Stock Market Integration and Volatility Spillover:India and its Major Asian Counterparts

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ABSTRACT

Return and volatility spillover among Indian stock market with that of 12 other developed and emerging Asian countries over a period from November 1997 to April 2008 is studied. Daily opening and closing prices of all major equity indices from the sample countries are examined by applying the GARCH model [Engle (1982) and Bollerslev (1986)] to explore the possibility of stock market integration and volatility spillover among India and its major Asian counterparties. Apart from different degrees of correlations, both in terms of return and squared return series, among Indian stock market with that of other Asian countries, the contemporaneous intraday return spillover among India and almost all the sample countries are found to be positively significant and bi-directional. More specifically, Hong Kong, Korea, Singapore and Thailand are found to be the four Asian markets from where there is a significant flow of information in India. Similarly, among others, stock markets in Pakistan and Sri Lanka are found to be strongly influenced by movements in Indian market. Though most of the information gets transmitted among the markets without much delay, some amount of information still remains and can successfully transmit as soon as the market opens in the next day.

Keywords: Asian stock markets; Integration; Information spillover; GARCH model

JEL Clasification: G10, G14, G15

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ABSTRACT

Return and volatility spillover among Indian stock market with that of 12 other developed and emerging Asian countries over a period from November 1997 to April 2008 is studied. Daily opening and closing prices of all major equity indices from the sample countries are examined by applying the GARCH model [Engle (1982) and Bollerslev (1986)] to explore the possibility of stock market integration and volatility spillover among India and its major Asian counterparties. Apart from different degrees of correlations, both in terms of return and squared return series, among Indian stock market with that of other Asian countries, the contemporaneous intraday return spillover among India and almost all the sample countries are found to be positively significant and bi-directional. More specifically, Hong Kong, Korea, Singapore and Thailand are found to be the four Asian markets from where there is a significant flow of information in India. Similarly, among others, stock markets in Pakistan and Sri Lanka are found to be strongly influenced by movements in Indian market. Though most of the information gets transmitted among the markets without much delay, some amount of information still remains and can successfully transmit as soon as the market opens in the next day.

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1. INTRODUCTION

The increasing regionalization of economic activities and the liberalization of financial markets since the late 1980s resulted in *regional economic integrations* [1] around the world. Due to the increasing interdependence of major financial markets all over the world, the transmission of stock market information among the major Asian markets has become a much researched topic. Early research focused exclusively on the spillover of the first moment, i.e. the return among the major stock exchanges (Eun & Shim, 1989, Joen & Furstenberg, 1990 and Cumby, 1990 etc.). But, studying the stock market co-movements is a joint study of information spillover both in terms of returns as well as the volatility of returns. Volatility linkages, i.e. inter-market linkages in the conditional second moments of stock price is the another significant aspect of international

[1.] Regional economic integration can take place among the markets within the same region because of so many factors, such as economic ties among the countries, lower geographical distance, foreign investments, contagion effect etc.

financial relations. Several studies, such as (Kyle, 1985) have pointed out that much of the information would be revealed in the volatility of stock prices, rather than the price itself.

There are several reasons to analyze the cross-border volatility spillovers. In addition to various domestic factors, volatility of major foreign trading partners is one of the important determinants of stock return volatility in a domestic market. From the practitioners' point of view, they are interested to analyze the volatility with a view to assess the risk associated with various financial assets (Merton, 1980) and to facilitate the valuation of different financial products along with the development of different hedging techniques (Ng, 2000). As far as the academics are concerned, they believed that the changes in volatility reveal the arrival of new information (Ross, 1989).

This paper attempts to investigate the first and second moment interactions among Indian equity market with that of twelve other Asian countries. It is very well known that the volatility of stock return series is time varying, both intra-day and across the days. In light of this fact, application of Vector Auto Regression *(VAR)* [2] technique, assuming time invariant conditional variances; to investigate the transmission of stock price movements may not cover all the aspects of the transmission mechanism. Therefore, this study has examined the transmission mechanism of the conditional first and second moments in the stock prices across the markets allowing for changing conditional variances. The Generalized Autoregressive Conditional Hetroscedasticity (GARCH) model introduced by Engle (1982) and Bollerslev (1986) has been used to account for the time-variant conditional variances. Our results, based on daily price observations from November 1997 to April 2008, ensures that apart from different degrees of correlations, both in terms of return and squared return series, among Indian stock market with that of other Asian countries, the contemporaneous intraday return spillover among India and almost all the sample countries are found to be positively significant and bi-directional where as the same in terms of volatility is basically unidirectional, i.e. either from other Asian countries to India or vice versa. As far as the lagged spillover of market information is concerned, though most of the information gets transmitted among the markets without much delay, some amount of information, both in terms of return and volatility, still remains and can successfully transmit as soon as the market opens in the next day

The rest of this paper is organized as follows: Section 2 presents a brief and critical review of existing literature relevant with this study and pointed out the possible efforts trying to achieve through the study. The details of data used are presented in section 3. Section 4 gives a

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[2.] Interdependence among more than one market can be examined through a Vector Auto Regression technique where every endogenous variable in a system is modeled as a function of the lagged values of all of the endogenous variables in the system.

comprehensive description of the methods and the tests applied in the study. The analysis of major empirical findings is shown in section 5, followed by the conclusion in section 6.

2. REVIEW OF LITERATURE

There is a diverse amount of literature on the stock market integration and information spillover (both in terms of return and volatility) across the markets. Some studies have examined only the return spillover across the markets, while some other studies consider both the first and the second moments of equity prices to examine the cross border spillover. Apart from examining only the presence of such interdependence among the equity markets, some authors have also focused on the impact of some special events such as market crisis, market liberalization etc. on the spillover of information across the national borders. All the above studies aimed at examining only the spillover of information among the national equity markets, but there are also some studies that focused on the possible factors or in short, the determinants of such information spillover among different markets.

Elyasiani (1998), Janakiramanan (1998), Gilmore (2002), Hsiao (2003), Leong (2003), Nath (2003), Bessler (2003), Mukherjee (2005), Alexandr (2008), etc. are some of the important studies where the examination of return spillover across the markets has been the only concern. By applying the Vector Auto Regression model, Janakiramanan (1998) and Hsiao (2003) have tried to examine the possible linkages between the stock markets in the Pacific-Basin region and the Asia-Pacific region respectively with the US. The unidirectional linkages from the US market to the others are found to be significant in both the studies. Leong (2003) have analyzed the interdependence of five East Asian stock price indices where some of the pairs of markets are found to be cointegrated. Elyasiani (1998) have investigated the interdependence and dynamic linkages between the emerging capital markets of Sri Lanka with the markets of its major trading partners and have found no significant interdependence between the Sri Lankan market and the equity market of the US and other Asian countries. Gilmore (2002) have examined the short as well as long term relationships between the US stock market and other three Central European markets where it was shown that the markets are not cointegrated in the long-run. Results of cointegration and Granger causality test by applying very high frequency (from 5 minutes to 1 day) data from US, London, Germany and some other European markets, Alexandr (2008) has revealed the faster transmission of information among the markets within one hour, not within a day or beyond a day.

Apart from examining only the degree of spillover among the markets, studies like Sheng (2000), Cifarelli (2000), Hashmi (2001), Tan (2001), Ratanapakorn (2002), Jang (2002), Yang (2002), Kim (2005), Fan (2003), Melle (2002), Click and Plummer (2005), Lucey and Voronkova

(2008) etc. have also examined the affect of market crisis on the information spillover across the border of a country. Almost all of the above studies have examined the effect of 1997 / 98 Financial Crisis. By applying simple correlation, Granger causality, VAR etc. these studies have examined the degree of inter-linkages before, during and after the crisis. While, some studies like Cifarelli (2000), Fan (2003) etc. have accommodates the GARCH effect in the stock return while measuring the cointegration among the markets. Almost all the studies have confirmed that there is a shift in the pattern of return / volatility transmission during a crisis period and some studies have shown the persistence of such effect even after the crisis. Tan (2001), Click and Plummer (2005) have examined how the degree of capital-market integration of the East and South-East Asian (ESEA) and ASEAN-5 economies varied over the period 1988–2000 following the deregulation of these markets. Melle (2002) has examined whether the integration of the European stock markets has increased after the introduction of the Euro and concluded that the Euro has accelerated the intensity of the integration process. While examining the interrelationship among Russian and other equity markets during 1995-2004, Lucey and Voronkova (2008) have made it clear that instead of being remained isolated from the influence by international markets in the long run, though the Russian market might experienced a structural break in August 1998, it did not alter the nature of long-run relationships.

Unlike only return spillover, studies examining the spillover of information both in terms of return and volatility includes Hamao (1990), Christofi (1999), Kumar (2002), Hahm (2003), Kim (2005), Wang (2005), Abraham and Seyyed (2006), Baur and Jung (2006), Egert and Kocenda (2007), Chuang (2007), Gębka and Serwa (2007), Morana and Beltratti (2008), Yu and Hassan (2008), Alkulaib (2008) etc. Following the ARCH family of statistical models, Hamao (1990), Christofi (1999), Kim (2005), Wang (2005), Baur and Jung (2006) etc. have examined the volatility spillover among the developed and emerging European, American, and Asian equity markets with the US. Most of the studies have shown a unidirectional volatility spillover from the US to other country. Abraham and Seyyed (2006) have examined the flow of information among the Gulf equity markets of Saudi Arabia and Bahrain and have interestingly found an asymmetric spillover of volatility from the smaller but accessible Bahraini market to the larger but less accessible Saudi market. Chuang (2007) in their paper have investigated the volatility interdependence in six East Asian markets. Though their VAR results revealed a strong interdependence among the conditional variance of different markets, Japanese market is found to be most influential in transmitting volatility to the other East Asian markets. By applying the EGARCH-M models with a generalized error distribution, though Yu and Hassan (2008) have found large and predominantly positive volatility spillovers and volatility persistence in conditional volatility between MENA and world stock markets, volatility spillovers within the MENA region are found to be higher than cross-volatility spillovers for all the markets. At the same time, while examining the dynamic linkage between the MENA countries, Alkulaib (2008)

have found some regional inconsistency in the information spillover among the markets. Gębka and Serwa (2007) have also supported the fact that even if being significant both within and across the region, intra-regional volatility spillover is more pronounced than the inter-region spillover. Morana and Beltratti (2008) in their paper have found a progressive integration of four developed stock markets viz. US, the UK, Germany and Japan, and have revealed an increasing comovements in prices, returns, volatilities and correlations among all the four markets, especially the European markets. While analyzing the comovements within and across the Central, Eastern and Western European stock markets, Egert and Kocenda (2007) have revealed the absence of any robust cointegration relationship among any of the pair of markets, but have found some short-term bidirectional information spillover among the markets both in terms of stock returns and stock return volatility.

