation unit in the US and Indian stock market, respectively are also examined. Figure 1 and 2 have presented the results. They plot the time paths of the impulse responses for these seventeen stock markets to a market shock (i.e., in the US market) during the study period (Fig. 1) and also impulse responses of NIFTY to the corresponding market shock in other markets (Fig. 2) at the finest time scale (d1). In Fig. 1, the solid line plots the point estimates of the impulse responses of the Asian stock market indices returns to standard deviation shocks of the SP500. In Fig. 2, the solid line plots the point estimates of the impulse responses of the Indian stock market index, i.e., the S&P CNX NIFTY to standard deviation shocks of the other market returns. The dotted lines in both the figures are the two standard deviation bands around the points estimates.

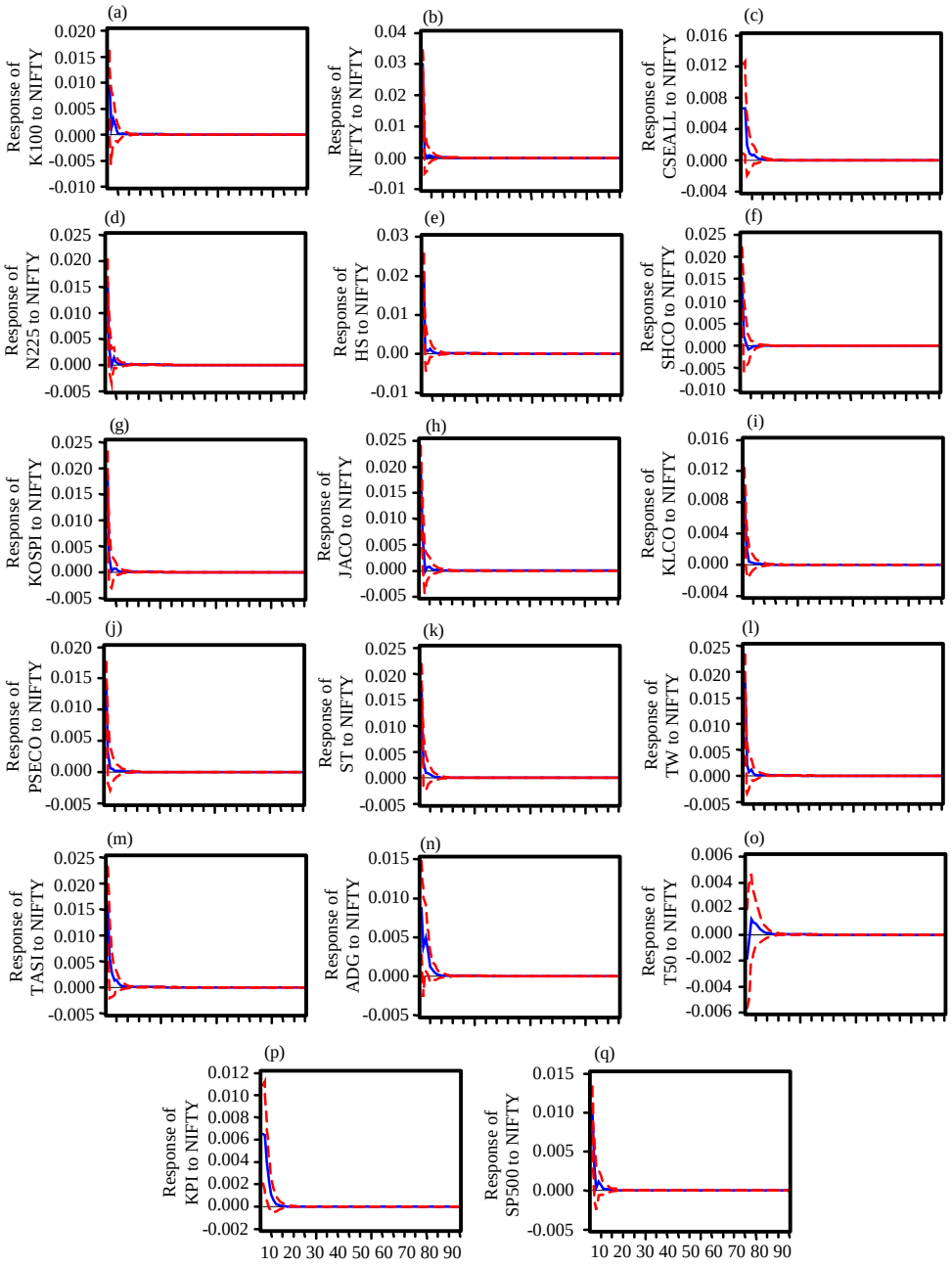

Fig. 2: Response to one SD innovations ± 2 SE (to NIFTY) (Overall study period (January, 2005-June, 2012))

The dynamic linkages of all these Asian markets to the US innovation are quite visible in the short-run. Especially, Indian, Hong Kong, Chinese, Korean, Indonesian, Malaysian, Thailand, Taiwan, Saudia Arabian and Kuwait stock markets are showing negative impact in response to the innovation/shock in the US market in the short-run. In regard to shock/innovation in the NIFTY, all these markets including the US SP500 (but excluding T50) are also extremely negative in their movement down. Thus, all these markets except Iran were also dynamically inter-linked with the Indian market in the short-run. However, these evidences for the short-run are not fully agreed with the Granger's test results.

However, it is worth mentioning here that a different ordering of the variables in the system may provide different results for Choleski decomposition of the innovation matrix, so, the arbitrariness of the ordering can be subject to criticism.

Table 6: Pair wise JJ co-integration tests results (Overall study period and sub-periods) (with the US)

	Likelihood ratio (trace) test results for co-integrating rank			Max-Eigenvalue test results for co-integrating rank		
Indices pair	Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	Hypothesized No. of CE(s)	Eigenvalue	Max-eigen statistic
NIFTY and SP500	r = 2***	0.310311	32.69324	r = 2***	0.310311	32.69324
K100 and SP500	r = 2***	0.243149	24.51582	r = 2***	0.243149	24.51582
CSEALL and SP500	r = 2***	0.204617	20.14597	r = 2***	0.204617	20.14597
N225 and SP500	r = 2***	0.318069	33.68872	r = 2***	0.318069	33.68872
HS and SP500	r = 2***	0.243895	24.60259	r = 2***	0.243895	24.60259
SHCO and SP500	r = 2***	0.226605	22.61295	r = 2***	0.226605	22.61295
KOSPI and SP500	r = 2***	0.319779	33.90964	r = 2***	0.319779	33.90964
JACO and SP500	r = 2***	0.294395	30.68560	r = 2***	0.294395	30.68560
KLCO and SP500	r = 2***	0.229795	22.97670	r = 2***	0.229795	22.97670
PSECO and SP500	r = 2***	0.295994	30.88521	r = 2***	0.295994	30.88521
ST and SP500	r = 2***	0.231473	23.16861	r = 2***	0.231473	23.16861
TW and SP500	r = 2***	0.260412	26.54622	r = 2***	0.260412	26.54622
TASI and SP500	r = 2***	0.254981	25.90239	r = 2***	0.254981	25.90239
ADG and SP500	r = 2***	0.217053	21.53275	r = 2***	0.217053	21.53275
T50 and SP500	r = 2***	0.186409	18.15423	r = 2***	0.186409	18.15423
KPI and SP500	r = 2***	0.198161	19.43462	r = 2***	0.198161	19.43462

	Pre-crisis		During-the-crisis		Post-crisis	
Hypothesized No. of CE(s)	Likelihood ratio (trace) test	Max-Eigen value test	Likelihood ratio (trace) test	Max-Eigen value test	Likelihood ratio (trace) test	Max-Eigen value test
NIFTY and SP500	r = 2**, r = 1*	r = 2**, r = 0*	r = 2**, r = 0*	r = 0***	r = 2**, r = 1*	r = 2**, r = 1*
K100 and SP500	r = 2**, r = 1*	r = 2**, r = 1*	r = 1***	r = 1***	r = 2**, r = 1*	r = 2**, r = 1*
CSEALL and SP500	r = 2**, r = 0*	r = 0***	r = 1***	r = 1***	r = 1**, r = 0*	r = 0***
N225 and SP500	r = 2**, r = 0*	r = 0***	r = 1**, r = 0*	r = 0***	r = 2***	r = 2**, r = 0*
HS and SP500	r = 2**, r = 1*	r = 2**, r = 1*	r = 1**, r = 0*	r = 1**, r = 0*	r = 2**, r = 1*	r = 0***
SHCO and SP500	r = 2**, r = 1*	r = 0***	r = 1**, r = 0*	r = 0***	r = 2***	r = 2***
KOSPI and SP500	r = 2**, r = 1*	r = 0***	r = 2**, r = 1*	r = 0***	r = 2**, r = 1*	r = 2**, r = 1*
JACO and SP500	r = 2**, r = 1*	r = 2**, r = 1*	r = 1**, r = 0*	r = 0***	r = 1***	r = 1***
KLCO and SP500	r = 1**, r = 0*	r = 1**, r = 0*	r = 1**, r = 0*	r = 0***	r = 1**, r = 0*	r = 0***
PSECO and SP500	r = 2***	r = 2**, r = 0*	r = 1**, r = 0*	r = 1**, r = 0*	r = 2**, r = 1*	r = 2**, r = 0*
ST and SP500	r = 1**, r = 0*	r = 0***	r = 1***	r = 1***	r = 1***	r = 1***
TW and SP500	r = 2**, r = 1*	r = 2**, r = 1*	r = 1***	r = 1**, r = 0*	r = 2**, r = 1*	r = 2**, r = 0*
TASI and SP500	r = 1**, r = 0*	r = 0***	r = 1**, r = 0*	r = 0***	r = 2**, r = 1*	r = 0***
ADG and SP500	r = 2**, r = 0*	r = 0***	r = 1***	r = 1***	r = 2***	r = 2**, r = 0*
T50 and SP500	r = 2**, r = 1*	r = 2**, r = 0*	r = 1***	r = 1***	r = 1**, r = 0*	r = 0***
KPI and SP500	r = 1**, r = 0*	r = 0***	r = 0***	r = 0***	r = 2**, r = 1*	r = 0***

