# Comparing Financial Contagion and Volatility Spill over and Structural Break Within Major Asian Economies Pre and Post Global Recession to that of Asian Crisis

**Raisul Islam**
**Jahangirnagar University**

*The significance and the originality of this paper lies in comparing, crisis effected Asian markets during the Asian Financial Crisis 2007, success of macroeconomic policy adjustments and implementation of tightening strategies to that of the impact of Financial crisis 2007 on the same markets. It is vital to introduce the roles of sample markets such as South Korea, China, Singapore, Malaysia, India, Japan, and Taiwan during the Asian crisis. Although the crisis initiated in Thailand, shocks propelled into South Korea, a first degree (where shocks generate) crisis prone market and spilled the crisis over to second degree markets (highly effected by shocks in first degree markets) of the Philippines, Malaysia, China and Singapore, those mark significant co-movement. This paper canvasses evidence for financial contagion and shock propagation that spread into specific Asian markets, generating from US equity markets. While many papers examined the contagion effect applying long term association methods, in a linear model; this paper concentrates on the conditional mean and variance framework in non-linear structure.*

## INTRODUCTION

Increased capital market integration has escalated the real linkage and subsequently pure financial linkage between emerging economies in the last decade. An appropriate degree of financial linkage as a tool of macroeconomic stabilization (Maneschiold, 2006) raises debate on crucial elements such as financial deepening through asset market integration (Gultekin et al., 1989; Taylor & Tonks, 1989; Mittoo, 1992). Financial deepening indicates the edging up of capital flows within financial institutions of any given host country. Investors and market makers are motivated by the negative co-movement of the asset market driven by *portfolio rebalancing* and ignore the significance of market integration in absence of the desired co-variance movement (Fleming, Kirby & Ostdiek, 1998). The action of strategic traders in fear of idiosyncratic shocks and in presence of information heterogeneity leads to contagion transmission and volatility spillover. The recurring market crisis in the last few decades resulting from irrational behavior of market makers brings about the discussion on the importance of regime shifting in spillover and in contagion studies. Such discussion is introduced by Kin and Wadhwany (1990) in the concept of *correlated information channel*.

The effect of risk preference of strategic traders and risk averse investors has been highly studied in empirical literature. A substantial function for time varying risk aversion in asset and equity markets is elaborated by Engstrom and Zing (2006); Graendier, Engstrom, Bekart (2006).The time varying volatility risk flowing from derivatives to equities are examined by Bollerslev, Gibson and Zhou (2004). It can be said that, the discussion of risks associated with market factors such as volatility, liquidity risk, credit

default risk and risks that are idiosyncratic in nature (country risk) fuels the transmission of shocks through non-contingent channels into countries of different peripheries with little or no financial linkages. Such transmission is better explained by contagion risk (Dungey et al., 2010). It is alarming to find that through correlated risk factors, overall risk is compounded during crisis periods. For instance, an international investor responds to the fear of credit risk by offloading liquid assets in presence of low default risk, resulting in a liquidity crisis in any given market (Greenspan, 1999). Such literature has spiked argument on the degree and direction of contagion risk correlation to other risk components during a crisis period.

A crisis under any given circumstances is simply the increased level of volatility and uncertainty in both macro and micro level. The market response to such sudden crisis indicates systematic risk; and in most cases institutional intervention results in intensification of such volatility. Dungey and Martin, in 2007 measured the effect of contagion by evaluating the transmission mechanism comparing crisis condition to non-crisis condition and suggested that regulatory actions and institutional interventions are often justified to the investors as preventive measure for both systematic and contagion risk. In the post 1997, East Asian crisis leading to the devaluation of Thai Baht, Malaysia's reversal to capital control, the announcement to defer Russian Bond payment has all been good examples of institutional intervention that resulted in increased systematic risk (Dungey et al., 2012).

There has been a plethora of studies conducted in finding the impact of contagion risk in the post Asian crisis period. Masson (1999) suggests contagion is short run phenomenon that disintegrates over time and simply defined as shock transmission from one market to another during a crisis period. Contagion in sociology, philosophy and medicine is defined as "Transmission by direct or indirect contact; the spread of a behavior pattern, attitude, or emotion from person to person or group to group through suggestion, propaganda, rumor or imitation; the tendency to spread, as of doctrine, influence or emotional"(Islam, 2013). On the other hand, contagion risk is argued to be induced if wider market integration causes reversal of the capital movement (Collins & Biekpe; 2003). The recent global market crisis which is to some extent is contributed by increased integration of financial assets and financial markets, fueled the dispute over contagion risk in the empirical literature. As proposed by Mason (1999), the propagation of shocks may become substantial through contingent and non-contingent channel crisis. The spillover of equity market crisis among countries having similar macroeconomic structure may properly be redefined as contingent channel crisis or "monsoonal effect crisis". Contingent channel propagation of shocks can be categorized as *shift contagion* and *pure contagion.* "Shift contagion illustrates the propagation of shock beyond normal level"(Masson, 1999); in presence of a crisis period. On the contrary "Pure contagion is the transmission of contagion purely due to unexplained fundamentals generally identified in post-crisis period" (Dungey & Tambakis, 2005; Percolli & Sbracia, 2003; Flavin & Panopoulou, 2010); and such propagation marks reversal in market confidence (Charumilind et al. 2006). However, in the discussion of financial linkage the significance of real linkage is undeniable; which has important implications in defining idiosyncratic shocks.

This can be better explained with an example. Let us assume the role of a strategic trader investing in international equity market in Korea. Now the trader receives private information, suggesting that South Korean government is expected to announce an important change in the monetary policy which may cause reversal in the current equity market and a bear market will follow. The private information has the probability of being asymmetric in nature and any reaction to such information may only be irrational. To avoid any such happenstance, the trader's portfolio rebalancing should have a stabilizing effect. So, in fear of a portfolio loss the trader would sell off a Korean stock and buy a Hong Kong stock which has a negative co-movement. The trader will also sell off Singapore stocks. It must be noted that the Singapore market have little or no direct integration to that of Korean market. Nevertheless, a pool of such actions in the occurrence of Korean market crash will also trigger a fall in the Singapore market causing a pure contagion of crisis.

Dungey, Milunovich and Thorp (2010) separated crisis period linkages into news impact on markets of different peripheries. The phenomenon of hypersensitivity to information from distant host country to domestic economy impairs the stability of the market environment in home economy. While, News

impact suggests the degree of impact of a troubled economy to a potentially non-crisis economy, Dungey (2010) delved into finding the effect of hypersensitivity to information phenomenon, and found news impact to be insignificant in crisis generation. Conversely, evidences are suggestive to the fact that, crisis countries have weak incentives in curbing the speed of spread. In contrast, countries in close proximity both economically and financially, must take proactive roles to circumvent the speed of crisis spreading from host market, otherwise spillover is eminent. Initiatives can be taken in the form of strengthening of domestic policy or increasing coordination between different markets (Dungey et al., 2010).