Though very little in number, studies like Bracker (1999), Pretorius (2002), Johnson (2003), Colthup (2005) etc. have focused also on the factors affecting the spillover of information across the national equity markets all over the world. Apart from stock market crisis, Pretorius (2002), Colthup (2005) have found that bilateral trade, inflation rate differential, industrial production growth differential, interest rate differential, stock market size and volatility, region etc. are some of the important factors that can affect the spillover of information among the markets. The results of Johnson (2003) revealed that the high share of trade with the US shows positive effect, while the increased bilateral exchange rate volatility shows reverse effect on the stock market comovements.

Though there is a vast amount of literature on the spillover of information across the markets, only a few of them have focused on the Indian equity market. Kumar (2002), Nath (2003), Mukherjee (2005), Wang (2005) etc. are some of the studies where Indian equity market has been treated as one of the market the price and volatility of which affects and also is affected by the price and volatility of other markets. By carrying a comprehensive analysis from correlation to Granger causality and then to application of GARCH models to examine the co-movement and volatility transmission between US and Indian stock markets, Kumar (2002) have found Significant return and volatility spillover from US to India. Nath (2003) have examined the interdependence of the three major stock markets in South Asia, viz. India, Singapore and Taiwan and have find out no cointegration between the stock market indices during the entire study period. By applying the Granger causality test and the Geweke measure of feedback, Mukherjee (2005) have examined the stock market inter-linkages (in terms of returns) among India and the world equity markets. Wang (2005) have examined the return and volatility spillover from US and Japan to three South-East Asian capital market viz. India, Pakistan and Sri Lanka. Though they have found a return spillover from US and Japan to all the three markets, there is a significant volatility spillover from US to India and Sri Lanka and from Japan to Pakistan.

All the past literature revealed that most of the studies, mainly focusing on developing Asian markets like India, have focused on the investigation of the first moment interaction among countries, and also the integration with other developed markets such as USA, UK, Japan, Singapore, etc. The present study contributes to the existing body of literature, especially Indian and Asian, not only by covering 12 stock exchanges both from developed and emerging Asian markets, but also by examined both the intraday as well as overnight information spillover from foreign to the domestic market, both contemporaneously and with a lag of one day.

3. DATA

The list of stock markets investigated consists of India and 12 other Asian countries. The details of all sample countries and their respective stock indices are mentioned in *Table 1*.

Intraday price observations (Open and Close) are obtained over a period from July 1997 to April 2008. All the relevant data have been collected from national (www.bseindia.com) and international (www.econstats.com) websites and are used here in local currency terms. The Asian countries and their respective equity indices other than of India have been selected arbitrarily based on the availability of data. The period of study differs only for two foreign markets viz. Sri Lanka and Thailand because lack of data availability. Though the trading session of the exchanges of different countries are partially overlaps, we have decomposed the daily return into two parts, intraday return and overnight return. This has enabled us to find out the spillover effect both for intraday trading and overnight trading. The Close-to-Close return $\left[\log(Close_t / Close_{t-1})\right]$, Open-to-Close return $\left[\log(Close_t / Open_t)\right]$ and Close-to-Open return $\left[\log(Open_t / Close_{t-1})\right]$ have been respectively treated as daily, intraday and overnight return, where open and close stand for opening and closing price levels.

4. METHODOLOGY

Though there are different methods of testing the spillover of information among the national markets, ARCH family of models is very well known in case of financial time series data. In order to capture the changing volatility in a time series, our study is based on simple GARCH (1, 1) model pioneered by Engle (1982) and Bollerslev (1986). The GARCH (1, 1) model is applied with different specifications based on the objective of the study and therefore is categorized into the following three sections.

4.1. Basic GARCH Model for Intraday and Overnight Return

We have first set up and estimate the basic GARCH (1, 1) model for intraday and overnight return series of all the sample equity indices taken from different Asian equity markets. It is very well known that a mean-variance efficient CAPM model of stock returns can be well expressed through GARCH in Mean or *GARCH-M* [3] model. The model is estimated using the Maximum Likelihood Procedure applying the Berndt-Hall-Hall-Hausman (BHHH) algorithm. The model, namely *Model 1*, is such that:

$$R_{i,t}^{k} = \gamma_0 + \gamma_1 R_{i,t-1}^{k} + \gamma_2 h_t^{1/2} + \varepsilon_t \qquad (1)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \qquad (2)$$

In the above model the first and the second equation respectively represent the conditional mean and conditional variance equation. $R_{i,t}^{k}$ represents the return of equity indices from different countries [where i = different countries and k = Intraday (Open-to-Close) or Overnight (Close-to-Open) returns] and h_t is the conditional variance. $h_t^{1/2}$ in the conditional mean equation of *Model 1*, representing the impact of risk factor in return, is the square root of the contemporaneous conditional variance. The variance equation is specified as GARCH (1, 1) model in which the 2nd and 3rd coefficients are respectively the *ARCH* and *GARCH* [4] parameters.

4.2. GARCH Model for Intraday (Open-to-Close) Information Spillovers

To capture the contemporaneous and dynamic effect of foreign market volatility on both the return as well as risk (i.e. volatility) of the domestic market, the specification for the conditional mean and variance equation, as mentioned in *Model 1*, is modified in such a way so that we can *separate* [5] the risk estimator of the conditional mean equation into two parts: a risk measure derived from the own market's volatility and the risk measure capturing the volatility spillover from foreign markets. Though it is well known that the actual information is revealed in the movement of the returns, i.e. in the volatility of the return, the levels of the foreign stock market return may also be important while determining the returns of domestic market. Therefore, we have included also the foreign market return series, along with the risk measure, as one of the exogenous variable in the conditional mean equation of *Model 2*. While forming the variable of volatility spillover, we have used the variance, rather than the squared residuals, derived from the

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3. Unlike in simple GARCH model, the GARCH-in-Mean model includes the conditional variance or its square root in the conditional mean equation along with other explanatory variables.

4. The coefficient of the ARCH and GARCH term can be represented as the recent and old news coefficient respectively. The un-conditional variance can be calculated as $\alpha_0 / (1 - \alpha_1 - \beta_1)$

5. The separation of the risk terms in the mean equation and the inclusion of them as exogenous variables in the variance equation ensure to investigate the complete effect of foreign market volatility spillover on the return and volatility of domestic market.

basic GARCH (1, 1) model as mentioned above. Therefore, the GARCH model of *information* [6] spillover as mentioned above is set up as follows:

$$R_{i,t}^{OC} = \gamma_0 + \gamma_1 R_{i,t-1}^{OC} + \gamma_2 R_{j,t}^{OC} + \gamma_3 h_{j,t}^{OC} + \varepsilon_t \quad (3)$$

$$h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \delta_1 h_{j,t}^{OC} \quad (4)$$

$R_{i,t}^{OC}$ and $h_{i,t}$ are the t-period intraday return and volatility in the domestic market. While, $R_{j,t}^{OC}$ and $h_{j,t}^{OC}$ are the contemporaneous spillover variable from foreign market in terms of intraday return and intraday volatility. It is to be noted here that though we have separated the risk estimator of the conditional mean equation into two parts, the own market's risk measure, i.e. the square root of the variance from the own market (as included in the first equation of *Model 1*) is not included in the conditional mean equation above because of its statistical insignificance in case of almost all the countries as estimated in *Model 1*. The above model will estimate the contemporaneous effect of intraday information spillover from foreign market because of the inclusion of the *overlapping* [7] spillover variables. Applying the same model but including the lagged return and volatility horizons from the foreign market, rather than the contemporaneous one, we can investigate the dynamic information spillover from foreign markets. The models will be one and the same both for investigating the effect of contemporaneous and dynamic information spillover except that the later includes $R_{j,t-1}$ and $h_{j,t-1}$ instead of simple $R_{j,t}$ and $h_{j,t}$. The purpose of including the lagged foreign market intraday return and volatility is to ensure the transmission of some information which fails to be transmitted from one market to another on the same day, but can be transmitted just in the next day. Therefore, an effort has been made to capture the spillover of information, both within the same day (Contemporaneous) and also across the day (Dynamic). Here, it is assumed that neither market can lead or lag beyond one day, and therefore the spillover variables are specified only with one day lag, i.e. at day (t-1).

4.3. GARCH Model for Overnight (Close-to-Open) Information Spillovers

The above model estimates the contemporaneous and dynamic spillover of information from foreign markets when the markets, i.e. the stock exchanges of different countries are open. But there may be some spillover of information that occurs when no trading takes place. It is well

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6. The present study concerns both the return and volatility spillover from the foreign markets. Since the market information is captured into both the first and second moment of the stock price, the return and volatility spillover can collectively be known as information spillover.

7. When the trading period in the stock exchanges of different countries are fully or partly the same, the stock exchanges are said to be overlapped. Almost all the sample Asian countries exhibit overlapping (may not be fully) trading period in a day.

known that an overlap in the trading period intervals across the markets may induce positive correlation in the returns and volatility of the markets (Hamao, 1990). Information relating to the concurrent intraday return in the foreign market may be transmitted to the overnight returns in the domestic market. This essentially accounts for the impact of overnight foreign trading on the opening price in the domestic market. Since all the countries selected in this study are more or less from the same region, there is a great chance of overlapping in the trading periods of all the stock exchanges. As far as our knowledge is concerned, the simplest way to find out the overnight information spillover, without going deep into the exact trading intervals of all the exchanges, is to examine the impact of recent (i.e. on day t-1) foreign market intraday trading on the overnight return of the domestic market on day t. This will ensure the overnight spillover effects from foreign markets to the domestic market and vice versa. The GARCH model of overnight information spillover, namely *Model 3*, estimates the spillover effects in both the conditional mean and conditional variance of the overnight returns in the domestic market such that

$$R_{i,t}^{CO} = \gamma_0 + \gamma_1 R_{i,t-1}^{CO} + \gamma_2 R_{j,t-1}^{OC} + \gamma_3 h_{j,t-1}^{OC} + \varepsilon_t \quad (5)$$

$$h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \delta_1 h_{j,t-1}^{OC} \quad (6)$$

$R_{i,t}^{CO}$ and $h_{i,t}$ are the overnight return and volatility in the domestic market. While, $R_{j,t-1}^{OC}$ and $h_{j,t-1}^{OC}$ represent the most recent (here one day lagged) intraday (open-to-close) return and the variance in the foreign markets.