Long-run results: After an in-depth study to find short-run relationships and dynamic linkages among these Asian and US stock markets in relation to the US and India, this study also reveals the long-run co-integration in between these markets. Here, one lag length is selected on the basis of either AIC or SIC. Under the JJ tests, test statistics are calculated allowing for an intercept and no trend term in the Co-integrating Equation (CE) and no intercept in VAR.

The results of the Johansen and Juselius's Trace test and Max-Eigenvalue tests are shown in Table 6 and 7. The results point out that for the overall study period both US and Indian stock markets were co-integrated in the long-run with all these Asian markets. They were mutually co-integrated as well. This is because both Trace and Max-Eigenvalue tests indicate two co-integrating equations for all these pairs under both 1 and 5% significance levels. Thus, it nullifies the presence of any kind of portfolio diversification opportunities for international investors including the Indian and US investors in these markets under this period.

However, when I consider the tests results under each sub-period, some contradictory results set in. The max-Eigenvalue test results indicate no co-integration in between the US and Sri Lankan, Japanese, Chinese, Korean, Thailand, Saudi Arabian, UAE and Kuwait stock markets pre-crisis and in the post-crisis with the Sri Lankan, Hong Kong, Malaysian, Saudi Arabian, Iranian and Kuwait stock markets. However, during-the-crisis period, the Indian stock market was co-integrated with the US market along with some of its ASEAN peers and some others. However, Trace results are different and indicate that most of these markets were co-integrated in all these sub-periods. In relation to the Indian market also, similar kind of results are observed. It is interesting to note here that during-the-crisis period results prove that the US crisis didn't have any long-run impact on Asian markets. Also, there was enough portfolio diversification opportunities for the US and international investors outside US including India especially during-the-crisis period. Both tests results point out that the Indian investors could gain from portfolio diversification process

Table 7: Pair wise JJ co-integration tests results (overall study period and sub-periods) (with India)

	Likelihood ratio (trace) test results for co-integrating rank			Max-Eigenvalue test results for co-integrating rank		
Indices pair	Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	Hypothesized No. of CE(s)	Eigenvalue	Max-eigen statistic
K100 and NIFTY	r = 2***	0.259652	26.45586	r = 2***	0.259652	26.45586
CSEALL and NIFTY	r = 2***	0.221595	22.04468	r = 2***	0.221595	22.04468
N225 and NIFTY	r = 2***	0.293525	30.57714	r = 2***	0.293525	30.57714
HS and NIFTY	r = 2***	0.251374	25.47739	r = 2***	0.251374	25.47739
SHCO and NIFTY	r = 2***	0.210625	20.81318	r = 2***	0.210625	20.81318
KOSPI and NIFTY	r = 2***	0.311474	32.84177	r = 2***	0.311474	32.84177
JACO and NIFTY	r = 2***	0.286578	29.71607	r = 2***	0.286578	29.71607
KLCO and NIFTY	r = 2***	0.223472	22.25714	r = 2***	0.223472	22.25714
PSECO and NIFTY	r = 2***	0.298902	31.24948	r = 2***	0.298902	31.24948
ST and NIFTY	r = 2***	0.228609	22.84130	r = 2***	0.228609	22.84130
TW and NIFTY	r = 2***	0.254862	25.88833	r = 2***	0.254862	25.88833
TASI and NIFTY	r = 2***	0.250476	25.37189	r = 2***	0.250476	25.37189
ADG and NIFTY	r = 2***	0.217667	21.60179	r = 2***	0.217667	21.60179
T50 and NIFTY	r = 2***	0.186467	18.16042	r = 2***	0.186467	18.16042
KPI and NIFTY	r = 2***	0.195307	19.12192	r = 2***	0.195307	19.12192
SP500 and NIFTY	r = 2***	0.310311	32.69324	r = 2***	0.310311	32.69324

	Pre-crisis		During-the-crisis		Post-crisis	
Hypothesized No. of CE(s)	Likelihood ratio (trace) test	Max-Eigen value test	Likelihood ratio (trace) test	Max-Eigen value test	Likelihood ratio (trace) test	Max-Eigen value test
K100 and NIFTY	r = 2***	r = 2***	r = 1***	r = 1***	r = 2***	r = 2***
CSEALL and NIFTY	r = 1***	r = 1**, r = 0*	r = 1***	r = 1**, r = 0*	r = 1***	r = 1***
N225 and NIFTY	r = 1**, r = 0*	r = 0***	r = 0***	r = 0***	r = 2***	r = 2***
HS and NIFTY	r = 2**, r = 1*	r = 0***	r = 1***	r = 1**, r = 0*	r = 2**, r = 1*	r = 2**, r = 1*
SHCO and NIFTY	r = 1***	r = 1**, r = 0*	r = 1***	r = 1***	r = 2***	r = 2***
KOSPI and NIFTY	r = 2**, r = 1*	r = 0***	r = 1***	r = 1**, r = 0*	r = 1***	r = 1**, r = 0*
JACO and NIFTY	r = 2**, r = 1*	r = 0***	r = 1***	r = 1***	r = 2***	r = 2***
KLCO and NIFTY	r = 0***	r = 0***	r = 1***	r = 1**, r = 0*	r = 2**, r = 1*	r = 2**, r = 1*
PSECO and NIFTY	r = 2***	r = 0***	r = 1***	r = 1**, r = 0*	r = 2***	r = 2***
ST and NIFTY	r = 1**, r = 0*	r = 0***	r = 0***	r = 0***	r = 2***	r = 2***
TW and NIFTY	r = 2**, r = 1*	r = 0***	r = 1**, r = 0*	r = 1**, r = 0*	r = 2**, r = 1*	r = 2**, r = 1*
TASI and NIFTY	r = 1***	r = 1**, r = 0*	r = 1**, r = 0*	r = 0***	r = 2**, r = 1*	r = 2**, r = 1*
ADG and NIFTY	r = 2**, r = 1*	r = 2**, r = 1*	r = 1**, r = 0*	r = 1**, r = 0*	r = 2***	r = 2***
T50 and NIFTY	r = 1***	r = 1**, r = 0*	r = 0***	r = 0***	r = 1***	r = 1***
KPI and NIFTY	r = 1**, r = 0*	r = 0***	r = 0***	r = 0***	r = 2***	r = 2***
SP500 and NIFTY	r = 2**, r = 1*	r = 2**, r = 0*	r = 2**, r = 0*	r = 0***	r = 2**, r = 1*	r = 2**, r = 1*

r = 2** and r = 2* denotes that trace test and/or max-Eigenvalue test (s) indicate (s) 2 co-integrating equation (s) at 5 and 1% levels, respectively. r = 1** and r = 1* denotes that trace test and/or max-Eigenvalue test (s) indicate (s) 1 co-integrating equation (s) at 5 and 1% levels, respectively. r = 0** and r = 0* denotes that trace test and/or max-Eigenvalue test (s) indicate (s) no co-integrating equation(s) at 5 and 1% levels, respectively. r = 2*** denotes that trace test and/or max-Eigenvalue test (s) indicate (s) 2 co-integrating equation (s) at both 5 and 1% levels. r = 1*** denotes that trace test and/or max-Eigenvalue test (s) indicate (s) 1 co-integrating equation (s) at both 5 and 1% levels. r = 0*** denotes that trace test and/or max-Eigenvalue test (s) indicate (s) no co-integrating equation (s) at both 5 and 1% levels. At r = 1, trace test: 5% critical value = 19.96 and 1% critical value = 24.60; max-Eigenvalue test: 5% critical value = 15.67 and 1% critical value = 20.20. At r = 2, trace test: 5% critical value = 9.24 and 1% critical value = 12.97; max-Eigenvalue test: 5% critical value = 9.24 and 1% critical value = 12.97

in during-the-crisis period by investing in the Japanese, Thailand, Iranian and Kuwait stock markets. However, in the post-crisis period there has been no such opportunity for the Indian investors.