It should be appropriate to put some lights on the most substantial financial crisis since that of the great depression, the global crisis of 2007-2008. Originating from the US mortgage market, in its second phase, the crisis becomes a truly global phenomenon. The importance of extensively studied Asian Crisis 1997 has fallen by the wayside, calling for contagion studies to cover the pre and post global crisis period and the shift in the existing market integration with structural break. Of the many available discussions, the one portrayed by Cabellaro (2013) is appealing. Relentless flow of capital in the US mortgage market causes asset scarcity and results in the formation of stochastic bubble. In the aftermath of simultaneous burst in bubble, the crisis intensifies as through contingent and non-contingent channels, scarcity is triggered in commodities and alternative investment vehicles. However, the increased oil prices turn financial assets seeking petrodollar in US, eventually reducing destabilization and reverse the tightening of commodity prices. Consequently, the process of dissipating this vicious cycle initiates. Such becomes a global phenomenon, enveloping both emerging and emerged markets likewise in the post 2008 period. It is suggestive to put emphasis on recent studies of contagion risk to identify the recent global financial crisis, even to understand the Asian contagion, as majority of the studies of contagion is concentrated in Asian crisis 2007.

In the investigation of contagion and crisis spilling into markets of less significance, or explosiveness of shock in the equity market, it is crucial to focus on equity and debt markets association, in connection to the housing market. In the study of Dungey, Milunovich and Thorp (2012), interesting association among US bond market returns, stock return and returns of Real Estate Investment Trusts (REIT) is found with direction of spillover, which may have serious consequences in the US Mortgage Backed Securities (MBS) bubble, leading to a global crisis. In the pre-crisis period, the spillover of shock from stock market returns to Treasury bond index has a negative direction. In contrast, the bullish market trend of equity leads to buoyant REIT market returns, that explains the bubble formation in MBS, and had direct impact on consumers reliant on leveraging housing equity (Mian and Sufi, 2010). The second phase of crisis marked significant change in the direction of association. The sign of spillover from debt to equity market marked a positive co-movement and eventually the link was broken, resulting in the plunge of bond and REIT returns linkage. The post crisis period marks a reversal. So, in accordance to conventional views, if shocks in MBS returns and property market meltdown triggered the latest global financial crisis, than information hypersensitivity linkage played an important role for crisis to transmit from REIT to stock returns, exacerbating the effect of financial crisis 2007. Due to regime switch, strong linkage between REIT and equity returns remain (Dungey et al., 2012). The asset market linkage suggests the importance of equity shocks in explaining global crisis, ignoring alternative investment vehicles in theoretical literature.

In contrast to previous studies, Yuan (2005) explained financial contagion using Rational Expectation Equilibrium (REE), a commonly studied theory in financial literature. Yuan suggested crisis is eminent, if investors borrowing constraints is significant. In presence of information asymmetry, contagion is triggered in the form of small shocks causing negative movements of large assets. In contradiction to popular belief, contagion is proved to be a function of investors borrowing constraints, rather than common shocks. Such constraints propagate shocks through a specific group of borrowers across national borders. Contagion spillover is non-linear and asymmetric by condition and assets are relatively more skewed (Connolly and Wang, 2003). Bank of International Settlement (BIS) (1998) proposed an all-encompassing framework defining contagion;“ i. Strong fundamentals imply immunity to contagion; ii. Trade and financial linkages between countries are associated with contagion transmission; iii. Regional proximity is important for contagion transmission; iv. Developing markets experience greater contagion

than developed markets; v. Developed markets operate as a conduit for contagion effects between regions; vi. Contagion effects differ by financial markets, contagion occurs across both asset markets and country borders." While majority of literature suggests contagion falls in the line of the framework, some contradicts to the suggestion, in post global crisis period.

Many important empirical literatures investigated contagion in East Asian equity markets during the Asian crisis of 1997-1998. Some crucial literature studied contagion concentrating on Hong Kong equity market turmoil 1997 (Baig and Goldfajn, 1999; Forbes and Rigobon, 2002; Baur and Schulz, 2005; Baur and Fry, 2005; Bond, Dungey and Fry, 2005; Dungey, Fry, Hermosillo and Martin, 2005b). Bond, Dungey and Fry (2005), Baur and Schulz (2005) identified Hong Kong as the *ground zero market* for contagion shocks. Japanese and Singapore markets have been important conduits in the transmission of crisis from Hong Kong to other East Asian economies. Thailand has been the *ground zero* for shocks propagating into the equity markets of Asia (Baur and Schulze, 2005; Kleimeier, Lehnert and Verschoor, 2003). Nonetheless, Forbes (2002), and Kleimeier et al., (2003) found little significance of contagion propagating from Thailand. Applying conditional correlation analysis, contagion is significantly found in major Asian economies during the Asian crisis (Caporale Cipollini and Spagnolo), while transmission from Hong Kong to Philippines and Singapore (Corsetti, Pericoli and Sbracia, 2001) and from Hong Kong to important Asian economies during eight percent of days over Asian Crisis was notable(Baur and Fry, 2005).

In spite of the availability of many articles regarding contagion crisis in Asia, majority covers the Asian crisis 1997-1998 period, and there is little concentration regarding contagion in Asia during global crisis of 2007. In this regard, the study of Islam (2013) advocates the phenomenon of spillover effect from US market to developed and emerging markets. In the multivariate GARCH framework, the authors found the transmission significance of 15 markets across two regions, and US market acted as the conduit of crisis. The findings implied, while own volatility spillover is profound in Asian markets during the second phase of the global crisis, such condition is reminiscent only in UK, Germany and France in Europe. In Europe, the intensity of cross volatility spillover results in extreme homogeneity and drives away investors seeking *portfolio rebalancing*. On the other hand, Asian markets are found to be significantly heterogeneous, with shocks propagating through pure contagion. The markets are more determined by their own past shocks rather than conditional shocks from neighboring countries. However, Japan and Singapore were important conduits for the spread of idiosyncratic shocks across Asian borders (Islam, 2013). Despite of such findings, it is important to check for the spillover, and structural break for significant Asian markets, comparing the inclusion and the exclusion of ground zero US market as the conduit. It is also important to re-examine the popular theory outlined in the BIS (1998) framework, that developing markets are more prone to contagion compared to developed markets.

The contradiction of contagion studies are irrefutable, explaining crisis propagation mostly through real linkage and idiosyncratic shocks (Helpman and Razin, 1978; Cole and Obstfeld, 1991; Backus, Kehoe and Kydland, 1992; Baxter and Crucini, 1993; Case and Pavlova, 2004). While most of the findings intend to rationalize contagion with insignificant degree of correlations of fundamental elements, such studies fail to examine the spread of shocks throughout Latin America, Eastern Europe, East Asia. Kaminsky and Reinhart (2000) illustrated the failure of such studies to explain the lack of spillover, in presence of crisis, within countries of close proximity.

Preponderance of studies recognized some fundamental causes for contagion transmission. Primarily, variation in commodity prices caused by economic shifts may end up triggering large capital flights into emerging economies. The studies of Corsetti, Pesenti and Roubini 1998; Radelet and Sachs 1998a, 1998b, identified the gain of U.S. dollar against yen in 1995-96 to contribute in the in East Asian export slump, leading East Asian economies towards financial hurdles in years to come. A crisis induced economy may affect its trading partners with currency depreciation, and upshot is that trading partner encounters subdued asset prices and subsequently become a target of speculative attack. Corsetti (1999) specified, excessive competitive devaluation may consequently induce stark currency depreciation, and blamed non-cooperative nature in the game. Such would, in effect, inspire a large outflow of securities, curtail in lending and a nosedive in short-term loans offered to international markets. Amid Asian Financial Crisis,

the steadfast economies to speculative attack; Singapore, Taiwan and China, could not resist propagation of exchange rate depreciation, earning some credence to this theory.