While estimating the spillover effect, first of all we have estimated the information (both in terms of return and volatility) spillover from other Asian markets' to Indian market and then we have looked into the spillover of information from Indian equity market to that of other Asian countries. But these two types of equations are not estimated simultaneously, like in case of Vector Auto Regression technique. Apart from the individual tests of significance of the spillover variables, we have computed *F statistic and Likelihood Ratio (LR)* [8] statistics for the joint significance of only volatility spillover variables included both in the conditional mean and conditional variance equation of *Model 2* and *3* above.

[8] The redundancy of the volatility spillover variables both in the conditional mean and variance equation is jointly examined by the F test Log Likelihood Ratio test under the null hypothesis that the values of respective coefficients are equal to zero. Since examination of the volatility spillover is our main concern in this study, the F test and LR test is restricted only to the information spillover in terms of the second moment, i.e. the volatility or variance.

5. EMPIRICAL RESULTS

The empirical results and findings derived from the present study are broadly categorized into two sections – initiated with some preliminary analysis, and then move to the final analysis based on the main objectives modeled in different GARCH framework. The preliminary analysis includes the analysis of different descriptive statistical measures followed by the analysis of co-movements among the equity returns and also among the volatility of equity returns of India and its major Asian counterparts.

5.1. Preliminary Analysis

The summary statistical measures of the stock index returns of India and its major Asian counterparts are described in *Table 2*. The test is performed for all the three series of returns – Daily, Intraday, and Overnight. Almost all the return series for all the sample markets are found closer to zero, and specifically negative for the intraday return series. This clearly reveals a negative change in the value of equity indices within a day, in almost all the sample markets. As far as the standard deviation measure of different return series is concerned, daily returns shows higher variation, followed by intraday return and then the overnight return. One more common but interesting observation is that the standard deviation is significantly higher during the trading period (i.e. for intraday return) than the non-trading period (i.e. for the overnight return) for the equity index of almost all the Asian markets. It ensures higher volatility during the periods when market is open comparative to the periods when there is no trading in the market. Most of the return series in majority of the markets possess a negative skewness that supports greater chances of higher actual returns than the average, in most of the markets. At the same time, higher values of kurtosis in case of overnight return in all the markets suggests the presence of extreme deviation or movement in the return when the market is closed, i.e. over the night.

As far as the co-movement among the markets is concerned, one of the simplest ways is to examine the correlation structures among the markets both in terms of return and volatility of returns. All the three return series – daily, intraday and overnight are considered separately to find out the correlation among the markets. The contemporaneous correlation for daily return series is based on the daily returns on day t which result in overlapping holding period. While the same for the intraday return is based on the Open-to-Close return series on day t. The contemporaneous correlation for the overnight return series is little different from the others and is based on the Close-to-Open return series of domestic market on day t and the Open-to-Close return series of foreign market on day (t-1). The correlation structure for the volatility series is just the same where the squared returns are taken as a proxy for volatility. These correlation measures help to

build up some idea about the *linear* [9] inter-linkage among the markets. Apart from the Pearson's measures of coefficient of correlation, one of the easiest way to look into the comovements among the equity market of different country is to see the line diagram where the price of some representative major stock indices in both the markets are plotted against time. The convergence of both the lines at any point of time reveals the possible interlinkages among the equity market in India and its major Asian counterparts.

Table 3 reports the correlation among the returns and also among the volatility of returns in India and its Asian counterparts. The correlation test is performed for all the three return series. The table confirms that almost all the return and volatility correlations except a very few are positive, indicating a common response to some global information. *Table 3* also reveals that the correlations among India and other Asian markets are not considerably higher in magnitude as normally being seen in case of developed markets. As far as the daily (Close-to-Close) and intraday (Open-to-Close) return series are concerned, Indian SENSEX is found to be significantly correlated with all other Asian countries except only with Sri Lanka. But the same is not true for the overnight return series. The domestic overnight return (i.e. overnight SENSEX return) is found to have a significant association with the recent intraday return (intraday return at day t-1) of only four out of twelve Asian foreign markets, viz. Hong Kong, Korea, Singapore and Thailand. Therefore, though there is an intraday spillover of information among India and its major Asian counterparts, the scope of spillover is limited to certain markets if the non-trading hours are taken into consideration. Almost a similar picture can be seen if the co movements in the volatility of returns are taken into consideration. As far as the simple correlation among the squared return, used as a proxy for the volatility, of SENSEX and equity indices of other Asian markets are concerned, most of them in daily squared returns series (except with Malaysia and Sri Lanka), and intraday squared returns series (except with China, Malaysia and Sri Lanka) are found to be statistically significant. But similar to the overnight return series, the correlation among Indian overnight squared return with the recent intraday squared return of most of its Asian counterparts (except with Hong Kong and Thailand) are found to be insignificant. Therefore, as far as the daily and intraday co-movements are concerned, Indian market is strongly associated with its Asian counterparts, both in terms of return and volatility. But while coming to the matter of any overnight inter-linkage, there is hardly any spillover, neither in terms of return, nor volatility, among India and its Asian counterparts with some exception. Overnight information spillover both in terms of return and volatility are found to be significant only with Hong Kong and Thailand. The correlation results among India and Sri Lanka clearly shows the absence of any significant interrelation between the markets, neither in terms of return nor in

[9.] Simple Pearson coefficient of correlation can measure only the linear relationship among two variables over a period of time. It fails to capture the non-linear interrelation (if any) among the variables, here among the equity return series in India and any of its major Asian counterparts

volatility of returns, irrespective of the three different return and volatility series. Not only the quantitative analysis, but also the graphical part, as depicted in *Figure 1*, exhibits the possible comovements among the equity market in India with its major Asian counterparts with a very few exception.

5.2. Basic GARCH Results for Intraday and Overnight Return

The Basic GARCH (1, 1) model of intraday and overnight return series is mainly set up not to test any spillover effect, but to estimate the spillover variables in terms of volatility in both the markets viz. India and its Asian counterparts. Due to the shortage of space, the results of the basic GARCH model are not presented in the study, but will be available on request. The basic GARCH (1, 1) results, in case of almost all the markets and also for the intraday and overnight return series, confirm the insignificance of the risk factor as included in the conditional mean equation (Equation 1) of *Model 1*. The recent (ARCH) and old (GARCH) news coefficients, as specified in the conditional variance equation, for almost all the Asian markets are found to be positively significant both in case of intraday and overnight return series. Only the recent news coefficients for Sri Lankan and Malaysian overnight return shows statistical insignificant. The conditional variance series of different Asian equity returns (intraday and overnight) derived from these basic GARCH (1, 1) model are used as the spillover variable to test the volatility spillover between India and its other Asian counterparts. Return Variance of other Asian market is used as an exogenous variable both in the conditional mean and variance equation of SENSEX return to test the volatility spillover from other Asian countries to India. Similarly, the variance series of SENSEX return is used to test the volatility spillover from India to those other Asian markets.

5.3. Results on Intraday Information Spillover

The results on the intraday spillover of information both in terms of the first and second moment of stock price are broadly divided into two parts – Contemporaneous spillover and Dynamic spillover. In case of contemporaneous intraday spillover, emphasis is given on the simultaneous spillover of information among the markets within a same day, i.e. intraday. At the same time, in case of dynamic intraday spillover, the spillover variable considered here is of intraday, but lagged by one day. In other words, we have examined whether there is any spillover of recent or lagged intraday information from foreign market to the intraday operations of the domestic market. Here, it is assumed that due to the difference in trading time and due to some weak information transmission mechanism, any information generated in one market during a day may fails to be transmitted in other market completely during the same day. In that case, some amount of information may get transferred in the next day. Therefore, along with the contemporaneous spillover of information among the markets, there may be some possible

information spillover lagged by some time, here by one day. The results of these two types of spillover – Contemporaneous and Dynamic are tabulated separately in *Table 4* to *Table 7*. The first two table deals with the results of contemporaneous spillover and the next two tables exhibit the results of dynamic spillover.

The results of contemporaneous return spillover, as exhibited in *Table 4* and *Table 5*, confirm a significant bi-directional spillover of returns between India and its major Asian counterparts, except only with Sri Lanka. The results exhibited in the 5th column of *Table 4* and *Table 5* respectively reveals the significance of foreign market (major Asian counterparts of India) volatility on Indian equity return and the significance of Indian volatility on the return of its other Asian counterparts. *Table 4* confirms that the intraday equity return in India is significantly influenced by a contemporaneous intraday volatility spillover from Korea, Pakistan, Singapore and Taiwan. At the same time, the intraday volatility in Indian market, as exhibited in *Table 5*, is found to have a significant impact on the intraday equity return of Philippines and Sri Lanka only. These results support the fact that foreign market volatility not only affects the volatility of the domestic market, but also may affect domestic market return as well.

The previous paragraph reveals the spillover of foreign market intraday information to affect only the intraday return of the domestic market. The results of contemporaneous volatility spillover, as reported in column 9 of *Table 4*, shows a significant spillover of intraday volatility from Hong Kong, Indonesia, Korea, Singapore and Thailand to affect the intraday volatility in India. At the same time, there is hardly any volatility spillover, as reported in column 9 of *Table 5*, from Indian market to its major Asian counterparts, except only to Pakistan and Sri Lanka. These two are the only Asian market, within the specific sample, the equity volatilities of which are influenced by the volatility of Indian equity market. These results clearly depicts the fact that though there is a contemporaneous bi-directional information spillover in the returns of India and its major Asian counterparts, the same is not true as far as the volatility among the markets are concerned.