In line with the suggestions from the existing literature, I have also considered here the sign and size of the co-integration coefficients to comment in regard to portfolio diversification opportunities as available to the international investors especially the US and Indian ones within these Asian markets under both overall and during-the crisis period. It is significant to note that the coefficients of all these markets are showing both positive and negative signs in relation to the Indian and US markets under both above-mentioned periods. It implies their differential risk situations which is the ideal condition for the investors of these countries to invest in the long-run for gaining benefits from portfolio diversification.

The results under Table 8 show that in absolute terms the Sri Lankan, Japanese, Iranian and mostly the US investors could be attracted towards the Indian market during-the-crisis period. On the contrary, Thailand and Taiwan investors would look at the US market during this period.

Table 9 also suggests that the US investors could also invest in the Chinese, Saudi Arabian, Japanese and UAE stock markets in that order only in the overall study period to gain maximum from portfolio diversification process. During-the-crisis period they could invest in six out of remaining fifteen Asian markets namely the

Table 8: Co-integration relation (sign and size) of India and US with other Asian markets (overall study period (January, 2005-June, 2012) and during-the-crisis period (July, 2007-December, 2009))

India (NIFTY)			US (SP500)		
Stock returns	Overall	During the crisis	Stock returns	Overall	During the crisis
NIFTY (-1) (Normalized)	1.000000	1.000000	SP500 (-1) (Normalized)	1.000000	1.000000
K100 (-1)	-0.466643 (-17.1859)	-2.460282 (-6.06602)	K100 (-1)	-1.880495 (-17.1033)	0.040947 (0.88570)
CSEALL (-1)	-0.208096 (-7.08946)	3.610820 (4.04311)	CSEALL (-1)	-0.838592 (-7.08766)	-0.788423(-7.54213)
N225 (-1)	0.037628 (0.58217)	-3.611858 (-3.41441)	N225 (-1)	0.151633 (0.63787)	0.369685 (3.02600)
HS (-1)	-0.408824(-5.65490)	0.799018 (0.84987)	HS (-1)	-1.647494 (-5.49229)	-0.281674 (-2.69412)
SHCO (-1)	-0.021640 (-0.71277)	-0.419016 (-5.23426)	SHCO (-1)	-0.087204 (-0.71337)	0.975425 (7.27170)
KOSPI (-1)	-0.168333 (-2.69266)	0.132465 (0.82771)	KOSPI (-1)	-0.678353 (-2.70559)	-1.414038 (-5.60096)
JACO (-1)	-0.660093 (-12.1530)	-0.984480 (-5.55673)	JACO (-1)	-2.660066 (-11.7234)	0.045830 (0.16296)
KLCO (-1)	0.561958 (5.69793)	0.792811 (2.48544)	KLCO (-1)	2.264600 (5.81487)	-1.056684 (-2.01441)
PSECO (-1)	-0.274180 (-4.46916)	-1.283798 (-6.51369)	PSECO (-1)	-1.104900 (-4.38889)	0.031861 (0.03793)
ST (-1)	0.093962 (0.88152)	0.804709 (3.44384)	ST (-1)	0.378652 (0.88422)	-4.105843 (-4.10056)
TW (-1)	0.197890 (3.20900)	-0.381789 (-1.98536)	TW (-1)	0.797466 (3.20462)	4.156895 (5.10901)
TASI (-1)	-0.032572 (-1.15211)	-0.375387 (-3.25761)	TASI (-1)	-0.131258 (-1.11525)	-1.185060 (-2.48680)
ADG (-1)	0.068670 (2.03787)	1.687197 (3.53811)	ADG (-1)	0.276727 (2.02587)	-0.275377 (-3.47840)
T50 (-1)	0.309940 (8.92874)	3.060166 (4.65087)	T50 (-1)	1.249007 (9.44053)	-0.499467 (-5.38256)
KPI (-1)	0.099364 (2.35105)	-0.690644 (-1.33808)	KPI (-1)	0.400420 (2.37295)	0.112724 (1.44686)
SP500 (-1)	0.248149 (2.88827)	-6.126864 (-9.63513)	NIFTY (-1)	4.029836 (18.1645)	-0.163216 (-3.34662)

Table 9: Co-integration relation (sign and size) of other Asian markets in terms of India and US (overall study period (January, 2005-June, 2012) and during-the-crisis period (July, 2007-December, 2009)

India (NIFTY)			US (SP500)		
Stock returns	Overall	During the crisis	Stock returns	Overall	During the crisis
K100 (-1) (Normalized)	1.000000	1.000000	K100 (-1)(Normalized)	1.000000	1.000000
	-2.142966 (-18.2306)	-0.406457 (-0.98874)		-0.531775 (-2.88486)	24.42168 (5.62021)
CSEALL (-1)(Normalized)	1.000000	1.000000	CSEALL (-1)(Normalized)	1.000000	1.000000
	-4.562042 (-18.0624)	0.276945 (1.02438)		-1.189925 (-3.01125)	-1.268355 (-4.70187)
N225 (-1)(Normalized)	1.000000	1.000000	N225 (-1)(Normalized)	1.000000	1.000000
	26.57618 (18.2248)	-0.276866 (-0.98358)		6.594853 (3.17514)	2.705007 (6.18112)
HS (-1)(Normalized)	1.000000	1.000000	HS (-1)(Normalized)	1.000000	1.000000
	-2.446041 (-19.5536)	1.251536 (1.23639)		-0.606983 (-3.01975)	-3.550199(-5.19098)
SHCO (-1)(Normalized)	1.000000	1.000000	SHCO (-1)(Normalized)	1.000000	1.000000
	-46.21177 (-18.1773)	-2.386546 (-7.21609)		-11.46741 (-2.89274)	1.025194 (3.09476)
KOSPI (-1)(Normalized)	1.000000	1.000000	KOSPI (-1)(Normalized)	1.000000	1.000000
	-5.940620 (-18.1394)	7.549140 (7.49088)		-1.474159 (-2.89814)	-0.707195 (-3.58961)
JACO (-1)(Normalized)	1.000000	1.000000	JACO (-1)(Normalized)	1.000000	1.000000
	-1.514938 (-18.9120)	-1.015764 (-7.28590)		-0.375930 (-2.90085)	21.81969 (3.01970)
KLCO (-1)(Normalized)	1.000000	1.000000	KLCO (-1)(Normalized)	1.000000	1.000000
	1.779492 (18.2120)	1.261334 (7.41699)		0.441579 (2.95525)	-0.946357 (-3.13938)
PSECO (-1)(Normalized)	1.000000	1.000000	PSECO (-1)(Normalized)	1.000000	1.000000
	-3.647239 (-18.6244)	-0.778938 (-5.38253)		-0.905059 (-2.90821)	31.38634 (0.75245)
ST (-1)(Normalized)	1.000000	1.000000	ST (-1)(Normalized)	1.000000	1.000000
	10.64258 (18.1136)	1.242685 (4.84781)		2.640947 (2.88899)	-0.243555 (-0.83972)
TW (-1)(Normalized)	1.000000	1.000000	TW (-1)(Normalized)	1.000000	1.000000
	5.053303 (18.1364)	-2.619250 (-4.69473)		1.253972 (2.87988)	0.240564 (0.71907)
TASI (-1)(Normalized)	1.000000	1.000000	TASI (-1)(Normalized)	1.000000	1.000000
	-30.70154 (-18.7251)	-2.663918 (-5.33828)		-7.618557 (-2.88218)	-0.843839 (-0.77189)
ADG (-1)(Normalized)	1.000000	1.000000	ADG (-1)(Normalized)	1.000000	1.000000
	14.56250 (18.2406)	0.592699 (2.10672)		3.613669 (2.88330)	-3.631387 (-5.96302)
T50 (-1)(Normalized)	1.000000	1.000000	T50 (-1)(Normalized)	1.000000	1.000000
	3.226432 (18.3550)	0.326780 (2.15597)		0.800636 (3.08586)	-2.002134 (-7.18372)
KPI (-1)(Normalized)	1.000000	1.000000	KPI (-1)(Normalized)	1.000000	1.000000
	10.06402 (18.2052)	-1.447923(-2.03651)		2.497377 (2.92172)	8.871228 (6.33988)

Figures in brackets indicate t-statistics

Philippines, Pakistani, Indonesian, Kuwait, UAE and Hong Kong stock markets in that order only to gain maximum benefits from portfolio diversification process as one per cent change in SP500's return could cause more percentage change in such respective country's return. However, most of these results don't come out from earlier JJ co-integration tests results.