Tightly integrated economies and highly liquid financial markets are more susceptible to crisis spillover largely due to cross-market hedging of macroeconomic risks, and due to prevailing comovement of partially integrate economies even during tranquil periods (Kaminsky and Reinhart, 1998b). An overall adverse impact can be experienced as commercial banks attempt to maximize profit by selling off high risk assets on the back of a crisis (Schinasi and Smith, 2000). Calvo and Mendoza specified that information asymmetries, and investors attitude to evade additional costs related to collection of country specific information, lends to **herd** behavior of even rational investors. Increased herding hinges on escalation of economic and financial growth, inducing higher degrees of portfolio diversification, but causing larger capital outflows eventually (Scharfstein and Stein, 1990; Wermers 1995). Contagion propagation might not be limited to issues related to financial markets integration only, as suggested by Diamond and Dybvig's (1983). Competitive devaluation, plummeting asset prices, capital outflow and sovereign debt defaults consequently shifts market expectations and economy as a whole immerses into bad equilibrium. Fear gripped investors would collectively withdraw funds from foreign exchange reserve, leading the economy towards debt crisis, mimicking a bank run on.

The significance and the originality of this paper lies in comparing, crisis effected Asian markets during Asian Financial Crisis 2007, success of macroeconomic policy adjustments and implementation of tightening strategies to that of the impact of Financial crisis 2007 on the same markets. It is vital to introduce the roles of sample markets such as South Korea, China, Singapore, Malaysia, India, Japan, and Taiwan during the Asian crisis. Though crisis initiated in Thailand, shocks propelled into South Korea, a first degree (where shocks generate) crisis prone market and spilled crisis over to second degree markets (highly effected by shocks in first degree markets) of Philippines, Malaysia, China and Singapore, those mark significant comovement. According to BIS (1998), Japanese market (data derived from Tokyo stock exchange) played pivotal role as conduit for crisis transmission. Inclusion of India is crucial for academic purpose. In response to exacerbation of capital outflows, by doubling currency devaluation, South Korea subsequently tripled its per capital GDP. In oppose to Malaysia's profound restrictions on capital account convertibility, China and Singapore uplifted capital flow restrictions and quickly healed due to their improved total factor productivity (Daly, 2003). Considering successful Asian market response to Asian crisis, it is imperative to identify the reincarnation of Asian crisis in the back of 2007 financial crisis, kindled by the shock of US mortgage backed securities. This study examines own volatility spillover, cross volatility spillover, interdependence of markets and conduit effects, which rejuvenates in Asian markets 10 years after the learnings and implementations from the Asian crisis. It is also vital to see if an accord can be drafted to respond to crisis.

This paper canvasses evidence for financial contagion and shock propagation that spread into specific Asian markets, generating from US equity market. While many papers examined the contagion effect applying long term association methods, in a linear model; this paper concentrates on the conditional mean and variance framework in non-linear structure. The conditionality of concerned series demands non-linearity and asymmetric distribution as majority crisis contagion markets are skewed in nature and time varying. The time varying conditional mean and conditional variance models also envelope "volatility clustering" and "leverage effect" with more success. Important Asian markets are selected to explain contagion transmission within themselves and in presence and absence of US equity market shock, as global proxy. The selected Asian countries are India, Japan, Malaysia, South Korea, Singapore, Taiwan and China. The purpose of including these markets are properly portrayed in the literatures reviewed in this paper. In Asian crisis, Japan and Singapore were important conduits, while contagion was significant from Korea and Hong Kong to other economies. It is imperative to re-examine the time varying conditional transmission. The markets are tested for mean spillover of and cross spillover in a multivariate GARCH diagonal VECH framework, up to five lags. Partial asymmetric EGARCH addresses non-negativity constraints of clustered volatility of the previous model, but captures post crisis linkage structure with 'structural break' model. Contagion, spillover and regime switch addresses pre and post crisis period, combining the non-linear conditional models.

In the first section, concept of contagion is embedded in introduction and previous researches are highlighted. In the second section, empirical framework is illustrated, and in the succeeding section, results of analysis are elaborated. Finally, respond to the objective of the study and some remarks on policy reforms are outlined.

## EMPIRICAL FRAMEWORK

To examine excess return instability and crisis spillovers, the weekly stock prices of eight major stock markets (India, Japan, China, South Korea, Taiwan, Malaysia, Singapore and Srilanka) from the Asian region are considered. The countries under study have well-structured stock indices and elevated amount of international effect in contrast to other countries of this region. It has been highly examined in the primary section of this study is that these particular countries had exhibited significant roles in the contagion transmission during the pre and post Asian Crisis of 1997, notably resulting in regime shifting. As a blend of emerging and developed economies, the conduit effect proposed by BIS (1998) will be examined in the pre and post global crisis, in addition to the impact of global proxy. These indices are also somewhat closely linked, so the indication of hypersensitivity to information effect might be found.

Using of weekly data tender some recompense over the use of daily stock indices data. Firstly, it removes the interferences associated with the utilization of analogous data as the particular trading day in any given market may ignore a community holiday in a different country. Secondly, it also outwits the difference in trading time. We assemble the data over the episode 01/01/1999 to 04/02/2013 for a total number of 728 observations. The periods under analysis, attempts to circumvent the profound impact of the Asian crisis, but begin from the post crisis period market transformation of the Asian contagion. The purpose is to canvass the interaction among the markets post regime shift caused by the extensively debated Asian Crisis, which would mark the pre-regime shift period interaction. The structural break analysis should successfully portray the shifting integration in the post global financial crisis of 2007.

For investigating the transmission of global financial shock, US market shock is considered as exogenous shock and also the ground zero to crisis. Weekly proceeds of the stock indices are transformed into logarithmic expressions where the string of experiential returns rehabilitated into squared proceeds. In fact, it gives the intrinsic volatility approximation for each point in time (t). The impact of non-linearity is adjusted with the log transformation of the ratio of the highest experiential price to the lowest observed price for each weekly proceeds at time (t). $\sigma_t^2 = \log\left(\frac{High_t}{Low_t}\right)$

Linear structure models fail to indicate some crucial nature of equity market returns. The expected indication of 'leverage effect' and 'volatility clustering' is not properly assessed with linear models, which is a profound error in many of the previous studies focusing on long term market association. In order to explain, time varying contagion transmission, dynamic conditional mean and variance must be assessed with proper tests for non-linearity and heterogeneity for the series under consideration. It must be noted, while contagion is captured with GARCH models, due to the possible linearity in mean (own spillover) and non-linearity (cross spillover) in variance, structural break is studied with threshold GARCH, which satisfies the need of the study, signifying non-linearity in both mean and variance.

For this particular study, we analyze the joint procedure of existing stock market indices for Asian region using the Multivariate GARCH-Diagonal VECH model. The restricted variance-covariance equations for the boundless VECH model contain 21 parameters. The VECH model's restricted variance-covariance matrix is rebounded to the form developed by, Bollerslev, Engle and Wooldridge (1988), where, A and B are assumed to be diagonal. The model is characterized by,

$$h_{ij,t} = \omega_{ij} + \alpha_{ij} u_{i,t-1} u_{j,t-1} + \beta_{ij} h_{ij,t-1} \quad \text{for } i, j = 1, 2 \tag{1}$$

At equation (1), $\omega_{ij}$, $\alpha_{ij}$ and $\beta_{ij}$, are the restrictions. The diagonal VECH multivariate GARCH model could also be shown as an unbound order multivariate ARCH model, where the covariance corresponds to

as a geometrically decaying weighted average of existing cross products of unforeseen returns, with recent observations carrying greater weights.