As we have discussed earlier, apart from some contemporaneous information spillover, the presence of market imperfection may lead to spillover of information from foreign to domestic market lagged (at most) by one day. Results on the dynamic information spillovers from other Asian markets to India and also from India to its major Asian counterparts are exhibited respectively in *Table 6* and *Table 7*. The first table clearly reveals a significant information spillover only from Malaysia and Taiwan (in terms of return) and only from Hong Kong and Korea (in terms of volatility of returns) to India. Therefore, the stock market return in Malaysia and Taiwan and the volatility in the equity market of Hong Kong and Korea are found to play an important role to affect the same in Indian market, not only within the same day (contemporaneous) but also beyond the day (dynamic). At the same time, the lagged or dynamic

intraday spillover (in terms of returns) from Indian market has been found to be significant to half of its sample Asian counterparts, viz. Indonesia, Japan, Korea, Malaysia, Philippines, and Taiwan. But the same is not true for the volatility or variance series. Lagged intraday volatility of Indian equity return has been found to have a significant impact only on the intraday volatility of Sri Lankan equity market. Therefore, though there is a significant lagged return spillover from India to some of its major Asian counterparts, there is hardly any lagged volatility spillover in the same direction. As far as the impact of lagged foreign market volatility on the intraday domestic return is concerned, a significant spillover has been found only from Korea and Pakistan to India and from India to Philippines and Sri Lanka.

Therefore, the results as exhibited in *Table 4* to *Table 7* clearly reveals the fact that most of the intraday information gets spilled over from one market to another within the day itself. Though there may be some chances of lagged or dynamic spillover of information, it has been found to be very poor and is limited only between a very few markets.

5.4. Results on Overnight Information Spillover

The above section has dealt with the spillover of information among India and its Asian counterparts during the time when the markets in both the countries are open, i.e. the spillover of information within the day when trading takes place. But in this section, an effort has been made to reveal whether there is any transmission of information from one market to the other over the night. In other words, this section deals with examining the possible impact of foreign market lagged (by one day) intraday information (both in terms of return and volatility) on the overnight trading of the domestic market. Here, we have tested such overnight information spillover both from other Asian countries to India and vice versa. In this section, it is assumed that whatever intraday information in foreign market remains to be transferred during the trading time, gets transmitted to the domestic market in the next day when the market opens. Therefore, in this section, we have tested the significance of foreign market intraday information at day (t-1) on domestic overnight trading at day t.

The results relating to overnight information spillover are reported in *Table 8* and *Table 9*. *Table 8* reports the overnight return and volatility spillover from the other Asian countries to the Indian equity market. At the same time, any overnight spillover of information from India to its other Asian counterparts is exhibited in *Table 9*. The results of overnight information spillover again can be analysed in two different sections. One is the impact of foreign market lagged return and volatility on domestic overnight return and the other is the impact of foreign market lagged volatility on the overnight volatility of domestic market.

If we look into the spillover effects on the overnight return of SENSEX (as reported in *Table 8*), then it can be observed that the most recent (here on day t-1) intraday returns of the foreign markets (India's Asian counterparts), except one, have positive influences on the opening price of SENSEX. But out of twelve Asian markets, only five viz. Hong Kong, Korea, Singapore, Taiwan and Thailand, are found to exhibit statistical significance. At the same time, the recent intraday volatility of the foreign market, for most of the other Asian countries except Taiwan, failed to have any significant effect on Indian overnight return. Therefore, Taiwan has found to be the only country from where recent intraday information, both in terms of return and volatility, gets transmitted to India's overnight return. At the same time, there is also a significant spillover of recent intraday return from Indian market to the overnight return of almost all the other Asian markets except of China and Malaysia. These clearly reveal that as soon as the equity market opens in those ten Asian countries, there is a transmission of information from India which was captured in its recent intraday return. Therefore, as far as overnight return spillover is concerned, India is found to play a stronger leading role comparative to its major Asian counterparts. But the recent or lagged intraday volatility in India has been found to have a significant impact only on the overnight return of Hong Kong.

At the same time, if we focus on the impact of recent intraday foreign market volatility on the overnight volatility of the domestic market, as specified in the 9th column of *Table 8* and *Table 9*, then it can be clear that there is an overnight volatility spillover from Hong Kong, Korea, Pakistan, Taiwan and Thailand to Indian market. On the other hand, there is also a significant overnight volatility spillover from India to China, Hong Kong, Malaysia, Pakistan and Sri Lanka. Therefore the overnight volatility spillover between India with Hong Kong and Pakistan are found to be bi-directional. Apart from testing the individual test of significance, we have used some other measures to test the joint significance of only the lagged foreign market volatility both in the conditional mean and variance equation. These are F test and Log-likelihood test which have given some insight on the joint significance of the exogenous variable (here foreign market intraday variance lagged by one day) on the overnight return of the domestic market. The test has shown some mixed results. In some cases, though the variable is individually significant in any of the two equations, it shows statistical insignificance in the joint test (s) and vice versa. This may be due to the fact that the joint significance tests take care off the probable significance of the variable in both the equation and may fail to represent the significance in any of the variable – return or volatility of returns. A glimpse of significant information spillover between India and all of its Asian counterparts are exhibited in *Table 10*.

6. CONCLUSION

By applying the simple GARCH (1, 1) model with the spillover variables on the intraday (both opening and closing) price index data over a period from November 1997 to April 2008, an effort has been made to investigate the stock market integration and volatility spillover among India and 12 other Asian markets.

Spillover of information, both in terms of first and second moment of stock price, from foreign market to the domestic market is tested not only during the same day, but also across the day. In other words, the present study investigates the return and volatility spillover among India and its major Asian counterparts during trading (without any time lag and with a time lag of one day) and non-trading (over the night) hours. The purpose here is to test the transmission of market information not only when the market is open, but also in the absence of any trading, i.e. over the night.

Our study ensure that apart from different degrees of correlations, both in terms of returns and volatility of returns, among Indian equity index viz. SENSEX with that of twelve other Asian countries, there is a significantly positive and bi-directional contemporaneous intraday (open-to-close) return spillover among India and almost all the foreign countries except only with Sri Lanka. But unlike contemporaneous spillover, transmission of information lagged by one day, alternatively dynamic intraday spillover among India and its major Asian counterparts are not found to be stronger, especially in one direction, i.e. from other Asian countries to India. These facts clearly suggest that the information generated in Indian market gets transferred into other Asian markets not only on the same day but also in the next day. Now, as far as the spillover of volatility is concerned, we have tested the effect of foreign market volatility both in the return and volatility of the domestic market. Though the intraday volatility from few other Asian markets has been found to have a contemporaneous impact on the Indian intraday return, the reverse transmission is not so significant. At the same time, the impact of foreign market lagged or dynamic intraday volatility on the return of the domestic market has been found to be significant only for two out of twelve pairs of markets, in both the direction between India and other Asian countries. So far we have summarized how intraday information (both in terms of returns and volatility of returns) generated in foreign market can affect the intraday return of the domestic market. As far as the intraday volatility transmission is concerned, though there is a significant and contemporaneous spillover of intraday volatility from almost half of the foreign markets to India, the reverse is true only for two (viz. Pakistan and Sri Lanka) out of twelve markets. At the same time, the results for dynamic intraday volatility spillover among India and its major Asian counterparts has been found to be very poor and reveals the fact that volatility generated in one market gets transferred to another without much delay.

Unlike intraday information spillover, the interlinkages among India and its major Asian counterparts are not much significant in case of overnight spillover. If the overnight return spillover is taken into consideration, there is a significant spillover of information from almost half of our sample Asian markets to India. But the recent intraday return in Indian market has been proved to have a significant impact on the overnight return of almost all the sample Asian markets (except of two). This fact also made it clear that information generated in Indian market continues to get transmitted to the other market over the night and gets reflected in the return of the later as soon as the market opens. As far as the overnight volatility spillover among the markets is concerned, there is a significant volatility spillover from other Asian markets to India and also vice versa almost for half of the sample countries. If the results towards both the intraday and overnight volatility spillover are taken together, then a significant volatility transmission has been found from Hong Kong, Korea and Thailand to India in one hand and from India to Pakistan and Sri Lanka in the other. Therefore, to sum up:

- ✓ There is a bi-directional contemporaneous intraday return spillover between India and its Asian counterparts;
- ✓ Hong Kong, Korea, Singapore and Thailand are found to be the four Asian markets from where there is a significant flow of market information in India;
- ✓ Among others, stock markets in Pakistan and Sri Lanka are strongly influenced by the movements in Indian stock market
- ✓ Unlike intraday information spillover among the markets, transmission of information over the night is not common between India and all sample Asian counterparts, but is more country specific, supported by both Correlation analysis and GARCH analysis.
- ✓ Though most of the information gets transmitted among the markets without much delay, some amount of information still remains and can successfully transmit as soon as the market opens in the next day.

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Table 1: **Details of Sample Countries & their Stock Indices**

Sl. No.	Sample Countries	Stock Index	Sample Period	No. of Daily Observations
1	India	Sensex	July 4, 1997 – 30 April, 2008	2568
2	China	Shanghai Composite	July 4, 1997 – 30 April, 2008	2494
3	Hong Kong	Hang Seng	July 4, 1997 – 30 April, 2008	2568
4	Indonesia	Jakarta Composite	July 4, 1997 – 30 April, 2008	2515
5	Japan	Nikkei 225	July 4, 1997 – 30 April, 2008	2526
6	Korea	KOSPI 200	July 4, 1997 – 30 April, 2008	2549
7	Malaysia	KLSE Composite	July 4, 1997 – 30 April, 2008	2564
8	Pakistan	Karachi 100	July 7, 1997 – 30 April, 2008	2525
9	Philippines	PSE Composite	July 4, 1997 – 30 April, 2008	2569
10	Singapore	Straits Times	July 4, 1997 – 30 April, 2008	2569
11	Sri Lanka	CSE All Share	Sept. 28, 1998 –30 April, 2008	2223
12	Taiwan	Taiwan Weighted	July 4, 1997 – 30 April, 2008	2540
13	Thailand	SET	July 4, 1997 – 10 June, 2004	1619

Note: Different sample countries and their respective stock indices are selected based on the availability of data.