For the overall study period the US market has been one of the favourable destination to the Indian investors as per the coefficient result which implies that a percentage change in the NIFTY index returns could be associated with a 4.03% change in the US market's return during the same period. Table 10 also points out that for the overall study period the Indian investors could gain from portfolio diversification process by investing in eleven out of remaining fifteen markets namely the Chinese, Saudi Arabian, Japanese, UAE, Thailand, Kuwait, Korean, Taiwan, Sri Lankan, Philippines and

Table 10: Variance Decomposition Analysis (VDA) (overall study period) (ASIAN and US markets-own impact) (NIFTY, K100, ..., SP500 sequence)

Periods	NIFTY	K100	CSEALL	N225	HS	SHCO	KOSPI	JACO	KLCO
1	100.0000	91.21483	94.09113	53.21474	35.29353	60.40998	37.12136	33.04220	37.62416
2	80.07523	75.00787	76.20131	42.89223	29.21937	44.57701	34.17433	25.66553	29.83238
3	76.30492	71.40651	73.04732	41.10524	28.10238	43.14252	33.20795	24.14581	28.20729
4	75.63419	70.52723	71.81341	40.61238	27.70592	42.89219	32.93450	23.75344	27.60122
5	75.33586	70.35255	71.41859	40.48288	27.54877	42.80210	32.83121	23.58417	27.42075
6	75.20698	70.28913	71.24732	40.44810	27.48648	42.77775	32.79834	23.50885	27.33315
7	75.14444	70.26157	71.17015	40.43154	27.45417	42.77015	32.78437	23.47619	27.29310
8	75.11766	70.24883	71.13289	40.42411	27.44045	42.76793	32.77804	23.46173	27.27510
9	75.10549	70.24302	71.11578	40.42098	27.43408	42.76719	32.77516	23.45523	27.26707
10	75.09992	70.24052	71.10840	40.41959	27.43120	42.76688	32.77381	23.45229	27.26339
11	75.09735	70.23939	71.10499	40.41895	27.42988	42.76674	32.77319	23.45093	27.26170
12	75.09615	70.23885	71.10340	40.41866	27.42927	42.76668	32.77291	23.45031	27.26092
Periods	PSECO	ST	TW	TASI	ADG	T50	KPI	SP500	-
1	50.20558	15.47346	30.39349	59.47557	67.27380	89.01041	59.60474	35.04508	-
2	39.67701	11.99735	26.80366	52.40124	57.98642	71.62286	47.40820	25.35681	-
3	37.73163	11.37492	26.18251	51.10088	54.58925	67.59990	44.37908	23.39597	-
4	37.07452	11.18023	25.82018	50.97202	53.62507	65.98313	43.53219	22.80011	-
5	36.79042	11.10232	25.66784	50.82196	53.26624	65.33975	43.24066	22.57971	-
6	36.67254	11.07707	25.62654	50.77720	53.10364	65.03501	43.13105	22.49602	-
7	36.62027	11.06338	25.60350	50.75996	53.03843	64.89946	43.08544	22.45194	-
8	36.59666	11.05691	25.59370	50.75113	53.00887	64.83820	43.06468	22.43391	-
9	36.58565	11.05391	25.58888	50.74713	52.99489	64.81014	43.05540	22.42554	-
10	36.58061	11.05257	25.58672	50.74534	52.98856	64.79736	43.05118	22.42167	-
11	36.57831	11.05196	25.58575	50.74450	52.98566	64.79150	43.04924	22.41988	-
12	36.57726	11.05168	25.58530	50.74410	52.98431	64.78880	43.04835	22.41907	-

Table 11: Variance Decomposition Analysis (VDA) (overall study period) (ASIAN and US markets-own impact) (SP500, K100, ..., NIFTY sequence)

Periods	SP500	K100	CSEALL	N225	HS	SHCO	KOSPI	JACO	KLCO
1	100.0000	94.98363	94.64766	48.83709	43.21054	60.60061	40.19195	35.29307	37.36348
2	71.34470	77.83219	77.07181	39.28189	35.77515	44.71829	36.31831	27.54630	29.62753
3	65.69288	74.05455	73.84873	37.64073	34.56860	43.26949	35.25204	25.94241	28.00630
4	64.31886	73.13987	72.57004	37.35351	34.07788	43.01990	34.95978	25.47458	27.40398
5	63.81134	72.94993	72.14581	37.23704	33.87634	42.93008	34.85121	25.28180	27.22057
6	63.61643	72.87719	71.96831	37.19452	33.79001	42.90558	34.82155	25.19919	27.13227
7	63.51099	72.84795	71.88633	37.17611	33.75215	42.89798	34.80509	25.16157	27.09211
8	63.46691	72.83466	71.84650	37.16837	33.73638	42.89577	34.79799	25.14513	27.07403
9	63.44740	72.82854	71.82830	37.16499	33.72873	42.89505	34.79488	25.13782	27.06594
10	63.43845	72.82586	71.82042	37.16345	33.72523	42.89474	34.79342	25.13446	27.06224
11	63.43429	72.82464	71.81677	37.16274	33.72363	42.89460	34.79275	25.13291	27.06054
12	63.43237	72.82407	71.81507	37.16242	33.72290	42.89454	34.79244	25.13220	27.05976
Periods	PSECO	ST	TW	TASI	ADG	T50	KPI	SP500	-
1	50.43469	15.73430	30.92736	60.62512	67.47400	93.36069	59.68729	23.15565	-
2	38.81441	12.17628	27.29454	53.38569	58.05202	76.85180	47.40083	18.49086	-
3	37.08432	11.51431	26.63530	52.07533	54.66018	72.93572	44.32498	17.73902	-
4	36.46880	11.31448	26.26377	51.90081	53.69546	71.25043	43.47166	17.59352	-
5	36.20766	11.23208	26.10758	51.74966	53.33520	70.59581	43.18044	17.51919	-
6	36.09922	11.20199	26.05959	51.70362	53.17113	70.27643	43.07098	17.49366	-
7	36.05153	11.18645	26.03442	51.68517	53.10542	70.13516	43.02545	17.47980	-
8	36.03006	11.17928	26.02385	51.67590	53.07563	70.07137	43.00472	17.47391	-
9	36.01995	11.17601	26.01874	51.67173	53.06152	70.04211	42.99546	17.47111	-
10	36.01530	11.17454	26.01643	51.66986	53.05514	70.02883	42.99125	17.46981	-
11	36.01319	11.17386	26.01538	51.66898	53.05220	70.02273	42.98931	17.46922	-
12	36.01222	11.17355	26.01490	51.66857	53.05085	70.01993	42.98842	17.46895	-

Iranian stock markets in that order only as 1% change in NIFTY's return could cause more percentage change in such respective country's return. However, in during-the-crisis period, the Indian investors could only look at the Korean market to gain an above-average return and may be to Saudi Arabian, Taiwan and Chinese markets if they compromise with average returns.

Due to different sign of coefficient Japan, Malaysia, Thailand, Taiwan, UAE, Iran, Kuwait and US markets for the overall study period and Sri Lanka, Hong Kong, Korea, Malaysia, Thailand, UAE and Iran markets during-the-crisis period are the main competitors of the Indian market within Asia in attracting Foreign investors in the country. This implies that when Indian markets fall (rise), they also rise (fall). It is also evident that the Indian and US market was conterminous during-the-crisis period but not in other periods (Fig. 3-6).

Variance Decomposition Analysis (VDA) results: The results of the VDA in detail are presented in Table 10-13. Table 10 and 11 show the contradictory VDA results for the overall study period under two different sequences which indicate that due to different ordering results can