Due to the sample of seven stock indices, the restricted variance-covariance matrix ($H_t$) has seven dimensions with the diagonal and non-diagonal matrix erected for the variance and the covariance conditions, correspondingly. $H_t$ can be articulated as the matrix form,

$$H_t = \begin{pmatrix} h_{11t} & h_{12t} & \cdots & \cdots & h_{18t} \\ h_{21t} & . & \cdots & \cdots & h_{28t} \\ \vdots & . & . & . & \vdots \\ \vdots & . & . & . & \vdots \\ h_{81t} & h_{82t} & \cdots & \cdots & h_{88t} \end{pmatrix} \quad (2)$$

In this Matrix model for the stock proceeds of country *I* , $h_{ijt}$ is a restricted variance at the point of time *t* and refers to the restricted covariance connecting the stock indices of country *i* and country *j* ($i \neq j$ ) at time *t*.

To explain the variance and covariance matrix, this paper applies the diagonal VECH model (Bollerslev et al., 1988), and this model is sufficient when more than two variables are considered (Scherrer and Ribarits, 2007). The diagonal VECH expression is based on the theory that the restricted variance is determined by squared lagged residuals and the restricted covariance is contingent on the cross-lagged residuals and lagged covariance of other series (Harris and Sollis, 2003). The specification of diagonal VECH model is as follows,

$$VECH\ (H_t) = C + AVECH\ (\varepsilon_{t-1}\varepsilon'_{t-1}) + BVECH\ (H_{t-1}).\ \ e_t|\psi_{t-1} \sim N\ (0, H_t) \quad (3)$$

Here, *A* and *B* are 1/2 *N* (*N* +1) × 1/2 *N* (*N* +1) parameter matrices and *C* is a 1/2 *N* (*N* +1) ×1 vector of constants.

The impact from preceding squared innovations on the present volatile nature is explained by the diagonal elements of matrix *A* ($a_{11}$, $a_{22}$, ⋯ $a_{77}$), which depicts own volatility shocks. On the other hand, non-diagonal fundamentals signifies the cross product consequences of the lagged transformation representing the cross-volatility shocks. In the same manner, the diagonal components of matrix *B* ($b_{11}$, $b_{22}$, ⋯ $b_{77}$) present the influences from past squared volatilities on the present volatility which can be expressed as own volatility spillovers and non-diagonal essentials inspects the cross product property of the lagged cross-volatilities on the cross-volatility spillovers.

The diagonal VECH model is not without its limits. This model is without success in capturing 'leverage effect', which suggests, a negative shock following a positive shock is stronger in shape and duration, in contrast to the other direction (Brooks, 2002). Due to explained non-negativity constraint property of Generalized ARCH model, which limits the models capacity to capture the direction of shock, and the impact of the global proxy, EGARCH (1,1) is applied in two phases to explore *structural break* as an indicator of regime switch (Islam et al., 2013).

This study uses the partial asymmetric GARCH model, popularly the EGARCH formulated by Nelson (1991) to identify the volatility and leverage effect within the elected stock indices. The model dimensions is provided below,

$$\mathrm{Ln}\sigma^2_{j,t} = \omega_j + \beta_j \ln(\sigma^2_{j,t-1}) + \gamma \frac{\varepsilon_{t-1}}{\sqrt{\sigma^2_{t-1}}} + \alpha \left[ \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma^2_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] \quad (4)$$

Here, $\sigma^2_{j,t}$ is one step onward approximation of variance also known as provisional variance, and $\omega,\beta,\gamma,\alpha$ are the parameters to be estimated. An important advantage of EGARCH (1,1) model is, $\sigma^2_t$ will always be positive even if the parameters are depressing. In equation (4) parameter $\alpha$ illustrates the symmetric effect of the model, $\beta$ represents volatility persistence and $\gamma$ denotes the leverage effects (Alexander, 2009).

## EMPIRICAL RESULTS

Table 1, represents the descriptive statistics for all the stock indices, encompassing the global market proxy U.S. For all the stock indices mean returns render to be positive, ranging from a least amount 0.0125 (Malaysia) to an utmost 0.0219 (South Korea). As illustrated by the standard deviations, while Chinese stock indices is found to be least volatile with a standard deviation of 0.0086, South Korean stock indices is observed to be the most volatile series with a standard deviation of 0.0137. All indices are tilted to right, as can be seen from the projected skewness. This finding is supporting the conditions of short term dynamic model. As anticipated for highly regularized capital market indices series, such larger than three for Japan and U.S., mimicking a classic leptokurtic distribution, whereby the series are spikier around the mean with thick tails compared to the normal distribution. In addition, conclusion of the J-B test illustrate that the null hypothesis of normal distribution is rejected for all stock indices.

**TABLE 1**
**DESCRIPTIVE STATISTICS OF THE STOCK INDICES**

| | Mean | Median | Std. Dev. | Skewness | Kurtosis | Jarque-Bera |
|---|---|---|---|---|---|---|
| China | 0.0131 | 0.0107 | 0.0086 | 1.5882 | 6.3267 | 641.7516*** |
| India | 0.0211 | 0.0182 | 0.0127 | 2.2283 | 10.8789 | 2485.4500*** |
| Japan | 0.0178 | 0.0159 | 0.0105 | 4.0168 | 32.6605 | 28643.2500*** |
| Malaysia | 0.0125 | 0.0100 | 0.0094 | 2.9817 | 17.4706 | 7430.4710*** |
| South Korea | 0.0219 | 0.0185 | 0.0137 | 2.2583 | 11.9355 | 3040.6950*** |
| Singapore | 0.0157 | 0.0134 | 0.0104 | 2.8830 | 17.2101 | 7133.5670*** |
| Srilanka | 0.0150 | 0.0116 | 0.0123 | 2.7253 | 14.4202 | 4857.3220*** |
| Taiwan | 0.0194 | 0.0169 | 0.0110 | 1.7337 | 7.6651 | 1024.8410*** |
| USA | 0.0138 | 0.0108 | 0.0108 | 3.6350 | 25.3936 | 16814.5700*** |

Table 2 shows the cross-correlation between Asian stock indices with U.S. stock indices. The correlation coefficients of Asian region and U.S. market emerge as moderately correlated which is around 60%. In this region, the superior correlation is with Singapore (0.583) and the lowest is with Srilanka (0.061). Srilanka also has negative correlation with most of investigative indices.

**TABLE 2**
**CORRELATION COEFFICIENTS OF THE STOCK INDICES**

| | China | India | Japan | Malaysia | South Korea | Singapore | Srilanka | Taiwan | USA |
|---|---|---|---|---|---|---|---|---|---|
| China | 1.000 | 0.198 | 0.132 | 0.109 | 0.186 | 0.224 | -0.060 | 0.074 | 0.226 |
| India | 0.198 | 1.000 | 0.369 | 0.375 | 0.513 | 0.543 | -0.001 | 0.276 | 0.472 |
| Japan | 0.132 | 0.369 | 1.000 | 0.248 | 0.404 | 0.540 | 0.104 | 0.371 | 0.445 |
| Malaysia | 0.109 | 0.375 | 0.248 | 1.000 | 0.382 | 0.424 | -0.074 | 0.267 | 0.214 |
| South Korea | 0.186 | 0.513 | 0.404 | 0.382 | 1.000 | 0.540 | 0.002 | 0.357 | 0.419 |
| Singapore | 0.224 | 0.543 | 0.540 | 0.424 | 0.540 | 1.000 | 0.065 | 0.342 | 0.583 |
| Srilanka | -0.060 | -0.001 | 0.104 | -0.074 | 0.002 | 0.065 | 1.000 | -0.053 | 0.061 |
| Taiwan | 0.074 | 0.276 | 0.371 | 0.267 | 0.357 | 0.342 | -0.053 | 1.000 | 0.217 |
| USA | 0.226 | 0.472 | 0.445 | 0.214 | 0.419 | 0.583 | 0.061 | 0.217 | 1.000 |

*** 1%, ** 5%,* 10% level of significance.

Table 3 stipulated the essential non-linearity condition for 8 Asian countries. Autoregressive Conditionally Heteroskedasticity (1,1) tests were conducted, in order to estimate the suitability of the model and the results were fitting that satisfies the essential non-linearity of the indices. The result of the ARCH test (up to 5 lags) is indicative of the non-linearity of observations.