Table 2: **Summary Statistics of Stock Index Return of Different Asian Markets**

Returns	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Obs.
INDIA_CC	0.0005	0.0012	0.086	-0.118	0.017	-0.380	6.58	2568
INDIA_CO	0.0017	0.0018	0.064	-0.090	0.009	-1.104	17.51	2568
INDIA_OC	-0.0012	-0.0005	0.070	-0.108	0.015	-0.439	6.06	2568
CHINA_CC	0.0005	0.0005	0.094	-0.093	0.016	-0.002	7.43	2494
CHINA_CO	0.0003	0.0001	0.087	-0.062	0.006	2.298	47.08	2494
CHINA_OC	0.0001	0.0004	0.066	-0.095	0.015	-0.240	6.58	2494
HK_CC	0.0002	0.0005	0.134	-0.110	0.017	-0.023	8.57	2568
HK_CO	0.0005	0.0006	0.071	-0.083	0.010	-0.284	12.30	2568
HK_OC	-0.0003	0.0001	0.086	-0.068	0.013	0.118	7.56	2568
INDO_CC	0.0005	0.0008	0.131	-0.128	0.019	-0.102	10.15	2515
INDO_CO	0.0001	0.0001	0.062	-0.113	0.008	-2.077	41.69	2515
INDO_OC	0.0003	0.0007	0.131	-0.126	0.017	-0.032	10.56	2515
JAPAN_CC	-0.0001	0.0000	0.077	-0.077	0.015	-0.104	4.79	2526
JAPAN_CO	0.0004	0.0005	0.047	-0.038	0.007	0.555	8.04	2526
JAPAN_OC	-0.0006	-0.0003	0.073	-0.068	0.012	0.012	5.73	2526
KOREA_CC	0.0003	0.0012	0.110	-0.168	0.022	-0.234	7.00	2549
KOREA_CO	0.0007	0.0010	0.134	-0.098	0.013	0.135	13.77	2549
KOREA_OC	-0.0004	0.0001	0.060	-0.075	0.017	-0.195	4.70	2549
MAL_CC	0.0001	0.0003	0.228	-0.242	0.017	0.592	46.40	2564
MAL_CO	0.0004	0.0002	0.146	-0.047	0.006	5.893	159.95	2564
MAL_OC	-0.0003	-0.0002	0.146	-0.269	0.015	-1.500	54.98	2564
PAK_CC	0.0009	0.0018	0.128	-0.132	0.018	-0.420	8.15	2525
PAK_CO	0.0007	0.0003	0.056	-0.123	0.007	-3.421	55.16	2525
PAK_OC	0.0001	0.0007	0.104	-0.076	0.016	0.007	6.59	2525
PHIL_CC	0.0000	-0.0002	0.178	-0.104	0.016	0.900	17.72	2569
PHIL_CO	0.0004	0.0000	0.127	-0.054	0.007	2.991	66.27	2569
PHIL_OC	-0.0004	-0.0005	0.090	-0.088	0.013	-0.038	6.78	2569
SING_CC	0.0002	0.0004	0.129	-0.092	0.014	0.017	10.25	2569
SING_CO	0.0007	0.0006	0.055	-0.090	0.007	-1.364	25.44	2569
SING_OC	-0.0006	-0.0005	0.125	-0.089	0.012	0.468	12.62	2569
SL_CC	0.0007	0.0006	0.183	-0.139	0.013	0.582	35.13	2223
SL_CO	0.0002	0.0000	0.073	-0.085	0.004	0.254	240.92	2223
SL_OC	0.0005	0.0004	0.131	-0.139	0.012	-0.325	26.93	2223
TAI_CC	0.0000	-0.0001	0.085	-0.099	0.017	-0.132	5.69	2540
TAI_CO	0.0017	0.0023	0.101	-0.088	0.011	-0.576	13.18	2540
TAI_OC	-0.0017	-0.0018	0.072	-0.075	0.013	0.061	5.28	2540
THAI_CC	0.0000	-0.0004	0.215	-0.100	0.021	1.037	13.02	1619
THAI_CO	0.0018	0.0010	0.124	-0.079	0.010	1.542	41.61	1619
THAI_OC	-0.0019	-0.0022	0.091	-0.100	0.018	0.287	5.49	1619

Note: HK=Hong Kong, INDO = Indonesia, MAL= Malaysia, PAK= Pakistan, PHIL= Philippines, SING= Singapore, SL= Sri Lanka, TAI= Taiwan, THAI= Thailand
CC=> Daily (Close-to-Close) Return; CO=> Overnight (Close-to-Open) Return; OC=> Intraday (Open-to-Close) Return

Table 3: **Correlation among Indian Equity Market and of Other Asian Countries**

India & Foreign Country	Correlations among Returns:			Correlations among Squared Returns:		
	Daily Returns CC - CC	Intraday Returns OC - OC	Overnight Returns CO - OC (-1)	Daily Squared Returns CC - CC	Intraday Squared Returns OC - OC	Overnight Squared Returns CO - OC (-1)
China	0.1031**	0.0527**	-0.0235	0.1023**	0.0095	0.0215
	(5.15)	(2.63)	(-1.17)	(5.11)	(0.48)	(1.07)
Hong Kong	0.3445**	0.1865**	0.1016**	0.2234**	0.0791**	0.0540**
	(17.45)	(9.45)	(5.15)	(11.32)	(4.01)	(2.74)
Indonesia	0.2777**	0.1549**	0.0091	0.1926**	0.1085**	0.0250
	(13.92)	(7.77)	(0.46)	(9.66)	(5.44)	(1.25)
Japan	0.2782**	0.1321**	0.0009	0.1799**	0.1035**	0.0180
	(13.98)	(6.64)	(0.05)	(9.04)	(5.20)	(0.90)
Korea	0.2894**	0.1840**	0.0647**	0.2553**	0.1092**	0.0227
	(14.61)	(9.29)	(3.27)	(12.89)	(5.51)	(1.15)
Malaysia	0.1601**	0.0990**	0.0084	0.0255	0.0050	0.0041
	(8.10)	(5.01)	(0.43)	(1.29)	(0.25)	(0.21)
Pakistan	0.1272**	0.0552**	0.0190	0.1014**	0.0520**	0.0204
	(6.39)	(2.77)	(0.96)	(5.09)	(2.61)	(1.02)
Philippines	0.2087**	0.0699**	0.0113	0.1408**	0.0471*	-0.0060
	(10.59)	(3.55)	(0.57)	(7.14)	(2.39)	(-0.30)
Singapore	0.3216**	0.1854**	0.0792**	0.3216**	0.0832**	0.0216
	(16.43)	(9.47)	(4.05)	(16.43)	(4.25)	(1.11)
Sri Lanka	0.0306	0.0231	0.0106	-0.0061	-0.0069	-0.0190
	(1.44)	(1.09)	(0.50)	(-0.29)	(-0.33)	(-0.90)
Taiwan	0.2264**	0.1339**	0.0354	0.1351**	0.0852**	0.0211
	(11.41)	(6.75)	(1.78)	(6.81)	(4.29)	(1.06)
Thailand	0.2098**	0.1443**	0.0725**	0.1459**	0.1589**	0.0597*
	(8.44)	(5.80)	(2.92)	(5.87)	(6.39)	(2.40)

Note: Figures in Parenthesis represent the t-statistic for the respective coefficient of correlation to test the test of significance.

** Significant at 1%; * Significant at 5% level of significance.

Daily Return Series (CC) $= \ln(P_t^{Close} / P_{t-1}^{Close})$; Intraday Return Series (OC) $= \ln(P_t^{Close} / P_t^{Open})$; Overnight Return Series (CO) $= \ln(P_t^{Open} / P_{t-1}^{Close})$.

Squared return is taken as the proxy measure of volatility for this purpose

Table 4: Intraday Information Spillover from Other Asian Countries to India – Contemporaneous

$R_{i,t}^{OC} = \gamma_0 + \gamma_1 R_{i,t-1}^{OC} + \gamma_2 R_{j,t}^{OC} + \gamma_3 h_{j,t}^{OC} + \varepsilon_t \qquad h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \delta_1 h_{j,t}^{OC}$; i = India (Sensex), j = Other Country