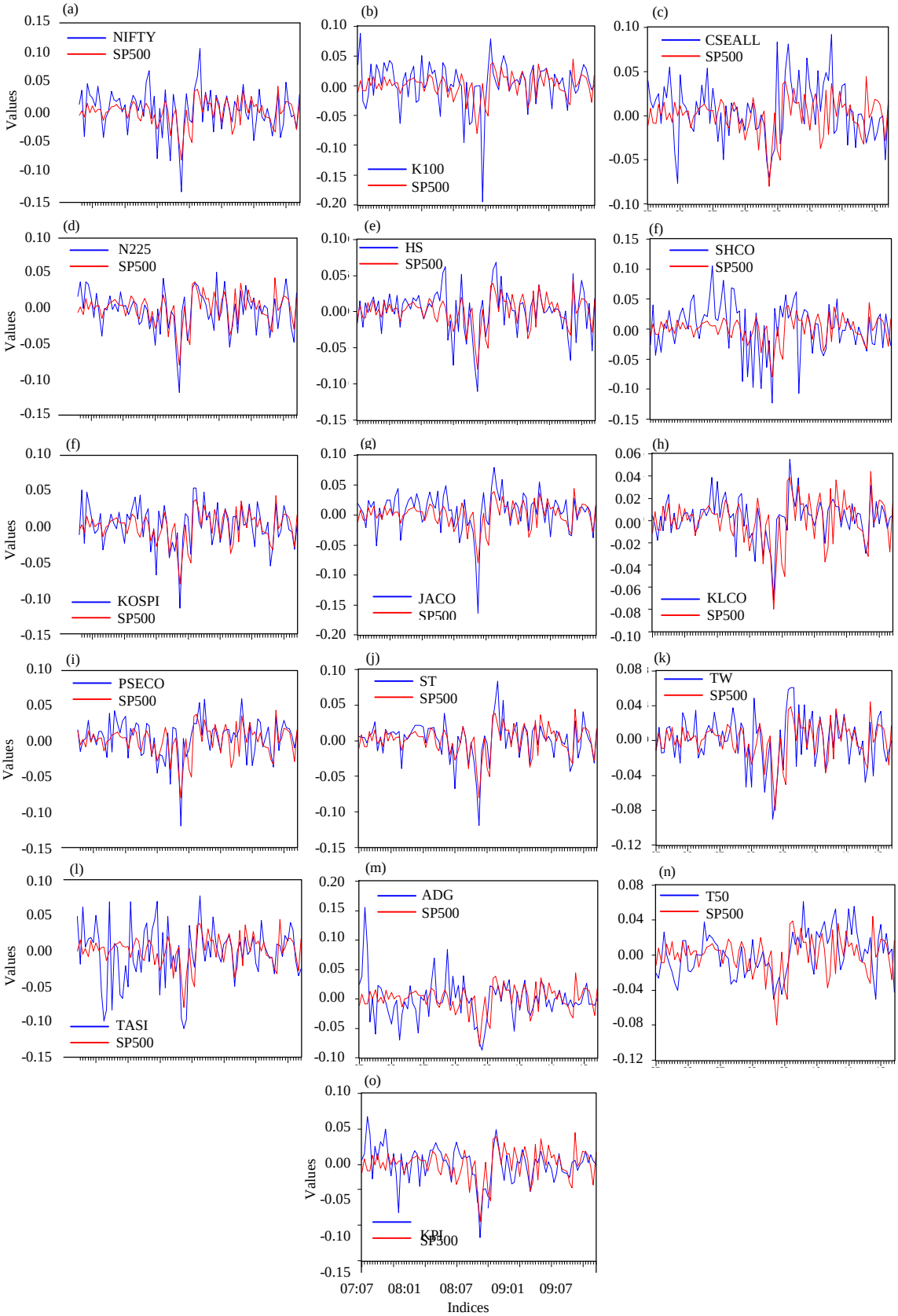

Fig. 3: NIFTY and Asian indices returns (Overall study period (January, 2005-June, 2012)

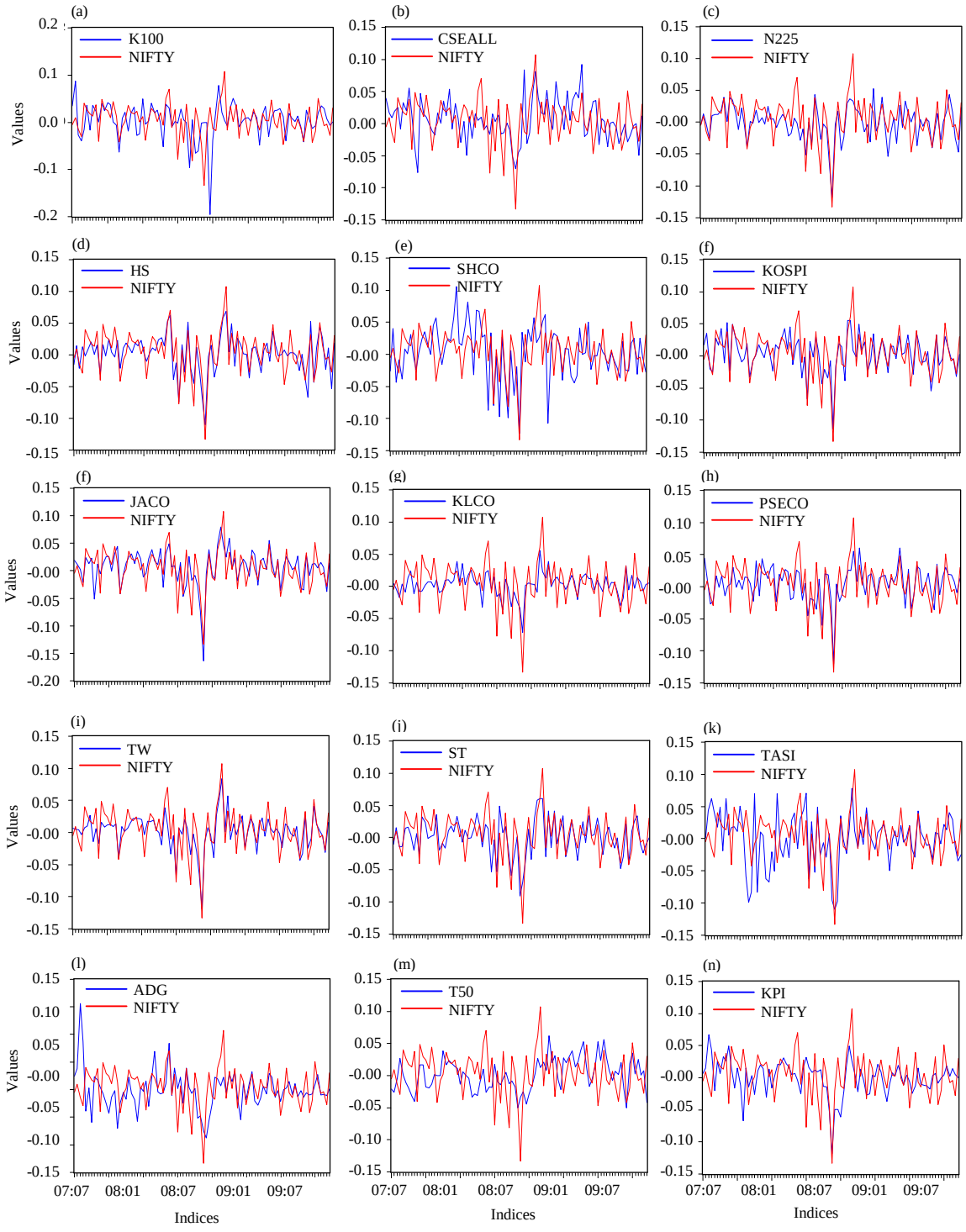

Fig. 4: NIFTY and Asian indices returns (During-the-crisis period (July, 2007-December, 2009))

be different. This is especially true for the Indian and US markets which are the first and last markets in undertaken ordering, respectively. However, some of the markets including Pakistan, Sri Lanka, Saudi Arabia, UAE, Iran and Kuwait are showing that innovation in local stock returns were causing the most variation in the short to long-run. This may be due to their detachment from the international (mainly US) and other Asian markets and lack of interest in terms of portfolio diversification. Table 12 points out that when NIFTY

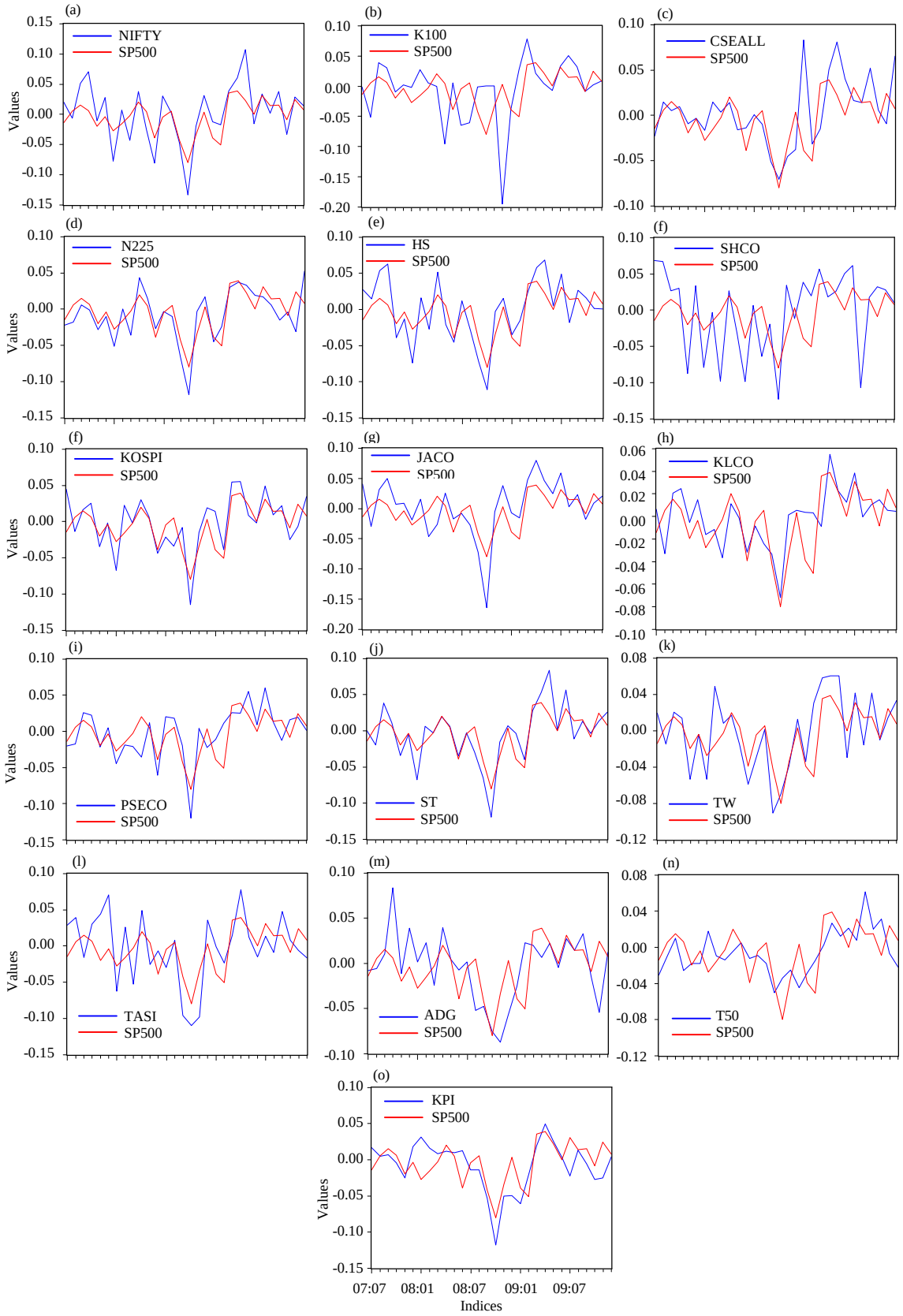

Fig. 5: SP 500 and Asian indices returns (during-the-crisis period (July, 2007-December, 2009))

