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Return and Volatility Spillover across stock markets of China and its Major Trading Partners: Evidence from Shanghai Stock Exchange Crash

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Abstract

This study analyses the return and volatility spillover effects of Shanghai Stock Exchange (SSE) crash to its Major Trading Partners (MTPs) – U.S.A. (S&P 500), Germany (DAX), Japan (Nikkei 225), South Korea (KOSPI), and Hong Kong (HSI) - using Diebold and Yilmaz (2012) spillover index model. The findings indicate the presence of increased return and volatility spillover between SSE and stock exchanges of MTPs during the sample period. The return spillover transmission is found to be higher than the volatility spillover transmission. Results also highlighted low level of return and volatility spillover from SSE to the stock markets of U.S.A. and Germany. Evidence of high integration between SSE and HSI are also indicated, which promote the geographical proximity impact on financial markets integration. The low return and volatility spillover between SSE and the stock markets of U.S.A. and Germany provide useful portfolio diversification benefits for international investors. The findings of this study provide useful information to potential investors for making rational decisions regarding portfolio diversification in the periods of crisis.

Keywords: *Shanghai Stock Exchange, stock market crash, financial markets integration, major trading partners, volatility spillover, spillover index.*

JEL classification: *G10, G15, G19*

1. Introduction

International trade has been identified as a major factor contributing to the stock market integration among the trading economies (Baur, 2010). The previous literature also recognized factors of high trade, investment relationship and global financial markets' integration contributing to the phenomenon of volatility spillover (Engle, Lto

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& Lin, 1988; Forbes & Chinn, 2004; Beine & Candelon, 2010). Trade relationship is no doubt a significant factor enhancing financial markets' integration among the global economies (Chambet & Gibson, 2008). Findings of Paramati, Roca, and Gupta (2016) also supported the evidence of increased comovement and interdependence among the stock markets due to trade. The dark side of global financial integration can be explored through the analysis of volatility spillover among the financial markets across different regions. Although Chinese stock market is relatively considered an isolated market, having little impact beyond Chinese territories, as a small number of foreign investors (only 2% of Chinese shares) are interested in this stock market. The trade horizon of China is expanding day by day making it more influential in global financial system.

The major concern is analysing trade as a channel of financial market integration. China is no doubt a major player in the world trade. China is a major player in the world economy due to the expansion of Chinese trade and market share all over the world. Chinese contribution to global economic development for more than two decades is rightly attracting world's attention towards Chinese leadership. China is the first largest exporter and the second largest importer of merchandise goods in the world (Rao & Pathak, 2016). With such huge dimensions of trade across the world, the recent financial stress in Chinese economy could hamper the global trade patterns, particularly affecting the stock markets of its Major Trading Partners (MTPs) – U.S.A., Germany, Japan, South Korea, and Hong Kong. The stock markets integration between China, Hong Kong and U.S.A. has increased after 1997, indicating potentials of spillover effects among these economies (Cheng & Glascock, 2006). Bekiros (2014) also reported the existence of increased interdependence among the U.S.A. and Chinese stock markets. With presence of spillover potential among China and its trading partners, Chinese as well as international investors should be watchful when deciding to invest in any of the China's major trading partner. The investors should not only focus on the fundamentals of the destination market but also on the economic and financial forecast of the Chinese economy, to fully utilize the benefits of international diversification.

Shanghai stock exchange with a market capitalization of $5.9 trillion (May 2015) is world's3rd largest stock exchange (World Federation of Exchanges, 2015) after New York Stock exchange ($19.7 trillion) and National Association of Securities Dealers Automated quotations (NASDAQ) OMX ($7.4 trillion). According to Riley and Yan (2015), during the first half of the year 2015, the Shanghai stock exchange depicted a 150% increase, due to Chinese government encouraging people to invest in stock market. These huge inflows of investment generated a bubble in the stock prices, which was prone to burst. Shanghai Composite and Shenzhen stock markets were

witnessing large fluctuations and predicting a drastic decline in the overall value even prior to 12th June 2015 when the former stock exchange exposed to 30% drop and the later depreciated around 40%, injected alarm among millions in China. Stock index fell below 4,000 points for the first time since April 2015, when rapidly inflating bubble that had driven share prices to dizzying heights suddenly burst on 2nd July 2015. According to the Economist (2015) more than $3 trillion were wiped off the stock market since the stock exchange crash begun.