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	δ_1	F Statistic	LR Statistic
China	-0.0005	0.0177	0.0418**	0.2736	0.0000**	0.1751**	0.7722**	0.0036	-0.1385	0.6686
	(-1.29)	(0.79)	(2.58)	(0.18)	(3.61)	(6.44)	(26.42)	(0.40)	(1.00)	(0.72)
Hong Kong	-0.0002	0.0049	0.2182**	-2.0586	0.0000**	0.1626**	0.7611**	0.0352**	2.0900	15.1270**
	(-0.60)	(0.23)	(11.75)	(-1.05)	(5.43)	(10.95)	(33.26)	(3.25)	(0.12)	(0.00)
Indonesia	-0.0003	0.0153	0.1315**	-1.2208	0.0000**	0.1522**	0.7906**	0.0088*	1.3748	6.7770*
	(-1.13)	(0.69)	(7.72)	(-1.59)	(4.27)	(5.74)	(26.65)	(2.10)	(0.25)	(0.03)
Japan	0.0002	0.0111	0.1494**	-3.8889	0.0000**	0.1555**	0.7813**	0.0354	1.5982	10.6302**
	(0.48)	(0.50)	(6.83)	(-1.50)	(3.61)	(6.01)	(24.42)	(1.87)	(0.20)	(0.00)
Korea	0.0005	0.0043	0.1480**	-3.7300**	0.0000**	0.1599**	0.7740**	0.0154*	5.5364**	19.1941**
	(1.32)	(0.19)	(9.27)	(-3.43)	(3.79)	(5.73)	(23.65)	(2.28)	(0.00)	(0.00)
Malaysia	-0.0005	0.0133	0.0711**	0.0033	0.0000**	0.1622**	0.7850**	0.0036	1.2015	2.7932
	(-1.84)	(0.60)	(2.93)	(0.01)	(4.39)	(5.99)	(26.01)	(1.27)	(0.30)	(0.25)
Pakistan	0.0002	0.0029	0.0376**	-2.3821*	0.0000**	0.1690**	0.7771**	0.0063	3.1580*	6.8370*
	(0.54)	(0.14)	(2.60)	(-2.33)	(5.07)	(11.92)	(41.87)	(1.12)	(0.04)	(0.03)
Philippines	-0.0009*	0.0133	0.0592**	2.3061	0.0000**	0.1628**	0.7867**	0.0085	-0.4782	1.8071
	(-2.18)	(0.60)	(2.89)	(1.07)	(3.86)	(5.78)	(24.69)	(0.73)	(1.00)	(0.41)
Singapore	0.0000	0.0087	0.2061**	-2.8267**	0.0000**	0.1529**	0.7905**	0.0132*	2.7143	12.1021**
	(-0.18)	(0.39)	(8.86)	(-3.01)	(4.30)	(5.96)	(26.80)	(2.21)	(0.07)	(0.00)
Sri Lanka	-0.0004	0.0123	0.0246	-0.3608	0.0000**	0.1697**	0.7804**	-0.0021	-0.0477	0.9286
	(-1.42)	(0.54)	(1.16)	(-0.51)	(6.08)	(11.93)	(41.40)	-(0.65)	(1.00)	(0.63)
Taiwan	0.0004	0.0017	0.1201**	-4.0867**	0.0000**	0.1614**	0.7828**	0.0173	1.9458	7.2811*
	(1.07)	(0.08)	(5.93)	(-1.97)	(3.84)	(5.96)	(25.35)	(1.72)	(0.14)	(0.03)
Thailand	-0.0008	0.0139	0.1161**	-0.5580	0.0000**	0.1878**	0.7313**	0.0216*	0.5340	4.7838
	(-1.66)	(0.50)	(5.54)	(-0.41)	(3.24)	(5.47)	(17.25)	(2.39)	(0.59)	(0.09)

Note: ** Significant at 1%; * Significant at 5%. Figures in parenthesis are z statistics (probability of significance in last two columns).
Null Hypothesis for F test and Likelihood Ratio test, only for the spillover volatility component, is: $\gamma_3 = \delta_1 = 0$

Table 5: **Intraday Information Spillover from India to Other Asian Countries – Contemporaneous**

$R_{i,t}^{OC} = \gamma_0 + \gamma_1 R_{i,t-1}^{OC} + \gamma_2 R_{j,t}^{OC} + \gamma_3 h_{j,t}^{OC} + \varepsilon_t \qquad h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \delta_1 h_{j,t}^{OC}$; i = Other Country, j = India (Sensex)

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	δ_1	F Statistic	LR Statistic
China	0.0004	-0.0652**	0.0462**	-1.4588	0.0000**	0.1134**	0.8693**	-0.0030	1.4527	2.1406
	(1.11)	(-2.79)	(2.84)	(-1.27)	(2.99)	(6.25)	(42.96)	(-0.79)	(0.23)	(0.34)
Hong Kong	0.0000	-0.0308	0.1613**	0.6965	0.0000	0.0493**	0.9479**	0.0008	-0.0086	1.1566
	(0.10)	(-1.51)	(14.42)	(0.95)	(1.59)	(9.62)	(174.66)	(0.85)	(1.00)	(0.56)
Indonesia	0.0016**	0.1180**	0.1760**	-2.5695	0.0000**	0.1090**	0.8798**	-0.0006	-0.2870	3.2165
	(4.04)	(5.12)	(8.56)	(-1.49)	(3.04)	(5.93)	(44.66)	(-0.10)	(1.00)	(0.20)
Japan	-0.0002	-0.0438*	0.1084**	0.1984	0.0000	0.0901**	0.8907**	0.0096	0.0860	9.4109**
	(-0.69)	(-2.11)	(7.01)	(0.15)	(1.52)	(6.23)	(50.50)	(1.66)	(0.92)	(0.01)
Korea	0.0003	-0.0003	0.1961**	-0.6856	0.0000	0.0670**	0.9297**	-0.0001	-0.0190	0.2220
	(0.65)	(-0.02)	(10.74)	(-0.42)	(1.79)	(6.34)	(86.00)	(-0.03)	(1.00)	(0.89)
Malaysia	0.0005*	0.1453**	0.0732**	-1.2086	0.0000*	0.1560**	0.8442**	0.0038	0.6788	9.0289**
	(2.43)	(6.42)	(6.47)	(-1.36)	(2.39)	(7.33)	(48.48)	(1.45)	(0.51)	(0.01)
Pakistan	0.0009**	0.0176	0.0408*	-2.1693	0.0000**	0.2054**	0.7379**	0.0121*	1.9712	5.2861
	(2.63)	(0.81)	(2.43)	(-1.55)	(8.16)	(11.65)	(40.88)	(2.04)	(0.14)	(0.07)
Philippines	0.0005	0.1209**	0.0508**	-3.5916**	0.0000**	0.1227**	0.8031**	0.0209	3.0230*	20.3566**
	(1.69)	(5.57)	(3.02)	(-2.92)	(2.71)	(5.10)	(25.30)	(1.77)	(0.05)	(0.00)
Singapore	0.0000	0.0215	0.1396**	-0.8735	0.0000**	0.1067**	0.8924**	0.0004	-0.0468	0.9984
	(-0.02)	(1.03)	(10.12)	(-0.82)	(2.86)	(7.65)	(70.90)	(0.25)	(1.00)	(0.61)
Sri Lanka	0.0009**	0.2563**	-0.0028	-1.8687**	0.0000**	0.3672**	0.6227**	-0.0063**	1.2621	13.2522**
	(3.97)	(12.89)	(-0.35)	(-2.76)	(12.49)	(21.93)	(53.24)	(-3.18)	(0.28)	(0.00)
Taiwan	-0.0012**	-0.0531*	0.1064**	-1.3964	0.0000	0.0679**	0.9219**	0.0057	-1.2721	5.8636*
	(-3.68)	(-2.43)	(6.01)	(-1.00)	(1.50)	(4.79)	(62.49)	(1.51)	(1.00)	(0.05)
Thailand	-0.0008	0.0213	0.1745**	-0.6469	0.0000	0.0694**	0.9149**	0.0117	0.1473	2.7202
	(-1.35)	(0.81)	(5.78)	(-0.28)	(1.47)	(4.85)	(53.68)	(1.34)	(0.86)	(0.26)

Note: ** Significant at 1%; * Significant at 5%. Figures in parenthesis are z statistics (probability of significance in last two columns).
Null Hypothesis for F test and Likelihood Ratio test, only for the spillover volatility component, is: $\gamma_3 = \delta_1 = 0$

Table 6: **Intraday Information Spillover from Other Asian Countries to India – Dynamic**

$R_{i,t}^{OC} = \gamma_0 + \gamma_1 R_{i,t-1}^{OC} + \gamma_2 R_{j,t-1}^{OC} + \gamma_3 h_{j,t-1}^{OC} + \varepsilon_t \qquad h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \delta_1 h_{j,t-1}^{OC}$; i = India (Sensex), j = Other Country

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	δ_1	F Statistic	LR Statistic
China	-0.0006	0.0190	-0.0086	0.7246	0.0000**	0.1754**	0.7730**	0.0032	-0.3021	0.8641
	(-1.57)	(0.85)	(-0.53)	(0.49)	(3.66)	(6.41)	(26.47)	(0.36)	(1.00)	(0.65)
Hong Kong	-0.0003	0.0107	-0.0347	-1.6085	0.0000**	0.1623**	0.7726**	0.0256**	1.5966	10.2455**
	(-0.86)	(0.48)	(-1.58)	(-1.15)	(4.22)	(5.91)	(23.96)	(2.84)	(0.20)	(0.01)
Indonesia	-0.0002	0.0225	0.0174	-1.3850	0.0000**	0.1602**	0.7787**	0.0086	1.7622	6.4308*
	(-0.70)	(0.97)	(1.06)	(-1.77)	(4.26)	(5.85)	(25.07)	(1.93)	(0.17)	(0.04)
Japan	0.0002	0.0197	-0.0260	-4.3998	0.0000**	0.1593**	0.7818**	0.0278	0.8167	7.8031*
	(0.43)	(0.87)	(-1.05)	(-1.72)	(3.80)	(6.10)	(25.38)	(1.75)	(0.44)	(0.02)
Korea	0.0004	0.0136	-0.0050	-3.5155**	0.0000**	0.1695**	0.7660**	0.0125*	4.3256**	14.9866**
	(1.13)	(0.59)	(-0.30)	(-3.19)	(3.86)	(5.97)	(23.32)	(2.03)	(0.01)	(0.00)
Malaysia	-0.0005*	0.0146	0.0355*	0.1224	0.0000**	0.1711**	0.7775**	0.0009	0.0833	0.7927
	(-1.91)	(0.66)	(2.44)	(0.77)	(4.42)	(6.14)	(25.32)	(0.83)	(0.92)	(0.67)
Pakisthan	0.0003	0.0019	0.0192	-2.9237**	0.0000**	0.1717**	0.7768**	0.0048	3.6176*	9.2435**
	(0.92)	(0.09)	(1.17)	(-2.91)	(4.24)	(6.09)	(25.58)	(0.96)	(0.03)	(0.01)
Philippines	-0.0009*	0.0169	0.0191	2.3066	0.0000**	0.1646**	0.7843**	0.0053	-0.5988	1.4186
	(-2.07)	(0.76)	(0.95)	(1.03)	(3.96)	(5.90)	(24.66)	(0.47)	(1.00)	(0.49)
Singapore	-0.0002	0.0130	0.0019	-1.6815	0.0000**	0.1583**	0.7869**	0.0112	0.9827	5.2700
	(-0.88)	(0.57)	(0.09)	(-1.64)	(4.20)	(6.04)	(25.93)	(1.84)	(0.37)	(0.07)
Sri Lanka	-0.0004	0.0134	0.0189	-0.5319	0.0000**	0.1696**	0.7795**	-0.0009	0.0166	0.8471
	(-1.28)	(0.56)	(1.02)	(-1.07)	(4.33)	(5.34)	(23.43)	(-0.37)	(0.98)	(0.65)
Taiwan	0.0001	0.0117	-0.0403*	-3.1459	0.0000**	0.1654**	0.7803**	0.0171	1.0370	5.4541
	(0.15)	(0.52)	(-2.06)	(-1.55)	(3.80)	(6.08)	(25.24)	(1.64)	(0.35)	(0.07)
Thailand	-0.0009	0.0166	0.0172	-0.7026	0.0000**	0.1914**	0.7329**	0.0125	0.4768	1.9012
	(-1.83)	(0.58)	(0.88)	(-0.53)	(3.38)	(5.20)	(17.03)	(1.65)	(0.62)	(0.39)