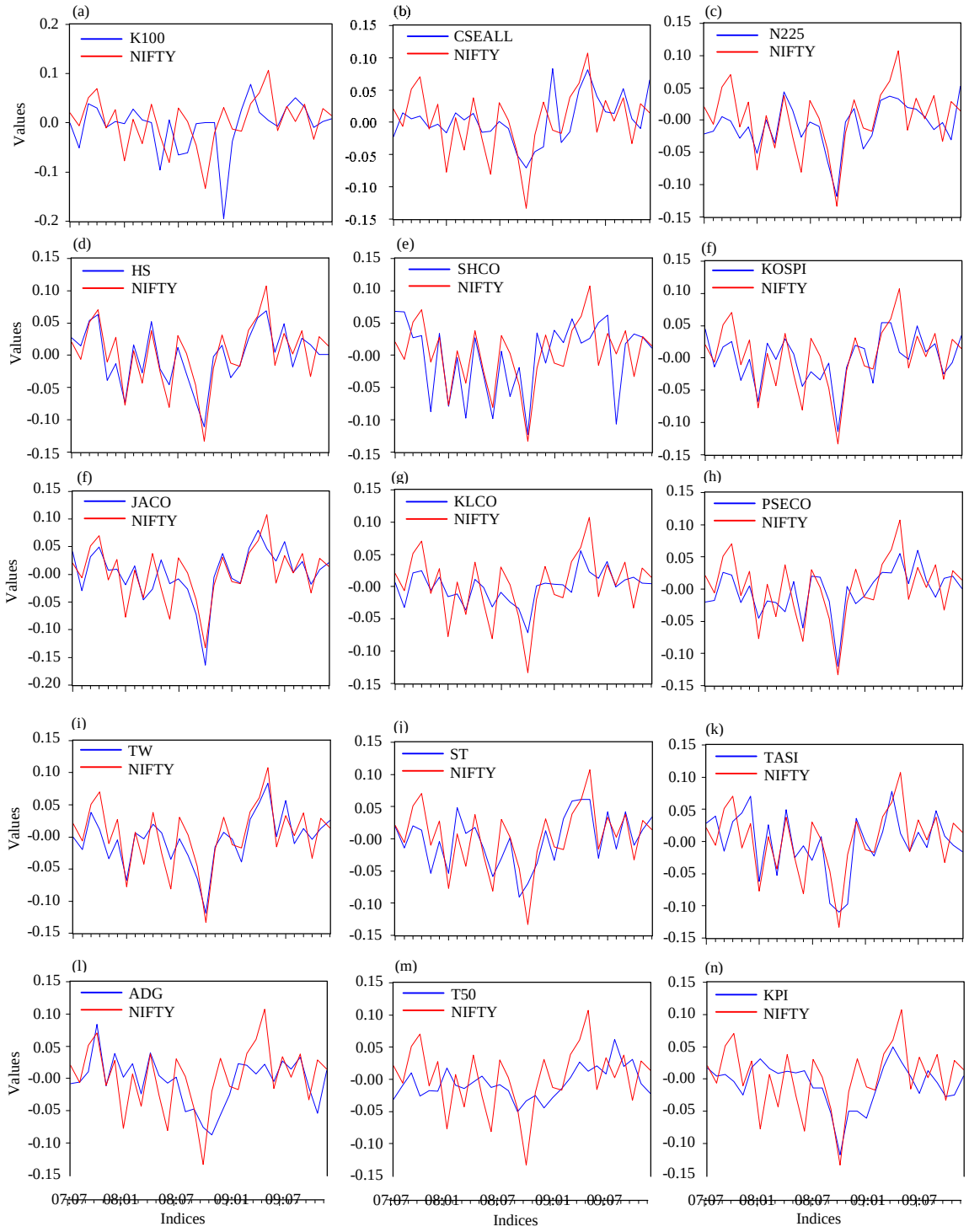

Fig. 6: NIFTY and Asian indices returns (During-the-crisis period (July, 2007-December, 2009))

comes first in the order, the US market was not causing any transmission of innovation whereas the Indian and Japanese markets in that order caused dominant impact on it. However, Table 13 presents that the US market returns were causing extreme variation followed by the Hong Kong market in NIFTY's returns but the Indian market was causing no such impact when I follow the reverse order.

Table 12: Variance Decomposition Analysis (VDA) (overall study period) (other asian markets significant impact (i.e., more than 10%) on Indian and US markets) (NIFTY, K100, ..., SP500 sequence)

Periods	SP500	-
On India (NIFTY)		
1	0.000000	-
2	1.115761	-
3	1.068305	-
4	1.065787	-
5	1.076923	-
6	1.079441	-
7	1.079214	-
8	1.079809	-
9	1.079877	-
10	1.079918	-
11	1.079940	-
12	1.079952	-
Periods	N225	NIFTY
On US (SP500)		
1	13.64726	40.79897
2	12.80040	31.02935
3	11.94742	28.44830
4	11.77324	28.03235
5	11.70840	27.85048
6	11.70353	27.74921
7	11.69688	27.69945
8	11.69229	27.67866
9	11.69043	27.66970
10	11.68977	27.66557
11	11.68946	27.66364
12	11.68931	27.66274

Table 13: Variance Decomposition Analysis (VDA) (overall study period) (Other Asian markets significant impact (i.e., more than 10%) on Indian and US markets) (SP500, K100, ..., NIFTY sequence)

Periods	SP500	HS
On India (NIFTY)		
1	40.79897	13.74948
2	32.61998	11.81646
3	31.10713	11.71108
4	30.91332	11.60435
5	30.84710	11.55541
6	30.82628	11.53481
7	30.81010	11.52560
8	30.80404	11.52211
9	30.80131	11.52026
10	30.80009	11.51941
11	30.79952	11.51901
12	30.79925	11.51884
Periods	T50	NIFTY
On US (SP500)		
1	0.000000	0.000000
2	8.192973	0.010956
3	9.201324	0.094672
4	9.586884	0.096951
5	9.795097	0.095992
6	9.929355	0.107336
7	9.998052	0.112338
8	10.02185	0.113769
9	10.03319	0.114315
10	10.03860	0.114579
11	10.04114	0.114711
12	10.04229	0.114776

Table 14: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests results (with intercept and no trend) (Overall study period (January, 2005-June, 2012))

Indices	ADF results	Conclusion	PP results	Conclusion
NIFTY	-6.529067*	I (0)	-8.716446*	I (0)
K100	-7.278577*	I (0)	-7.999168*	I (0)
CSEALL	-5.367752*	I (0)	-7.529486*	I (0)
N225	-6.231142*	I (0)	-7.802311*	I (0)
HS	-5.289442*	I (0)	-8.358881*	I (0)
SHCO	-4.898714*	I (0)	-8.677959*	I (0)
KOSPI	-6.275988*	I (0)	-9.210304*	I (0)

Table 14: Continue

Indices	ADF results	Conclusion	PP results	Conclusion
JACO	-5.963540*	I (0)	-7.344691*	I (0)
KLCO	-4.934817*	I (0)	-7.520312*	I (0)
PSECO	-5.987172*	I (0)	-8.873046*	I (0)
ST	-5.213696*	I (0)	-7.331041*	I (0)
TW	-5.310914*	I (0)	-7.892682*	I (0)
TASI	-5.315156*	I (0)	-7.934558*	I (0)
ADG	-5.013305*	I (0)	-6.399055*	I (0)
T50	-4.408649*	I (0)	-4.978716*	I (0)
KPI	-4.539178*	I (0)	-5.444218*	I (0)
SP500	-6.306827*	I (0)	-7.389799*	I (0)

*MacKinnon critical values for rejection of hypothesis (i.e., $\lambda<0$) of a unit root (at level). **MacKinnon critical values for rejection of hypothesis (i.e., $\lambda<0$) of a unit root (at 1st difference)

Table 15: Augmented Dickey-Fuller (ADF) test results (with intercept and no trend) (sub-periods)