Due to the significant role of China in the global financial economy, SSE crash is seen as one of the major economic crises of this decade in Asia and is bound to have ripple effects across the world. With the start of the crisis on June 12, 2015 the Shanghai Stock exchange index fell by 8.5% at closing. This collapse of the SSE was followed by declines in various stock markets around the world. The Nikkei Index dropped by 4.5 %, Eurofirst Index dropped by 5 %, the Dow Jones Index declined 1,000 points, and the German DAX Index was also among the affected stock market indexes (Economist 2015). The effects of turmoil in financial markets of China will no doubt be felt by the global financial system (Feng & Stewart, 2016; Mafukata, 2016; Jin, Li and Wu, 2016). In Today's, integrated global financial system, turbulence in one market is transmitted to other integrated markets within no time. Advancement in technology and communication systems is playing a major role in this regard.

In this study, Diebold and Yilmaz (2012) spillover index methodology has been employed to identify the spillover effects of SSE crash on stock markets of the five MTPs' of China (U.S.A, Japan, Hong Kong, South Korea, and Germany). According to the CIA (2015) World Fact book, the selected economies are not only major export partners of China but also major import partners. The sample period for the study consists of September 1, 2014 to November 25, 2016 covering the whole crisis period. Despite the fact, that financial chaos spillover has eliminated the benefits of portfolio diversification. This paper provides useful help for the international investors, policy makers, academicians and researchers to look for better investment opportunities in trading economies. The present study hold importance as the share of China in global trade is increasing day by day. Secondly, the previous research has failed to empirically investigate the dynamics of SSE crash on the Stock markets of Chinese MTPs.

The findings of study indicate the existence of return and volatility spillover between SSE and MTPs' stock markets. The spillover affect are found to be more noticeable on Hong Kong stock exchange, supporting the notion that effect of SSE crash is felt more on MTPs with geographical proximity. The findings also indicate that SSE is more integrated with emerging and developed Asian stock markets than with developed German and U.S.A. stock markets. The remaining paper discusses published literature relevant to the topic in section II, the empirical methodology in

section III. Section IV comprises of data and descriptive of the data, followed by section IV, Results and Discussion. The last section VI provides conclusion of the study.

2. Literature Review

The significance of diversification as means to minimize risk was established by Markowitz (1952). It was emphasized that an optimal portfolio that minimizes the risk can be built based on the asset's correlations. The benefit of diversification can be enhanced through international diversification of the asset portfolio (Grubel, 1968; Solnik, 1974). In contrast, to these findings, Kasa (1992) argued that low correlation is not an accurate measure for portfolio diversification decision, as the correlations of assets are time varying and there is need for accurate measures of this time varying correlation structure of the assets. To better benefit from investments, investors should utilize the portfolio diversification. Portfolio diversification is a significant method to avoid diversifiable risk, which is the goal of international investors.

Globalization has made the world as an integrated web of economies, where effects of an event occurring in one economy are felt in the whole integrated system. Advancements in communication technologies have enhanced the access to global financial information. Advancement in communication technologies along with the liberalization of the economic and financial systems has created the opportunities of portfolio diversification for the investors globally. At times the benefits of diversification are eliminated due to the presence of volatility spillover among the financially integrated and inter-linked economies (Forbes, 2004). Two interrelated concepts are responsible for the elimination of the diversification benefits for the investors: Contagion and spillover effects. Contagion occurs when the correlation between the asset class of the inter-linked economies increase during the event of crisis, as compared to the tranquil period (Baur & Lucay, 2009). Similarly, Yarovaya, Brezaszczynski and Lau (2016) explained spillover phenomenon to occurs, when volatility in financial markets of one economy faced by crisis initiate volatility in another inter-linked economy or economies.

Contagion and spillover effects are more related to financial volatility introduced by an event of financial crisis in the financial markets. Such effects diminish the desired portfolio diversification benefits for the investors. Quick information flows and information accessibility of foreign financial markets, due to technological advances are mainly contributing to the contagion and spillover effects. Not only the developed economies are facing contagion and spillover effects of financial crisis, but the emerging economies are also prey to it (Yarovaya, Brezaszczynski & Lau, 2016). Engle, Lto and Lin (1988) explained the phenomena of contagion and spillover effects in the "meteor shower" and "heat waves" hypothesis. The experience of the past finan-

cial crisis of 1987 in the US, the 1994 Mexican crisis, the 1997 East Asian crisis, the 1998 Russian crisis and the 2007-08 global financial crisis (GFC) have empowered the believe that an event of crisis in one economy of the world can trigger crisis in other economies of the world (Forbes, 2004). The devastating impacts of the 1997 Asian financial crisis, the 2007-08 GFC and the 2010 European sovereign debt crisis had created a huge melt down in the global financial activity and had badly affected the global financial markets (Karanasos, Yfanti & Karoglou, 2016). Experience of the various crises has enhanced the significance and need for studying the integration of global economy and presence of spillover between financial markets.