Note: ** Significant at 1%; * Significant at 5%. Figures in parenthesis are z statistics (probability of significance in last two columns).
Null Hypothesis for F test and Likelihood Ratio test, only for the spillover volatility component, is: $\gamma_3 = \delta_1 = 0$

Table 7: **Intraday Information Spillover from India to Other Asian Countries – Dynamic**

$R_{i,t}^{OC} = \gamma_0 + \gamma_1 R_{i,t-1}^{OC} + \gamma_2 R_{j,t-1}^{OC} + \gamma_3 h_{j,t-1}^{OC} + \varepsilon_t \qquad h_{i,t} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \delta_1 h_{j,t-1}^{OC}$; i = Other Country, j = India (Sensex)

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	δ_1	F Statistic	LR Statistic
China	0.0004	-0.0654**	0.0188	-1.3159	0.0000**	0.1127**	0.8700**	-0.0027	0.8136	1.7024
	(0.94)	(-2.78)	(1.08)	(-1.13)	(2.91)	(6.22)	(42.94)	(-0.68)	(0.44)	(0.43)
Hong Kong	0.0001	-0.0458	-0.0027	-0.0520	0.0000	0.0543**	0.9421**	0.0008	0.0485	0.2766
	(0.20)	(-2.11)	(-0.14)	(-0.04)	(1.58)	(5.46)	(100.70)	(0.45)	(0.95)	(0.87)
Indonesia	0.0014**	0.1175**	0.0401*	-1.7561	0.0000**	0.1203**	0.8646**	0.0012	-0.6200	1.5926
	(3.29)	(5.01)	(2.04)	(-0.98)	(3.06)	(5.93)	(37.73)	(0.15)	(1.00)	(0.45)
Japan	-0.0002	-0.0507*	0.0404*	-0.3336	0.0000	0.0845**	0.8986**	0.0088	-0.0725	11.2176**
	(-0.55)	(-2.35)	(2.37)	(-0.26)	(1.34)	(6.09)	(53.94)	(1.48)	(1.00)	(0.00)
Korea	0.0004	-0.0220	0.0668**	-1.8614	0.0000*	0.0757**	0.9200**	0.0005	-0.0115	1.5555
	(1.11)	(-1.08)	(3.28)	(-1.10)	(2.02)	(6.65)	(79.18)	(0.13)	(1.00)	(0.46)
Malaysia	0.0004*	0.1405**	0.0273*	-0.9072	0.0000**	0.1606**	0.8388**	0.0040	0.3359	7.1367*
	(1.96)	(6.09)	(2.32)	(-0.92)	(2.84)	(7.70)	(48.71)	(1.37)	(0.71)	(0.03)
Pakistan	0.0010*	0.0160	0.0254	-2.4250	0.0000**	0.2047**	0.7383**	0.0124	2.3412	6.2909*
	(2.29)	(0.63)	(1.24)	(-1.80)	(3.40)	(7.42)	(22.96)	(1.06)	(0.10)	(0.04)
Philippines	0.0005	0.1166**	0.0786**	-2.9780**	0.0000**	0.1247**	0.8029**	0.0167	1.8000	14.1504
	(1.48)	(5.39)	(4.37)	(-2.59)	(3.01)	(5.79)	(27.76)	(1.55)	(0.17)	(0.00)
Singapore	0.0000	0.0139	0.0213	-1.0163	0.0000**	0.1055**	0.8942**	0.0005	0.2079	1.1621
	(-0.12)	(0.64)	(1.60)	(-0.96)	(2.82)	(7.41)	(68.39)	(0.23)	(0.81)	(0.56)
Sri Lanka	0.0009**	0.2537**	0.0082	-1.7852**	0.0000**	0.3661**	0.6204**	-0.0069*	1.2360	13.5262**
	(3.88)	(6.93)	(0.82)	(-2.79)	(3.86)	(4.73)	(10.46)	(-2.11)	(0.29)	(0.00)
Taiwan	-0.0012**	-0.0673**	0.0549**	-1.8001	0.0000	0.0691**	0.9197**	0.0060	-1.7906	7.0249*
	(-3.59)	(-3.01)	(3.20)	(-1.27)	(1.38)	(5.02)	(62.90)	(1.32)	(1.00)	(0.03)
Thailand	-0.0011	0.0134	0.0172	-0.2113	0.0000	0.0645**	0.9228**	0.0061	0.0760	0.8890
	(-1.93)	(0.49)	(0.62)	(-0.09)	(1.76)	(4.47)	(57.91)	(0.78)	(0.93)	(0.64)

Note: ** Significant at 1%; * Significant at 5%. Figures in parenthesis are z statistics (probability of significance in last two columns).
Null Hypothesis for F test and Likelihood Ratio test, only for the spillover volatility component, is: $\gamma_3 = \delta_1 = 0$

Table 8: **Overnight Information Spillover from Other Asian Countries to India**

$R_{i,t}^{CO} = \gamma_0 + \gamma_1 R_{i,t-1}^{CO} + \gamma_2 R_{j,t-1}^{OC} + \gamma_3 h_{j,t-1}^{OC} + \varepsilon_t$; $h_{i,t} = \alpha_0 + \alpha_1 \varepsilon^2_{i,t-1} + \beta_1 h_{i,t-1} + \delta_1 h_{j,t-1}^{OC}$; i = India (Sensex), j = Other Country

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	δ_1	F Statistic	LR Statistic
China	0.0014**	0.0567	0.0041	0.7517	0.0000	0.1751**	0.8456**	0.0053	1.1577	29.4780**
	(5.22)	(1.44)	(0.35)	(0.75)	(0.93)	(3.67)	(20.48)	(0.91)	(0.31)	(0.00)
Hong Kong	0.0018**	0.0423	0.0751**	-1.5586	0.0000**	0.1328**	0.8291**	0.0246**	0.2653	78.8509**
	(11.15)	(1.76)	(7.39)	(-1.25)	(2.52)	(15.65)	(83.99)	(10.70)	(0.77)	(0.00)
Indonesia	0.0015**	0.0099	0.0127	-0.0495	0.0000*	0.0741**	0.9207**	0.0015	-0.0523	7.8080*
	(8.23)	(0.36)	(1.17)	(-0.09)	(2.08)	(3.80)	(51.22)	(1.18)	(1.00)	(0.02)
Japan	0.0017**	-0.0089	0.0120	-1.9020	0.0000	0.0697**	0.9236**	0.0059	1.4050	18.8521**
	(6.80)	(-0.33)	(0.95)	(-1.19)	(1.25)	(4.06)	(58.21)	(1.43)	(0.25)	(0.00)
Korea	0.0015**	0.0022	0.0516**	-0.7114	0.0000	0.0845**	0.9034**	0.0074**	-2.2517	76.0830**
	(5.85)	(0.06)	(3.72)	(-0.58)	(0.90)	(2.93)	(41.09)	(2.57)	(1.00)	(0.00)
Malaysia	0.0015**	0.0110	0.0047	-0.1889	0.0000**	0.0916**	0.8965**	0.0020	0.5181	15.1612**
	(11.39)	(0.43)	(0.36)	(-1.00)	(3.13)	(4.12)	(40.24)	(1.92)	(0.60)	(0.00)
Pakistan	0.0014**	0.0376	0.0037	-0.0977	0.0000**	0.1041**	0.8957**	0.0016**	-0.3755	5.6791
	(9.13)	(1.59)	(0.46)	(-0.22)	(11.13)	(23.23)	(328.95)	(4.94)	(1.00)	(0.06)
Philippines	0.0021**	0.0267	0.0128	-3.9169	0.0000	0.0843**	0.9079**	0.0063	-1.4842	26.9018**
	(6.76)	(1.06)	(1.05)	(-1.89)	(0.52)	(4.47)	(47.90)	(1.89)	(1.00)	(0.00)
Singapore	0.0014**	0.0073	0.0487**	-0.7812	0.0000	0.0334**	0.9689**	0.0009	-0.9860	9.2640**
	(9.86)	(0.30)	(3.34)	(-1.25)	(0.53)	(5.31)	(115.02)	(0.67)	(1.00)	(0.01)
Sri Lanka	0.0016**	0.0048	-0.0012	0.1738	0.0000**	0.0276**	0.9676**	0.0000	-0.0370	0.3887
	(10.95)	(0.22)	(-0.08)	(0.35)	(15.84)	(33.16)	(2083.32)	(0.49)	(1.00)	(0.82)
Taiwan	0.0019**	0.0372	0.0421**	-2.9999**	0.0000	0.1407**	0.8649**	0.0109*	3.3320*	64.0624**
	(10.38)	(0.87)	(3.53)	(-2.57)	(0.70)	(3.78)	(32.68)	(1.98)	(0.04)	(0.00)
Thailand	0.0015**	0.0430	0.0513**	0.3239	0.0000**	0.0132	0.9794**	0.0036*	0.9397	85.5732**
	(5.48)	(1.50)	(3.98)	(0.38)	(-3.78)	(1.61)	(121.23)	(5.71)	(0.39)	(0.00)

Note: ** Significant at 1%; * Significant at 5%. Figures in parenthesis are z statistics (probability of significance in last two columns).
Null Hypothesis for F test and Likelihood Ratio test, only for the spillover volatility component, is: $\gamma_3 = \delta_1 = 0$