**TABLE 3**
**ARCH (1,1) RESULTS FOR THE STOCK INDICES**

| | **China** | **India** | **Japan** | **Malaysia** | **South Korea** | **Singapore** | **Srilanka** | **Taiwan** |
|---|---|---|---|---|---|---|---|---|
| **F-statistic** | 2.8283** | 14.8286*** | 7.05265*** | 10.4671*** | 14.9412*** | 11.7194*** | 0.43694 | 2.7684** |
| **Obs*$R^2$ ($\chi^2$)** | 13.9841** | 67.7488*** | 33.8896*** | 49.1795*** | 68.2147*** | 54.6181*** | 2.19633 | 13.6934** |
| $u_{t-1}$ | 0.1055*** | 0.26964*** | 0.06124* | 0.06071* | 0.1665*** | 0.1684*** | 0.05203 | 0.01312*** |
| $u_{t-2}$ | 0.03213 | 0.01340 | 0.06228* | -0.00227 | 0.1856*** | 0.1350*** | -0.00967 | -0.0187 |
| $u_{t-3}$ | 0.03913 | 0.09190** | 0.18963*** | -0.02133 | 0.08859** | 0.07611** | 0.00828 | 0.0180 |
| $u_{t-4}$ | 0.02540 | 0.02062 | -0.00671 | 0.25594*** | -0.00332 | -0.02327 | 0.00971 | 0.0288 |
| $u_{t-5}$ | 0.04392 | 0.00691 | -0.01381 | -0.03433 | -0.03810 | 0.05386 | -0.01214 | 0.0190 |

*** 1%, ** 5%,* 10% level of significance.

Table 4 presents the outcome of the WALD test. It is important to estimate the non-linear restrictions of the dynamic model. WALD test is an important hypothesis testing procedure based on maximum likelihood principal. Joint WALD tests were carried out to scrutinize the null hypotheses. Null hypothesis

is suggestively ignoring any volatility spillover among the Asian markets. The study gains more strength as the hypothesis of no volatility spillovers among the investigative stock indices; in every case the null hypotheses has been rejected at 1% level of significance. The significance also outlines important of non-linear restrictions applied on the specific indices.

**TABLE 4**
**WALD TEST RESULTS FOR THE STOCK INDICES**

| $H_0$: No volatility spillovers within the stock indices | | | | | | | |
|---|---|---|---|---|---|---|---|
| | China | India | Japan | Malaysia | South Korea | Singapore | Taiwan |
| **Restrictions** | | | | | | | |
| $-1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 + \alpha_6 + \alpha_7$ | -0.9084*** | | | | | | |
| $-1 + \alpha_1 + \alpha_3 + \alpha_4 + \alpha_5 + \alpha_6 + \alpha_7$ | | -0.9149*** | | | | | |
| $-1 + \alpha_1 + \alpha_2 + \alpha_4 + \alpha_5 + \alpha_6 + \alpha_7$ | | | -0.9134*** | | | | |
| $-1 + \alpha_1 + \alpha_2 + \alpha_3 + \alpha_5 + \alpha_6 + \alpha_7$ | | | | -0.9074*** | | | |
| $-1 + \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_6 + \alpha_7$ | | | | | -0.9139*** | | |
| $-1 + \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 + \alpha_7$ | | | | | | -0.9103*** | |
| $-1 + \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 + \alpha_6$ | | | | | | | -0.9142*** |

$\chi^2$ is significant for all the three countries at 1% level of significance

The values of own mean spillovers of Asian ($\mu_{ii}$ for all $i$= 1... 7) that are significant at 1%, confirms a sway of the most recent returns of each stock indices from their first lag proceeds ($r_{iit-1}$ ), as is produced in Table 5. The own-mean spillovers spread from a minimum of 0.00596 (Singapore) to a maximum of 0.00894 (Taiwan). Optimistic cross mean spillover prevails for the markets under examination. The shocks cross mean spillover in this region is significant in both directions, ruling out the possibility of a higher degree of non-idiosyncratic shocks.

**TABLE 5**
**PARAMETER ESTIMATION FOR THE MEAN EQUATION**
**FROM DIAGONAL VECH (1,1) EQUATION**

| Parameter | | $\mu_{0i}$ | $\mu_{i1}$ | $\mu_{i2}$ | $\mu_{i3}$ | $\mu_{i4}$ | $\mu_{i5}$ | $\mu_{i6}$ | $\mu_{i7}$ |
|---|---|---|---|---|---|---|---|---|---|
| **China** | **Coef.** | 0.01129*** | 0.00838 | 0.01054 | 0.01096 | 0.01183 | 0.01063 | 0.00994 | 0.01172 |
| | **S.E.** | 0.00049 | 0.0005 | 0.0006 | 0.0006 | 0.0005 | 0.0006 | 0.0006 | 0.0007 |
| **India** | **Coef.** | 0.01781*** | 0.01722 | 0.00804 | 0.01404 | 0.01654 | 0.01294 | 0.01249 | 0.01480 |
| | **S.E.** | 0.00057 | 0.0008 | 0.0007 | 0.0009 | 0.0007 | 0.0008 | 0.0007 | 0.0009 |
| **Japan** | **Coef.** | 0.01635*** | 0.01527 | 0.00975 | 0.00884 | 0.01446 | 0.00957 | 0.00852 | 0.01176 |
| | **S.E.** | 0.00051 | 0.0007 | 0.0007 | 0.0006 | 0.0006 | 0.0006 | 0.0005 | 0.0007 |
| **Malaysia** | **Coef.** | 0.01030*** | 0.01056 | 0.00732 | 0.00969 | 0.00758 | 0.00742 | 0.00781 | 0.00864 |
| | **S.E.** | 0.00055 | 0.0006 | 0.0006 | 0.0007 | 0.0053 | 0.0006 | 0.0005 | 0.0007 |
| **South Korea** | **Coef.** | 0.01684*** | 0.01966 | 0.01150 | 0.01369 | 0.01556 | 0.00822 | 0.01208 | 0.01307 |
| | **S.E.** | 0.00051 | 0.0009 | 0.0008 | 0.0009 | 0.0008 | 0.0007 | 0.0008 | 0.0009 |
| **Singapore** | **Coef.** | 0.01320*** | 0.01172 | 0.00687 | 0.00802 | 0.01112 | 0.00769 | 0.00596 | 0.00955 |
| | **S.E.** | 0.00046 | 0.0007 | 0.0006 | 0.0007 | 0.0006 | 0.0006 | 0.0005 | 0.0007 |
| **Taiwan** | **Coef.** | 0.01708*** | 0.01786 | 0.01454 | 0.01315 | 0.01573 | 0.01192 | 0.01253 | 0.00895 |
| | **S.E.** | 0.00057 | 0.0007 | 0.0008 | 0.0008 | 0.0006 | 0.0007 | 0.0006 | 0.0007 |

Notes: (1) i = 1 for China, i = 2 for India, i = 3 for Japan, i = 4 for Malaysia, i = 5 for South Korea, i = 6 for Singapore, i = 7 for Taiwan. (2) *** 1%, ** 5%,* 10% level of significance. (3) From μi1 – μi7 all coefficients are statistically significant at 1% level of significance.