Indices	ADF results	Conclusion
Pre-crisis period-January 2005-June 2007 (30 months)		
NIFTY	-4.021730*	I (0)
K100	-5.198143*	I (0)
CSEALL	-3.411293*#	I (0)
N225	-3.117783*#	I (0)
HS	-3.496420*#	I (0)
SHCO	-3.076918*#	I (0)
KOSPI	-3.581775*#	I (0)
JACO	-4.272942*	I (0)
KLCO	-6.513580**	I (1)
PSECO	-3.873819	I (0)
ST	-2.895489*##	I (0)
TW	-3.695121*	I (0)
TASI	-2.791910*##	I (0)
ADG	-3.123585*#	I (0)
T50	-3.105652*#	I (0)
KPI	-2.927817*##	I (0)
SP500	-3.575073*#	I (0)
During-the-crisis period-July 2007-December 2009 (30 months)		
NIFTY	-3.086808*#	I (0)
K100	-3.5470*#	I (0)
CSEALL	-2.791014*##	I (0)
N225	-3.259084*#	I (0)
HS	-2.730080*##	I (0)
SHCO	-2.859715*##	I (0)
KOSPI	-3.119723*#	I (0)
JACO	-2.939422*#	I (0)
KLCO	-6.163431**	I (1)
PSECO	-2.824967*##	I (0)
ST	-4.578827**	I (1)
TW	-4.687220**	I (1)
TASI	-2.832574*##	I (0)
ADG	-4.059062**	I (1)
T50	-4.013981**	I (1)
KPI	-4.489877**	I (1)
SP500	-3.469966*#	I (0)
Post-crisis period-January 2010-June 2012 (30 months)		
NIFTY	-6.354376*	I (0)
K100	-5.359474*	I (0)
CSEALL	-2.714083*##	I (0)
N225	-4.431855*	I (0)
HS	-3.974757*	I (0)
SHCO	-4.551674*	I (0)
KOSPI	-5.213314*	I (0)
JACO	-4.832173*	I (0)
KLCO	-3.972975*	I (0)
PSECO	-4.683079*	I (0)
ST	-5.384974*	I (0)
TW	-4.569074*	I (0)
TASI	-4.012813*	I (0)
ADG	-4.376822*	I (0)
T50	-2.930686*##	I (0)
KPI	-4.244499*	I (0)
SP500	-4.016368*	I (0)

*MacKinnon critical values for rejection of hypothesis (i.e., $\lambda<0$) of a unit root (at level). # At 5% level. ## At 10% level. **MacKinnon critical values for rejection of hypothesis (i.e., $\lambda<0$) of a unit root (at 1st difference)

Table 16: Phillips-Perron (PP) test results (with intercept and no trend)

	Pre-crisis period-January 2005-June 2007 (30 months)		During the crisis period-July 2007-December 2009 (30 months)		Post-crisis period-January 2010-June 2012 (30 months)	
Indices	PP results	Conclusion	PP results	Conclusion	PP results	Conclusion
NIFTY	-5.397682*	I (0)	-4.605491*	I (0)	-5.964433*	I (0)
K100	-4.953336*	I (0)	-4.287649*	I (0)	-5.439523*	I (0)
CSEALL	-5.020290*	I (0)	-3.614516*#	I (0)	-4.186802*	I (0)
N225	-4.571206*	I (0)	-3.837393*	I (0)	-5.222833*	I (0)
HS	-7.655894*	I (0)	-3.951747*	I (0)	-6.672590*	I (0)
SHCO	-3.951608*	I (0)	-5.487400*	I (0)	-5.842871*	I (0)
KOSPI	-6.113926*	I (0)	-4.951629*	I (0)	-5.472805*	I (0)
JACO	-5.275701*	I (0)	-3.594460*#	I (0)	-6.151530*	I (0)
KLCO	-4.617964*	I (0)	-3.931127*	I (0)	-5.371379*	I (0)
PSECO	-6.360966*	I (0)	-4.517585*	I (0)	-5.782359*	I (0)
ST	-5.323491*	I (0)	-3.594483*#	I (0)	-5.839420*	I (0)
TW	-5.097195*	I (0)	-4.006769*	I (0)	-5.133513*	I (0)
TASI	-4.443933*	I (0)	-4.321152*	I (0)	-4.345948*	I (0)
ADG	-3.653732*#	I (0)	-3.170401*#	I (0)	-4.946087*	I (0)
T50	-2.779497*##	I (0)	-2.787173*##	I (0)	-3.196279*#	I (0)
KPI	-4.419965*	I (0)	-5.141621**	I (1)	-3.796290*	I (0)
SP500	-6.066181*	I (0)	-3.505055*#	I (0)	-5.549715*	I (0)

*MacKinnon critical values for rejection of hypothesis (i.e., $\lambda<0$) of a unit root (at level). # At 5% level. ## At 10% level. **MacKinnon critical values for rejection of hypothesis (i.e., $\lambda<0$) of a unit root (at 1st difference)

Table 17: Correlation results (Overall study period (January, 2005-June, 2012))

Indices	NIFTY	K100	CSEALL	N225	HS	SHCO	KOSPI	JACO	KLCO
NIFTY	1.000000	0.211116	0.285967	0.650966	0.787315	0.482844	0.736410	0.735177	0.639883
K100	0.211116	1.000000	0.084978	0.221503	0.196737	0.114226	0.291061	0.143922	0.207372
CSEALL	0.285967	0.084978	1.000000	0.261429	0.332079	0.118869	0.244076	0.338766	0.342600
N225	0.650966	0.221503	0.261429	1.000000	0.677010	0.370490	0.673057	0.645380	0.521881
HS	0.787315	0.196737	0.332079	0.677010	1.000000	0.606362	0.710386	0.696404	0.688368
SHCO	0.482844	0.114226	0.118869	0.370490	0.606362	1.000000	0.469185	0.434814	0.536231
KOSPI	0.736410	0.291061	0.244076	0.673057	0.710386	0.469185	1.000000	0.740193	0.602660
JACO	0.735177	0.143922	0.338766	0.645380	0.696404	0.434814	0.740193	1.000000	0.740070
KLCO	0.639883	0.207372	0.342600	0.521881	0.688368	0.536231	0.602660	0.740070	1.000000
PSECO	0.662769	0.223518	0.282423	0.484005	0.605293	0.429960	0.554863	0.689857	0.638346
ST	0.815155	0.243832	0.394077	0.735619	0.856747	0.514372	0.787533	0.799057	0.743403
TW	0.707685	0.295952	0.250430	0.642397	0.760125	0.446126	0.726154	0.655500	0.575841
TASI	0.380111	0.139985	0.182657	0.402427	0.360429	0.135255	0.389356	0.335936	0.249880
ADG	0.243963	0.243077	0.156262	0.292791	0.275340	0.121391	0.208646	0.227073	0.175615
T50	0.070404	0.128166	0.219371	0.098320	0.143170	-0.017225	0.067174	0.204449	0.240399
KPI	0.274148	0.279805	0.213063	0.438262	0.360785	0.170319	0.351760	0.386343	0.284252
SP500	0.690645	0.222098	0.300881	0.734058	0.747938	0.415387	0.687932	0.682708	0.600727
	PSECO	ST	TW	TASI	ADG	T50	KPI	SP500	-
NIFTY	0.662769	0.815155	0.707685	0.380111	0.243963	0.070404	0.274148	0.690645	-
K100	0.223518	0.243832	0.295952	0.139985	0.243077	0.128166	0.279805	0.222098	-
CSEALL	0.282423	0.394077	0.250430	0.182657	0.156262	0.219371	0.213063	0.300881	-
N225	0.484005	0.735619	0.642397	0.402427	0.292791	0.098320	0.438262	0.734058	-
HS	0.605293	0.856747	0.760125	0.360429	0.275340	0.143170	0.360785	0.747938	-
SHCO	0.429960	0.514372	0.446126	0.135255	0.121391	-0.017225	0.170319	0.415387	-
KOSPI	0.554863	0.787533	0.726154	0.389356	0.208646	0.067174	0.351760	0.687932	-
JACO	0.689857	0.799057	0.655500	0.335936	0.227073	0.204449	0.386343	0.682708	-
KLCO	0.638346	0.743403	0.575841	0.249880	0.175615	0.240399	0.284252	0.600727	-
PSECO	1.000000	0.695400	0.530686	0.068188	0.123543	0.226550	0.251904	0.621788	-
ST	0.695400	1.000000	0.780646	0.370553	0.270290	0.205116	0.415099	0.790129	-
TW	0.530686	0.780646	1.000000	0.360282	0.231807	0.189158	0.362029	0.677811	-
TASI	0.068188	0.370553	0.360282	1.000000	0.516333	0.079109	0.487239	0.370417	-
ADG	0.123543	0.270290	0.231807	0.516333	1.000000	0.072377	0.583882	0.248036	-
T50	0.226550	0.205116	0.189158	0.079109	0.072377	1.000000	0.164377	0.235818	-
KPI	0.251904	0.415099	0.362029	0.487239	0.583882	0.164377	1.000000	0.441156	-
SP500	0.621788	0.790129	0.677811	0.370417	0.248036	0.235818	0.441156	1.000000	-

*Results which show more than 0.500 values are as sumed to be significant under this study

Table 18: Correlation results (Sub-periods) (in relation to India and the US)