Table 9: Overnight Information Spillover from India to Other Asian Countries

$R_{i,t}^{CO} = \gamma_0 + \gamma_1 R_{i,t-1}^{CO} + \gamma_2 R_{j,t-1}^{OC} + \gamma_3 h_{j,t-1}^{OC} + \varepsilon_t$; $h_{i,t} = \alpha_0 + \alpha_1 \varepsilon^2_{i,t-1} + \beta_1 h_{i,t-1} + \delta_1 h_{j,t-1}^{OC}$; i = Other Country, j = India (Sensex)

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	δ_1	F Statistic	LR Statistic
China	0.0005**	-0.0165	0.0053	-0.2203	0.0000**	0.2221**	0.6395**	-0.0071**	NA	NA
	(2.55)	(0.38)	(0.84)	(-1.72)	(271.45)	(2.69)	(14.66)	(-65.28)		
Hong Kong	0.0002	0.0520*	0.0521**	2.2312*	0.0000	0.0954**	0.8944**	0.0097**	3.6696*	28.0166**
	(0.93)	(2.43)	(4.46)	(2.02)	(0.69)	(16.39)	(178.71)	(6.41)	(0.03)	(0.00)
Indonesia	-0.0002	-0.0096	0.0355**	0.7643	0.0000	0.2118**	0.6754**	0.0278	NA	NA
	(-0.83)	(-0.24)	(3.45)	(0.92)	(1.34)	(3.45)	(8.89)	(1.89)		
Japan	0.0005**	0.0432*	0.0173*	0.6305	0.0000*	0.0692**	0.9225**	0.0011	0.4554	8.4345**
	(2.90)	(2.05)	(2.14)	(0.99)	(2.10)	(5.52)	(68.77)	(0.91)	(0.63)	(0.01)
Korea	0.0006*	-0.0060	0.0581**	0.9556	0.0000	0.0644**	0.9311**	0.0030	0.4761	2.7492
	(2.03)	(-0.26)	(3.63)	(0.70)	(1.66)	(5.59)	(94.93)	(0.74)	(0.62)	(0.25)
Malaysia	0.0001	0.0456	0.0169	0.3652	0.0000	0.0947*	0.9321**	-0.0009**	7.0965**	24.9023**
	(0.54)	(0.99)	(1.40)	(0.64)	(1.85)	(2.05)	(66.46)	(-3.81)	(0.00)	(0.00)
Pakistan	0.0015**	0.0601**	0.0086*	-0.4038	0.0000**	0.9800**	0.4263**	0.0079**	1.4601	7.2746*
	(16.42)	(2.50)	(2.06)	(-0.88)	(25.33)	(53.34)	(43.44)	(5.83)	(0.23)	(0.03)
Philippines	0.0004**	0.0329	0.0259**	0.1546	0.0000	0.0931*	0.8916**	0.0071	-0.6970	79.8709**
	(2.50)	(1.02)	(2.69)	(0.23)	(0.02)	(2.47)	(30.25)	(1.56)	(1.00)	(0.00)
Singapore	0.0010**	-0.0395	0.0310**	0.8421	0.0000	0.1763*	0.8201**	0.0076	-0.1608	22.1583**
	(2.57)	(-0.62)	(2.87)	(0.75)	(1.03)	(2.36)	(17.66)	(1.55)	(1.00)	(0.00)
Sri Lanka	0.0001	0.1810**	0.0278**	0.8055	0.0000**	0.0084**	0.9088**	-0.0033**	NA	NA
	(0.47)	(5.95)	(2.56)	(1.90)	(62.99)	(12.24)	(436.46)	(-848.49)		
Taiwan	0.0018**	0.0711**	0.0481**	0.5274	0.0000	0.1020**	0.8910**	0.0090	-0.3108	14.7592**
	(6.04)	(2.75)	(2.98)	(0.43)	(0.66)	(6.05)	(57.98)	(1.45)	(1.00)	(0.00)
Thailand	0.0005	0.1704**	0.0728**	1.9698	0.0000	0.7047*	0.3591**	0.0715	7.1306**	47.3296**
	(1.53)	(3.17)	(2.76)	(1.74)	(1.03)	(2.11)	(3.13)	(1.71)	(0.00)	(0.00)

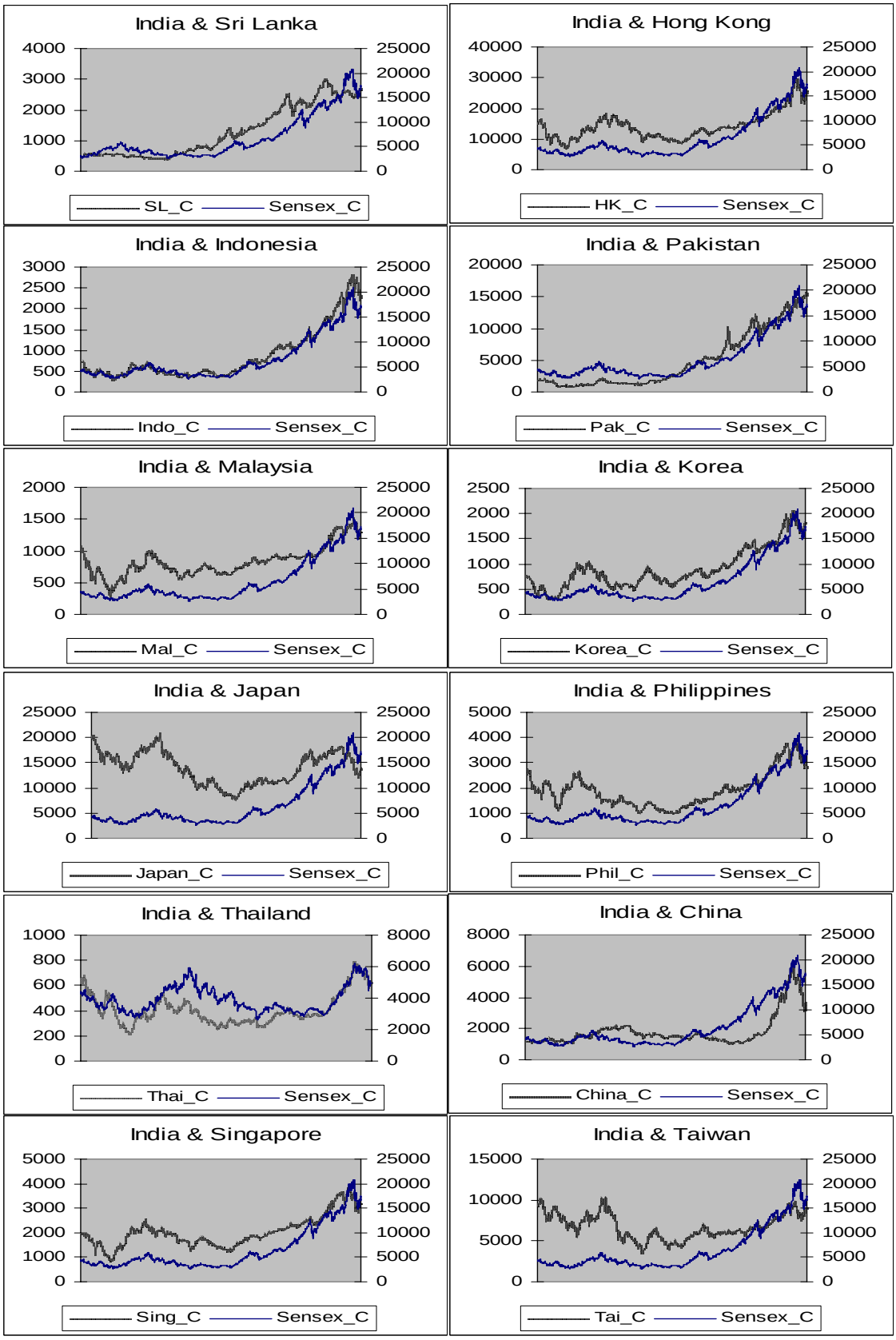
Note: ** Significant at 1%; * Significant at 5%. Figures in parenthesis are z statistics (probability of significance in last two columns).
Null Hypothesis for F test and Likelihood Ratio test, only for the spillover volatility component, is: $\gamma_3 = \delta_1 = 0$

Table 10: **Summary Results of Intraday and Overnight Information Spillover among India and its Asian Counterparts**

Other Asian Countries	Intraday Spillover								Overnight Spillover			
	Contemporaneous Spillover				Dynamic Spillover							
	Impact on India		Impact of India		Impact on India		Impact of India		Impact on India		Impact of India	
	Return	Volatility	Return	Volatility	Return	Volatility	Return	Volatility	Return	Volatility	Return	Volatility
China	Sig.	-	Sig.	-	-	-	-	-	-	-	-	Sig.
Hong Kong	Sig.	Sig.	Sig.	-	-	Sig.	-	-	Sig.	Sig.	Sig.	Sig.
Indonesia	Sig.	Sig.	Sig.	-	-	-	Sig.	-	-	-	Sig.	-
Japan	Sig.	-	Sig.	-	-	-	Sig.	-	-	-	Sig.	-
Korea	Sig.	Sig.	Sig.	-	-	Sig.	Sig.	-	Sig.	Sig.	Sig.	-
Malaysia	Sig.	-	Sig.	-	Sig.	-	Sig.	-	-	-	-	Sig.
Pakistan	Sig.	-	Sig.	Sig.	-	-	-	-	-	Sig.	Sig.	Sig.
Philippines	Sig.	-	Sig.	-	-	-	Sig.	-	-	-	Sig.	-
Singapore	Sig.	Sig.	Sig.	-	-	-	-	-	Sig.	-	Sig.	-
Sri Lanka	-	-	-	Sig.	-	-	-	Sig.	-	-	Sig.	Sig.
Taiwan	Sig.	-	Sig.	-	Sig.	-	Sig.	-	Sig.	Sig.	Sig.	-
Thailand	Sig.	Sig.	Sig.	-	-	-	-	-	Sig.	Sig.	Sig.	-

Note: 'Sig.' represents significant spillover effect, while blank cell denote statistical insignificance.

Figure 1: **Price Movements of Indian Equity Market with its Asian Counterparts**



Note: The above Line Graphs shows the linear movement of the prices of equity indices of India with its major Asian counterparts. Two different price scales are used where the right vertical scale represents the price of Indian SENSEX.