Table 6 suggests, the own-volatility distress for all seven indices (a11, a22 . . . a77) are significantly varying from 0.3820 (Malaysia) to 0.2267 (China), representing substantial ARCH effects. This implies that the pattern of distress occurring in the Malaysian market will have the strongest influence on its own future market volatility, contrasting to the shocks generated from other indices. The magnitude of the projected cross-volatility coefficients, aij($i \neq j$) , advocates that innovation in all of the seven stock market indices is reigned by the volatility of other indices, but the own-volatility shocks, aij($i = j$ ), are in general larger than the cross-volatility shocks. This suggests that preceding shocks in particular markets have a superior influence on their own future impulsiveness than preceding distress shocks stirring from other stock market indices. The largest value for cross-volatility shocks was found in between India and Malaysia (0.3482) and smallest was 0.2038 between China and Taiwan. Consequently, sit is noticeable that the lagged country-specific influence (ARCH effect), adds to the stock market distress for any given indices in a recursive way.

The estimated coefficients for the variance-covariance matrix (equation 3) suggests significance of all the indices imply the existence of elevated volatility persistence, where bij ($i \neq j$) represents one -lag conditional variance for the indices under investigation. The highest value for the own volatility influence

elongs to China (0.6192) and the smallest belongs to Japan (0.1890). These outcomes stress that the indices have the greater influence on their future volatility from their own past distress.

**TABLE 6**
**PARAMETER ESTIMATION FOR THE VARIANCE EQUATION**
**FROM DIAGONAL VECH (1,1) EQUATION**

| Parameter | | $C_{i1}$ | $C_{i2}$ | $C_{i3}$ | $C_{i4}$ | $C_{i5}$ | $C_{i6}$ | $C_{i7}$ |
|---|---|---|---|---|---|---|---|---|
| **China** | **Coef.** | 0.0000145*** | 0.00000208 | -0.0000004 | 0.0000004 | 0.0000032** | 0.00000003 | 0.0000017 |
| | **S.E.** | 0.0000029 | 0.0000015 | 0.0000018 | 0.0000016 | 0.0000014 | 0.0000011 | 0.0000020 |
| **India** | **Coef.** | | 0.0000324*** | 0.0000048 | 0.00001*** | 0.00000136*** | 0.0000084*** | 0.0000069*** |
| | **S.E.** | | 0.0000041 | 0.0000027 | 0.0000022 | 0.0000022 | 0.0000177 | 0.0000023 |
| **Japan** | **Coef.** | | | 0.0000446*** | 0.0000074*** | 0.0000058* | 0.000011*** | 0.0000112*** |
| | **S.E.** | | | 0.0000067 | 0.0000026 | 0.0000033 | 0.0000026 | 0.0000032 |
| **Malaysia** | **Coef.** | | | | 0.0000298*** | 0.0000096*** | 0.0000085*** | 0.0000072** |
| | **S.E.** | | | | 0.0000022 | 0.0000021 | 0.0000016 | 0.000003 |
| **South Korea** | **Coef.** | | | | | 0.000023*** | 0.0000073*** | 0.0000087* |
| | **S.E.** | | | | | 0.0000035 | 0.0000017 | 0.0000036 |
| **Singapore** | **Coef.** | | | | | | 0.0000161*** | 0.0000049** |
| | **S.E.** | | | | | | 0.0000024 | 0.0000021 |
| **Taiwan** | **Coef.** | | | | | | | 0.0000389*** |
| | **S.E.** | | | | | | | 0.0000058 |
| **Parameter** | | $a_{i1}$ | $a_{i2}$ | $a_{i3}$ | $a_{i4}$ | $a_{i5}$ | $a_{i6}$ | $a_{i7}$ |
| **China** | **Coef.** | 0.2267*** | 0.2409*** | 0.2397*** | 0.2388*** | 0.2223*** | 0.2115*** | 0.2038*** |
| | **S.E.** | 0.0395 | 0.0515 | 0.0728 | 0.0608 | 0.0510 | 0.0421 | 0.0557 |
| **India** | **Coef.** | | 0.3519*** | 0.3422*** | 0.3482*** | 0.3327*** | 0.3081*** | 0.2789*** |
| | **S.E.** | | 0.0526 | 0.0620 | 0.0618 | 0.0454 | 0.0398 | 0.0588 |
| **Japan** | **Coef.** | | | 0.3329*** | 0.3344*** | 0.3250*** | 0.2973*** | 0.2703*** |
| | **S.E.** | | | 0.0876 | 0.0795 | 0.0702 | 0.0603 | 0.0549 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Malaysia** | **Coef.** | | | | 0.3820*** | 0.3302*** | 0.2990*** | 0.2747*** |
| | **S.E.** | | | | 0.0659 | 0.0553 | 0.0554 | 0.0546 |
| **South Korea** | **Coef.** | | | | | 0.3439*** | 0.2896*** | 0.2536*** |
| | **S.E.** | | | | | 0.0470 | 0.0394 | 0.0409 |
| **Singapore** | **Coef.** | | | | | | 0.2624*** | 0.2525*** |
| | **S.E.** | | | | | | 0.0468 | 0.0455 |
| **Taiwan** | **Coef.** | | | | | | | 0.2576*** |
| | **S.E.** | | | | | | | 0.0369 |
| **Parameter** | | $b_{i1}$ | $b_{i2}$ | $b_{i3}$ | $b_{i4}$ | $b_{i5}$ | $b_{i6}$ | $b_{i7}$ |
| **China** | **Coef.** | 0.6192*** | 0.5204*** | 0.3345** | 0.4921*** | 0.5256*** | 0.5803*** | 0.4999*** |
| | **S.E.** | 0.0589 | 0.0855 | 0.1595 | 0.1570 | 0.0840 | 0.0721 | 0.1480 |
| **India** | **Coef.** | | 0.4486*** | 0.2895*** | 0.4254*** | 0.4598*** | 0.5007*** | 0.4272*** |
| | **S.E.** | | 0.0437 | 0.0829 | 0.0613 | 0.0458 | 0.0405 | 0.0604 |
| **Japan** | **Coef.** | | | 0.1890* | 0.2797** | 0.3018*** | 0.3289*** | 0.2918*** |
| | **S.E.** | | | 0.1067 | 0.1348 | 0.1153 | 0.1076 | 0.0985 |
| **Malaysia** | **Coef.** | | | | 0.4122*** | 0.4450*** | 0.4683*** | 0.4098*** |
| | **S.E.** | | | | 0.0316 | 0.0623 | 0.0730 | 0.0986 |
| **South Korea** | **Coef.** | | | | | 0.5274*** | 0.5207*** | 0.4493*** |
| | **S.E.** | | | | | 0.0392 | 0.0480 | 0.0913 |
| **Singapore** | **Coef.** | | | | | | 0.5652*** | 0.4880*** |
| | **S.E.** | | | | | | 0.0487 | 0.0788 |
| **Taiwan** | **Coef.** | | | | | | | 0.4224*** |
| | **S.E.** | | | | | | | 0.0618 |

Notes: (1) i = 1 for China, i = 2 for India, i = 3 for Japan, i = 4 for Malaysia, i = 5 for South Korea, i = 6 for Singapore, i = 7 for Taiwan. (2) *** 1%, ** 5%,* 10% level of significance.