The Asian financial crisis that started in 1997 spread quickly to other economies in a short time, creating financial stress in these economies. The event of crisis was short lived but intense. The crisis later created spillover effects in the Russian and Latin American economies. The damaged caused by the Asian crisis enhanced capital flight due to sharp decline in assets prices in the effected economies. The result was financial instability and stress in the global financial markets (Chiang, Jeon, & Li, 2007). The Asian financial crisis had overwhelming contagion effects on the inter-linked economies (Baig & Goldfajn, 1999; Chiang, Jeon, & Li, 2007; Cho & Parhizgari, 2008; Karanasos, Yfanti & Karoglou, 2016). Chiang, Jeon and Li (2007) identified two phases for how financial crisis spillover to other economies. In the first phase the correlation between the volatility of the inter-linked economies increases, showing evidence of contagion. In the second phase investors' herding behaviour was evident from the fact that the correlation between the inter-linked economies remained high. The spread of volatility from the source country to other economies in the Brazilian, Asian and Russian crisis provide evidence of spillover and contagion effects (Kenourgious Samitas, & Paltalidis, 2011). In present integrated global financial system, the investors should not only analyse the destination market conditions but should also analyse and investigate the economic and financial conditions of the inter-linked economies that can affect their investments' returns in the destination market.

Evidence of contagion and spillover was also found during GFC (Syllingnakis & Kouretas, 2011), indicating the presence of herding behaviour among the international investors (Kenourgios & Samitas, 2011). The sharp decline in the portfolio values during the GFC, altered the perception of international investors for stock market investments (Hoffmann, Post & Pennings, 2013) and made them more risk aversive (Barberis, 2013). A loss in the portfolio value forces the investors to rebalance their investment portfolio and shift their investment to safe assets. Stock market is the first to be affected by any event of financial crisis; therefore this market suffers the most capital flight during such events. During the search for alternative safe investments, investors focus on minimizing their risk exposure and doing so avoid risky investments

such as stocks.

By the time the GFC emerged, there existed increased interdependence between the US and the emerging economies, making them more vulnerable to volatility spillovers. The Latin American economies were also under the heat waves of the GFC that emerged from the US, mainly Mexico (Dufrenout, Mignon & Pengun-Feissolle, 2011). The European economies received the meteor shower effects of the GFC as many European banks were affected by the housing market crisis in America. Secondly, the global re-pricing of risk created huge impact on the financial stability of these economies (Choudhry and Jayasekera, 2014). The Latin American economies experience volatility spillover effects during the financial crisis, whereas the emerging Asian economies were partially affected by the GFC. On the contrary, Mollah, Quoreshi and Zafirov, (2016) found that the emerging economies of Asia and Middle East were unaffected by the GFC. Financial and economic integration of the global economy was identified as one of the major reasons for such spillover. The economies that were more integrated were the most effected during the GFC as compared to the less integrated economies.

The integration of global bond markets enhanced the pricing of sovereign risk and price discovery (Baldacci & Kumar, 2010). The EU member economies were marked with lower sovereign risk due to the enhanced credibility of policies due to membership in the European Union. By the time the European Sovereign debt crisis intensified in 2010, the macroeconomic conditions of the economy were the most important factor affecting the financial markets during this period of turmoil (Hauner, Jonas, & Kumar, 2010). The full fledge European Debt crisis was preceded by an increase in the sovereign risk during the period 2008. This turmoil period was short but had impacts on the later crisis (Beirne & Fratzscher, 2013). The event of European Sovereign debt crisis was another nightmare in the history of global financial markets. The spillover effects of the European crisis were felt across the global financial markets, with amplified affects in the European economies of Italy, Greece, Portugal, Ireland and Spain. Greece was the most effected economy due to the European sovereign debt crisis event. The European sovereign debt crisis had spillover effects on the Latin American emerging economies, whereas such spillover effects were not observed in the Asian emerging economies. For Africa and Middle Eastern emerging economies, evidence of partially impact was observed during the European Sovereign Debt crisis (Mollah, Quoreshi & Zafirov, 2016). Europe is considered to have one of the most integrated financial systems in the world. It was due to this unification and integration of financial system that the crisis spread to member economies in the first instance. The economies that were integrated with Europe through financial or trade links also suffered from the devastating effects of the crisis.