Indices	Pre-crisis period-January 2005-June 2007 (30 months)	During-the-crisis period-July 2007-December 2009 (30 months)	Post-crisis period-January 2010-June 2012 (30 months)
NIFTY	NIFTY and N225 (0.674812)	NIFTY and CSEALL (0.535386)	NIFTY and HS (0.657841)
	NIFTY and HS (0.507264)	NIFTY and N225 (0.727585)	NIFTY and KOSPI (0.764065)
	NIFTY and KOSPI (0.625044)	NIFTY and HS (0.889738)	NIFTY and JACO (0.681662)
	NIFTY and JACO (0.582343)	NIFTY and SHCO (0.616130)	NIFTY and KLCO (0.539564)

Table 18: Continue

Indices	Pre-crisis period-January 2005-June 2007 (30 months)	During-the-crisis period-July 2007-December 2009 (30 months)	Post-crisis period-January 2010-June 2012 (30 months)
	NIFTY and ST (0.615606)	NIFTY and KOSPI (0.760679)	NIFTY and PSECO (0.749003)
	NIFTY and TW (0.535687)	NIFTY and JACO (0.785095)	NIFTY and ST (0.774436)
	NIFTY and SP500 (0.757022)	NIFTY and KLCO (0.762839)	NIFTY and TW (0.647171)
		NIFTY and PSECO (0.752786)	NIFTY and TASI (0.505779)
		NIFTY and ST (0.867621)	NIFTY and ADG (0.552372)
		NIFTY and TW (0.758386)	NIFTY and SP500 (0.529073)
		NIFTY and TASI (0.657000)	
		NIFTY and ADG (0.527497)	
		NIFTY and SP500 (0.785599)	
SP500	SP500 and NIFTY (0.757022)	SP500 and NIFTY (0.785599)	SP500 and NIFTY (0.529073)
	SP500 and HS (0.584051)	SP500 and N225 (0.778549)	SP500 and N225 (0.746109)
	SP500 and KOSPI (0.568121)	SP500 and HS (0.769381)	SP500 and HS (0.777437)
	SP500 and JACO (0.611150)	SP500 and KOSPI (0.741322)	SP500 and SHCO (0.577993)
		SP500 and JACO (0.731374)	SP500 and KOSPI (0.706988)
		SP500 and KLCO (0.641989)	SP500 and JACO (0.648824)
		SP500 and PSECO (0.696079)	SP500 and KLCO (0.604289)
		SP500 and ST (0.836830)	SP500 and PSECO (0.560275)
		SP500 and TW (0.708698)	SP500 and ST (0.740848)
		SP500 and TASI (0.615322)	SP500 and TW (0.739082)
		SP500 and KPI (0.622093)	SP500 and TASI (0.509538)
			SP500 and ADG (0.590259)
			SP500 and KPI (0.508658)

*Results which show more than 0.500 values are assumed to be significant under this study

CONCLUSION

In line with Bekaert and Harvey (1995), my study has also rejected the hypothesis that international stock markets are either perfectly integrated, perfectly segmented or partially integrated but the extent of such co-integration is constant over time. Thus, an important implication of my findings is that the degree of co-integration among selected Asian and US markets tends to be time-variant, especially around periods marked by financial crises. Although, many of my study results as per their strengths and weaknesses contradict with each other under different periods but they agree and/or contradict with the stated empirical literature as many times.

I contradict with Yoshida (2010) as I find that volatility and non-normality is strongly evident in all these stock market's returns throughout the overall study period and especially during-the-crisis period. It is interesting to observe that except Sri Lanka and Pakistan all other Asian markets follow the US market in most periods including India. This is in line with most empirical studies (Atmadja *et al*., 2014; Dasgupta, 2016; Graham *et al*., 2012; Huyghebaert and Wang, 2020) but contradict with Glick and Hutchison (2013), Lee and Isa (2014), etc. Another critical finding is that out of all selected markets Indian market along with the Sri Lankan, Hong Kong and Indonesian markets had provided positive returns in during-the-crisis period also. This implies the strong presence and attractiveness of the Indian stock market among the international investors for maximizing benefits by their portfolio diversification process and strategies. However, in agreement with Glick and Hutchison (2013), Lee and Isa (2014), I have found that in the post-crisis period most of these Asian stock markets in direct influence of the US market have become normal and less volatile than other periods. Especially, the SAARC and ASEAN markets in line with the US had recovered and were giving positive returns.

In regard to India's short-run associations and dynamic linkages with other Asian markets and the US, I have found that the NIFTY Index (representing Indian stock market) have had short-run relationships with thirteen others (except Pakistan, Iran and Kuwait but include US) selected international stock markets in during the crisis period. This finding has supported earlier results by Atmadja *et al*. (2014) and Cheung *et al*. (2010). However, in the pre and post-crisis periods less short-run relationships are observed with the Indian stock market with the exception of ASEAN stock markets. The US market however as evident was always correlated with the Indian stock market in all periods. During the crisis results also indicate an overwhelming presence of short-run relationships in Asia and with the US than any other sub-periods.

The Granger's causality test results to find short-run relationships however mostly contradict with correlation results. It is found that the Indian stock market had only one (i.e., with Iran) and the US market had only two (i.e., with Pakistan and Iran) significant short-run causal relationships with other international markets. NIFTY and HS in during-the-crisis period and NIFTY and KOSPI in post-crisis period also had bidirectional causal relationships (though mostly not fully significant) in the

short-run. This proves that both Indian and US investors have had plenty of diversification opportunities available in Asia itself during all periods. Another interesting finding is that the Sri Lankan stock market had been Granger caused by most Asian peers in during the crisis period but not in other periods.

I have also found that the Indian, Hong Kong, Chinese, Korean, Indonesian, Malaysian, Thailand, Taiwan, Saudia Arabian and Kuwait stock markets are showing negative impact in response to the innovation/shock (i.e., information transmission) in the US market in the short-run. This finding has also supported earlier empirical studies (Atmadja *et al*., 2014; Dasgupta, 2013; Graham *et al*., 2012; Huyghebaert and Wang, 2010) results. However, these evidences are contradictory for the short-run with the Granger's test results.

The JJ tests results point out that for the overall study period both US and Indian stock markets were co-integrated in the long-run with all these Asian markets. Though these results agree with the findings by Dasgupta (2013, 2016a), Graham *et al*. (2012), Islam *et al*. (2013), etc. but in sharp contrast with Gupta and Guidi (2012). Overall, it nullifies the presence of any kind of portfolio diversification opportunities for international investors including the Indian and US investors in these markets under this period. However, my results show that there was enough portfolio diversification opportunities for the US and international investors outside US including India especially, during the crisis period. Both tests results under JJ co-integration technique also point out that the Indian investors could gain from portfolio diversification process in during-the-crisis period by investing in the Japanese, Thailand, Iranian and Kuwait stock markets. However, in the post-crisis period there has been no such opportunity for the Indian investors.

But when here I take into consideration the sign and size coefficients of co-integration vector, new results emerge. These results show that the US investors could also invest in the Chinese, Saudi Arabian, Japanese and UAE stock markets in that order only in the overall study period to gain maximum benefits from portfolio diversification process. During-the-crisis period they could also invest in six out of remaining fifteen Asian markets namely the Philippines, Pakistani, Indonesian, Kuwait, UAE and Hong Kong stock markets in that order only with the similar objective. In Indian context, I have found that for the overall study period the US market was one of the most favourable diversification destinations to the Indian investors. Indian investors could also gain from portfolio diversification process by investing in eleven out of remaining fifteen markets namely the Chinese, Saudi Arabian, Japanese, UAE, Thailand, Kuwait, Korean, Taiwan, Sri Lankan, Philippines and Iranian stock markets. It is also evident that the Indian and US market was conterminous during-the-crisis period but not in other periods. The US and Indian markets were also causing volatility transmission to other Asian markets.

Although, I have not found any specific market leader in Asia like some earlier studies (Dungey *et al*., 2010; Islam *et al*., 2013; Huyghebaert and Wang, 2010; Yang *et al*., 2003) but my results point out few of the strongest contenders like India and few of ASEAN markets. My results therefore would provide a guidance note to international investors especially the Indian and US ones to strategize their portfolio diversification process in similar periods in the future. From a policy-perspective, co-integrated stock markets would contribute to financial stability, since they cannot deviate too far from the long-run equilibrium path.

LIMITATIONS

But, my study suffers from few limitations. As the selection of market-combinations is very important in this kind of integration study, I have completely ignored the European developed markets whereas undertaken most developing and developed Asian markets including MENA representatives here. The interrelationships of these Asian markets in regard to trade relations, macroeconomic fundamentals and policy-perspectives are ignored rather I have investigated their co-integration and dynamic linkages under one broad panel on the basis of country-specific stock markets returns. I have a clear-cut objective to find the probable portfolio diversification destinations especially to the Indian and US investors in the overall study period and sub-periods among these Asian markets rather suggest measures to avoid such crisis impact to the policy-makers of these countries.

RECOMMENDATION

Future studies should take all these issues for investigation to enrich the already rich co-integration and dynamic linkages literature.

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