The echelon of inconsistency within the stock market indices is represented in table 7. This table also presents the unevenness of these stock market indices earlier than and after/within the financial calamity of 2007. The EGARCH (1,1) model was applied in estimating the parameters. The first part of the table presents the inconsistency of the overall investigation period and the remaining portion presents the earlier/without (i.e. 1st January, 1999 to 25th December, 2006) and after/within (i.e., 3rd January, 2007 to 4th February, 2013) financial crisis.

The parameter of EGARCH (1,1) 'α' symbolize the symmetric influence of the model. The value of 'α' before the financial crisis was significant for all the indices except for Malaysia, turning significant

during the crisis period. Also during the crisis period the value of the parameter gets larger except for India and Singapore indicating that these two indices were the most sensitive during the crisis period. The significance of 'α', indicates the influence of financial distress. The degree of sensitivity is explains that the markets in Asian region are not well integrated.

The leverage influence (γ) was positive for all, except for Malaysia, South Korea, Singapore and Taiwan during the financial crisis period. The positive leverage effect indicates that, the impact of positive information dissuades faster than that of the negative information. The negative leverage influence implies the fact that, a positive shock produces less instability than that of negative information or distress for the indices with negative leverage effect.

The last parameter "β" depicts the persistence conditional volatility irrespective of any episodes in the market indices. During the financial crisis the β of Singapore and Taiwan were more than 1, which implies that during the crisis period the market takes much time to recover from the shocks. In every other cases of significant β, the value is less than 1, indicating the market recovers from a catastrophic period swiftly.

**TABLE 7**
**PARAMETER ESTIMATION OF EGARCH (1,1) FOR REGIME SWITCHING**

| Parameters | China | India | Japan | Malaysia | South Korea | Singapore | Taiwan | Srilanka |
|---|---|---|---|---|---|---|---|---|
| **1999-2013(Full Sample Period)** | | | | | | | | |
| **ω** | -3.7997*** | -1.6587*** | -1.0553** | -0.4451 | -0.5610*** | -0.3133* | -0.5462** | -0.3220 |
| **α** | 0.0642 | 0.5162*** | 0.3485*** | 0.1272*** | 0.3488*** | 0.2980*** | 0.3842*** | 0.2171** |
| **γ** | 0.3406*** | 0.0754 | -0.1450** | 0.0911* | 0.0114 | -0.0487 | -0.0634 | 0.0042 |
| **β** | 0.6181*** | 0.8669*** | 0.9176*** | 0.9639*** | 0.9689*** | 0.9907*** | 0.9717*** | 0.9804*** |
| **1999-2006(Before Financial Crisis)** | | | | | | | | |
| **ω** | -5.9288*** | -1.9902*** | -5.2668** | -0.0128 | -0.6599*** | -3.6024*** | -2.2885*** | -2.3077** |
| **α** | -0.1998* | 0.5874*** | 0.3278*** | -0.0263 | 0.2788*** | 0.7241*** | 0.4711*** | 0.6695*** |
| **γ** | 0.6598*** | 0.0330 | -0.504 | -0.0108 | 0.0627* | -0.1920** | 0.0249 | -0.1763 |
| **β** | 0.3950*** | 0.8349*** | 0.4977** | 0.9973*** | 0.9531*** | 0.7000*** | 0.7921*** | 0.7869*** |
| **2007-2013(During/Post Financial Crisis)** | | | | | | | | |
| **ω** | -2.7809*** | -2.1036*** | -1.3372*** | -12.7193*** | -2.1573** | 0.0421 | -0.1143 | -3.3707*** |
| **α** | -0.0404 | 0.3645** | 0.4539*** | 1.1341*** | 0.6814*** | 0.1022*** | 0.2481*** | 0.0425 |
| **γ** | 0.3059*** | 0.2641** | -0.2900*** | -0.6224** | -0.1180 | -0.1500** | -0.1362*** | 0.3752*** |
| **β** | 0.7128 | 0.8177*** | 0.8935*** | -0.2150 | 0.8318*** | 1.1011*** | 1.0069*** | 0.6210*** |

*** 1%, ** 5%,* 10% level of significance.

In accordance to the suggestion of Bank of International Settlement (1998), that developed markets act as conduits among emerging stock markets. In addition, the investigation of Baur and Schulz (2005) during the Asian crisis advocates the idea that Japan and Singapore as developed markets within East Asia, were important conduits of contagion transmission, signifies the importance of re-examining the *conduit effects* during the global financial crisis. The post financial crisis is specifically tested, as regime shift is expected to alter market integration, as found in structural break. Table 8 and table 9, simultaneously examines the impact of spillover of Japan to other Asian economies, Singapore to other Asian economies and vice versa in the post financial crisis period. Significant spillover effect from Japan is found to all Asian markets under consideration. Japan to Taiwan has the highest interaction. On the other hand, spillover from India and China to Japan is significant with highest degree of spillover found for Japan to China, a true conduit effect.

**TABLE 8**
**VOLATILITY SPILLOVER OF JAPANESE MARKET (CONDUIT)**
**TO EMERGING ASIAN MARKETS**

| **Japan's spillover to other Asian Markets** | | | **Spillover of other Asian Markets to Japan** | | |
|---|---|---|---|---|---|
| | China | **0.7760*** ** | China | | 0.0859 |
| | | **(0.0842)** | | | (0.1750) |
| | India | **0.6964*** ** | India | | 0.0551 |
| | | **(0.0854)** | | | (0.1295) |
| | Malaysia | **0.7007*** ** | Malaysia | | 0.0756 |
| | | **(0.1567)** | | | (0.1588) |
| Japan → | South Korea | **0.3974*** ** | South Korea | Japan → | **0.6491*** ** |
| | | **(0.1385)** | | | **(0.1063)** |
| | Singapore | **0.5390*** ** | Singapore | | **0.6089*** ** |
| | | **(0.0820)** | | | **(0.1420)** |
| | Taiwan | **0.8140*** ** | Taiwan | | 0.0667 |
| | | **(0.0876)** | | | (0.1427) |

*** 1%, ** 5%,* 10% level of significance.

In extension, the other possible conduit, spillover effect of Singapore market to other Asian markets is laid out in Table 9. In contrast to Japan, Singapore has significant spillover effect to all of the considered Asian indices, with good degree of interaction in post crisis period. The highest spillover is found from Singapore to South Korea and South Korea to Singapore. This is an important finding, as the increased integration establishes the lingering effect of regime switch between these two markets. It is also determining that in addition to Singapore, South Korea with high degree of co movement emerges as an important Asian conduit in the aftermath of global financial crisis. It is notable, that Singapore has strong spillover impact on China and India, which is not as strong in the opposite direction.