A recent turmoil in the global financial markets was the crash of SSE in 2015. The Chinese stock market crash of 2015 resulted from the artificial bubble created due to Chinese state-owned media encouragement for the local investors to invest in the stock markets. The flows of huge investment into the stock markets created a sharp rise of around 150 % in the prices of Shanghai Stock Exchange (Riley & Yan, 2015). By the time the bubble bursted, the investors were faced by margin calls resulting in further selling of stocks. Most of the stock purchases were through borrowed money and this led to a stress in the Shanghai stock market (Riley & Yan, 2015). The crash of Shanghai stock exchange transmitted volatility to other global stock markets and created spillover in the global financial markets. Sharp falls were observed in the Japanese, European and US stock markets. According to an estimated almost $ 5 trillion were lost in the global financial markets as the results of aftershocks of the Shanghai stock market crash (The Economist, 2015). China being the world second largest economy and the second largest importer play a vital role in the global financial system. The situation in China has also affected the commodities prices especially the crude oil prices that declined further (Walker, 2016). Even though foreign investment in the Chinese stock market is negligible, the companies that were involved in trade with China suffered from the situation in China. Kumbla Iron Ore of South Africa, French alcoholic beverage company and British luxury goods company, Burberry are the few that suffered due to Chinese crisis. The Chinese companies on the US stock exchange were also affected by the turmoil (Agrawal, 2016). The multinational corporation are affected by a global turmoil event because they are not only concerned about their own markets, but they are also concerned about the effects of the situation in the other significant markets of the world (Nikkinnen & Sahlstrom, 2004). Now a day investors not only analyse the conditions of destination economy, but also analyse influence of the integrated economies on the destination market. This has further enhanced the significance of studying the spillover phenomena among the integrated economies.

The IMF has signalled the arrival of a new phase of recession due to the slowdown in the growth of China due to the fact, China being a major source of demand for the export led economies will have disruptive effects on these trade partners if the situation continues (Reynolds, 2016). Declining imports from China has caused a sharp decline in the prices of copper and aluminium (Agrawal, 2016). The instability of the Chinese economy is the beginning of new turmoil in the global financial system. The factors of high trade and investment relationship and global financial market integration are contributing to the transmission of spillover effects of a crisis event to other economies (Lin, Engle & Lto, 1994). The devastating effects of global financial interconnectedness can be explored through the analysis of volatility spillover among the financial markets across different regions. Even though the financial turmoil spillover has eliminated the benefits of portfolio diversification, but the knowledge

on the topic can provide useful implication for the domestic investors based on the effects of a crisis event in other interconnected economies.

3. Empirical Method

The argument in favour of contagion effects of crisis was criticized by some researchers on the fact that these correlations were not adjusted for heteroskedasticity. If the correlations among the economies in the event of crisis are adjusted for the effect of heteroskedasticity, the result will show no increase in the correlation among the economies during the crisis event. Rather, it can be interpreted as the existence of interdependence among the economies (Forbes & Rigobon, 2002; Bordo & Murshi, 2002; Basu, 2002). The Multivariate GARCH models provide a single measure of spillover and contagion for the entire set of economies, making it vague to identify the potential and magnitude of spillover among individual markets (Engle & Sheppard, 2001). The criticism on the past research regarding contagion literature provides room for further analyses into the topic. Over the time researchers have improved the methodological tools to provide insight into the existence of contagion among interlinked economies. Diebold and Yilmaz (2012) spillover index methodology not only provide pairwise measures of spillover but also allows calculating time varying nature of spillover among the sampled markets. It is important to analyse the time varying pattern of spillover because the nature and magnitude of spillover among the sampled economies do not remain constant over time. The time varying behaviour of total return and volatility spillover among the SSE and stock indices of its major trading partners during the sample period are investigated by applying 200-days rolling window analysis methodology of Diebold and Yilmaz (2012). With these attractive features, Diebold and Yilmaz (2012) methodology is most appropriate to analyse the dynamics and nature of spillover among the integrated financial markets.