**TABLE 9**
**VOLATILITY SPILLOVER OF SINGAPORE MARKET (CONDUIT) TO EMERGING ASIAN MARKETS**

| Singapore's spillover to other Asian Markets | | | Spillover of other Asian Markets to Singapore | | |
|---|---|---|---|---|---|
| | China | **0.9682*** (0.0132)** | China | | **0.6007*** (0.0804)** |
| | India | **0.9196*** (0.0317)** | India | | **0.6010*** (0.0852)** |
| Singapore → | Malaysia | **0.6916*** (0.1381)** | Malaysia | Singapore → | **0.5837*** (0.0727)** |
| | South Korea | **0.8834*** (0.0460)** | South Korea | | **0.8626*** (0.0398)** |
| | Taiwan | **0.8675*** (0.0528)** | Taiwan | | **0.5426*** (0.0845)** |

*** 1%, ** 5%,* 10% level of significance.

## CONCLUSION

The importance of this study lies in the fact that, the global financial crisis impacted many major economies around the globe, causing complete market transformations and altered the interaction between major markets. The interaction among markets in Asia is has not been significantly studied in the post global financial crisis for contagion effect, information hypersensitivity and heterogeneity, regime switch and volatility spillover relationship. Contagion definition suggests that market linkage increases in existence of a crisis. More importantly, empirical theories and literature indicates the lingering interaction the structural shift of markets in the post phase of a crisis is vital for investor's decision making process. As per the contagion framework, suggested by the Bank of International Settlement, developed countries are less impacted by contagion, while they are the major conduits of crisis spillover for developing markets. However, the later condition was outwitted by recent studies, notably that of Islam et al (2013), and it was suggested that developed European markets present strong crisis spillover in the aftermath of financial crisis. The degree of interaction rapidly propagated even the smallest of shocks quicker than before, and such information is not very inspiring for risk averse investors. Due to lack of true globalization, it was believed previously that Asian markets are, to some extent, free from such shock integration. The many indications received after the Asian crisis, it was believed that in presence of hypersensitivity to information and idiosyncratic shocks, Hong Kong, Japan and South Korean markets are more prone to be conduits to Asian crisis. Such findings lead to important shift in policies in some Asian countries. It was essential, to find the interactions among the Asian market in the pre and post global financial crisis period in presence and in absence of US market accession, which may contain important information for policy makers and investors alike. The markets considered are of China, India, Japan, Malaysia, South Korea, Singapore, and Taiwan.

The paper confirmed non-linearity and heterogeneity of the series under consideration with ARCH (1,1) effect estimation and with joint Wald test. The Wald tests also confirmed the presence of non-linear

restrictions of the dynamic model. For proper estimation of dynamic conditionality of the models, the non-linear restriction bears significance. Primarily the study examined the own and cross volatility spillover of seven major Asian markets, bearing substantial roles during Asian crisis. The study applied multivariate GARCH (1,1) estimation for mean and cross volatility spillover calculations. Most studies indicate US inclusion to be a necessary condition, for US market is the ground zero market for the global financial crisis 2007. Findings suggested Taiwan has the highest possible repeating shocks recorded, while highest volatility clustering is apparent for Malaysia. Own crisis spillover is profound for China, the post global financial crisis signifies a strong existence of cross volatility spillover generating from India and Malaysia. This is an important finding as India and Malaysia, two strong emerging markets, indicated significant economic growth in the last decade, and their stock markets became prominent, in very recent periods. In the existing literature, the role of India and Malaysia in contagion crisis spillover, carries very less significance. It can be suggested, that emerging markets in the aftermath of Asian crisis, had been important conduits during the global crisis. The real linkage for such economies might be profound, in comparison to that of financial linkage.

The paper than examines the structural break and leverage effect with threshold GARCH (1,1), comparing both the pre and the post financial crisis period. While during the crisis period Malaysia became significantly sensitive, the sensitivity to shocks lingered for Singapore and Taiwan. Such findings suggest, the increased integration purely contributed by the financial crisis 2007 for these two countries. Finally, volatility spillover tests conducted on specifically two major developed countries, Japan and Singapore is indicative to development of recent market integration. It was expected for the spillover direction from Japan to other economies, as Japan had been a conduit even during the Asian Crisis. The impact of US crisis into Japan is undeniable. However, a stronger spillover from China to Japan, for the post global crisis period must be noted, which is remarkably a recent development.

Plethora of studies offered suggestions to control contagion and curb crisis spillover. Hawkins and Turner (2000), predicted emerging markets will have difficulties complying with industrial-country standard, stressed on improved standards for supervision, surveillance for financial institutions, disclosure of real time data, and prudential controls. Tightening of financial policies stipulate that, increased monitoring of internal risk management, sanctions for poor systems, limiting maturity mismatches and the operations of hedge funds, holding excess foreign exchange assets relative to domestic currency liabilities, and capital controls on disproportionate outflows and some sort of inflows are essential in policy levels to prevent the propagation of sudden shocks. To avoid country level debt building, Supplemental Reserve Facility, Contingent Credit Lines of the IMF, guaranteed facility for the private sector by World Bank, are in place, reducing some degree of vulnerability (Dornbusch et al, 2000).

This is now time to draw the curtain off the research question and evaluate if the policy shifts adopted in the post Asian crisis period are sufficient to restrict capital flight on the back of recent global recession. In the analysis, cross market volatility spillover is found strongest between India and Malaysia, and China is robust to the spillover with minimum significance. It is a major concern, as with stringent measures taken on the speculators, a shift from floating to fixed regime, and strong capital controls, staggering Malaysian market yet cries out for pragmatic stance. It is essential to adopt coherent policy adjustment packages, close consultation with creditors and to address implicit deposit guarantees, while there is explicit lack of available fiscal resources; are advisable to Malaysian market; to control exacerbation of crisis (Summers, 2000). Indian markets reached a higher growth trajectory in the post Asian crisis period, and so the lax fiscal policies are more attractive, resulting in higher integration to other markets. Consequently, there was lack of investor and creditor confidence, implicit bailout guarantees, led to the reel of Indian market during global recession. However, strong safeguards can be placed by tightening monitory policy, maintaining of financial stability, lower interest rates can wheel off the market turbulence with better stabilization. China on the other hand remains least volatile for decades due to durable total factor productivity, and much adjustment will be less plausible.

This paper is successful in estimating strong spillover impact from Singapore to other Asian markets, which are to some extent higher than prevailing Japanese market. Japanese and US markets rode the horse in tandem from the last recession as ground zero to crisis in Asia. While as the strongest economy, it is

not surprising to find Japan playing a strong role as conduit, it must be noted that, according to analysis, shock recovery required longer period for Singapore, but Singapore successfully evaded strong impact from Asian crisis, due to timely government intervention. The recent impact of global recession in Singapore draws a stark contrast, due to lack of timely intervention that protected its markets from last recession. This was also a motivation to find the impact of idiosyncratic shocks within Asian market, and that can only be successfully assessed with a market structure of Singapore. Spillover from other markets to Singapore is not prominent, only except South Korea. South Korea has been an important conduit during Asian crisis of 1997, which gained stronger integration in the aftermath of Asian crisis. In the post financial crisis period, South Korea to Singapore and Singapore to South Korea spillover becomes strongly significant. Therefore, even without a separate estimation for South Korea, it can be concluded that South Korea remains a very strong conduit in the post global crisis period.

This study covered the Asian impact of the Global Financial Crisis of 2007-2008, and compared the situation to that of Asian Financial crisis 1997. From the analysis, some suggestions were derived to tackle eminent future shock. The Asian crisis caused some institutional intervention by policy makers, which did not prove healthy for the markets. Therefore, such dynamic conditional integration may not inspire the policymakers to follow the same path, but may draw a guideline for investor's portfolio rebalancing. It is essential to draft in an accord to tackle the next contagion in Asia, which requires extensive coherence between future researches that might lend to more pragmatic stances, not unilateral to any one market but to a pool of markets.

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