The spillover index methodology of Diebold and Yilmaz (2012) eliminates the dependence of results on the ordering of the variables. The method applies a covariance stationary N-variable VAR (p),

$$x_t = \sum_{i=1}^{p} \Psi_t x_{t-i} + \varepsilon_t \qquad (1)$$

where ε_t is an independently and identically distributed vector of error terms and

$$x_t = \sum_{i=0}^{\infty} C_i \varepsilon_{t-i} \qquad (2)$$

represents the moving average, where C*i* are NxN coefficient matrices obeying the recursion $Q_i = \theta_1 C_{i-1} + \theta_2 C_{i-2} + \ldots + \theta_p C_{i-p}$, where C_0 is an identity matrix with $C_i=0$ for i<0. Own variance contribution to H-step ahead forecast error variance in x_i is due to shock to x_i, for i=1,2,...N, and cross spillover contribution, to H-step ahead

forecast error variance in x_i is due to shock to x_j,i,j=1,2,...N, i,j,=1,2,...N, such that j≠i.

The KPPS H-step ahead forecast error variance (Pesaran and Shin 1998; Koop at al. 1996) is computed as,

$$\gamma_{ij}^{g}(H)=\frac{\sigma_{ii}^{-1}\sum_{h=0}^{H-1}\left(e_i'C_h\Theta e_i\right)^2}{\sum_{h=0}^{H-1}\left(e_i'C_h\Theta C_h'e_i\right)} \qquad (3)$$

where Θ denotes variance matrix for ε, σ_{ii}, denotes the standard deviation of the error term for equation *i* and e_j denotes the selection vector with one as the *ith* element and zero otherwise. The row sum of variance decomposition does not equal to 1, because the shock to each variable are not orthogonalized.

$$\sum_{j=1}^{N}\gamma_{ij}^{g}(H)\neq 1 \qquad (4)$$

To compute the spillover index we normalize each entry of variance decomposition matrix by row/column sum as:

$$\tilde{\gamma}_{ij}^{g}(H)=\frac{\gamma_{ij}^{g}(H)}{\sum_{j=1}^{N}\gamma_{ij}^{g}(H)} \qquad (5)$$

By construction, $\sum_{j=1}^{N}\tilde{\gamma}_{ij}^{g}(H)=1$ and $\sum_{i.j=1}^{N}\tilde{\gamma}_{ij}^{g}(H)=N$.

The total volatility spillover is computed as:

$$S^{g}(H)=\frac{\sum_{\substack{i,j=1\\ i\neq j}}^{N}\tilde{\gamma}_{ij}^{g}(H)}{\sum_{i.j=1}^{N}\tilde{\gamma}_{ij}^{g}(H)}\times 100=\frac{\sum_{\substack{i,j=1\\ i\neq j}}^{N}\tilde{\gamma}_{ij}^{g}(H)}{N}\times 100 \qquad (6)$$

4. Data and Descriptive

The daily data of stock indexes for China (SSE), U.S.A. (S&P 500), Hong Kong (HSI), South Korea (KOSPI), Germany (DAX) and Japan (Nikkei 225) were selected for empirical investigation. The data sample contained China and its major trading partners. The daily open, high, low and closing prices were obtained for each stock index for the sample period ranging from September 1, 2014 to November 25, 2016. Returns were calculated as a difference of the natural logarithm of closing price at day "t" and day "t-1". The returns on non-synchronized public holidays were assumed to zero. The normalized high, low, and close prices are used to calculate the daily volatility for each market (Rogers and Satchell 1991) as:

$$\sigma^2=P_{h,t}\left(P_{h,t}-P_{c,t}\right)+P_{l,t}\left(P_{l,t}-P_{c,t}\right) \qquad (7)$$

where $P_{h,t}$ is high price, $P_{l,t}$ is low price and $P_{c,t}$ is closing price at day *t*.

The descriptive statistics for stock indices return and volatilities are presented in Table 1. Table 1 indicates that the SSE has the highest mean return (0.07), whereas HSI and KOSPI have the lowest mean return (-0.01). The skewness statistics for all return series is negative, indicating the presence of large negative returns. The high kurtosis value for the return series indicates the presence of sharp peaks in the returns' distributions. The Jarque-Bera statistics for the returns series show that all series are abnormally distributed. The ADF statistics shows the presence of stationarity for all return series.

Table 1: Descriptive Statistics

		Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	ADF
Return	SSE	0.07	5.60	-8.87	1.93	-1.20	7.44	620.89	-22.47
	Nikkei225	0.03	7.43	-8.25	1.48	-0.12	7.84	573.08	-26.77
	HSI	-0.01	4.02	-6.02	1.20	-0.27	5.34	141.00	-23.84
	DAX	0.02	4.85	-7.07	1.37	-0.39	4.59	76.36	-24.30
	KOSPI	-0.01	2.91	-3.14	0.75	-0.27	4.89	94.63	-23.31
	S&P 500	0.02	3.83	-4.02	0.89	-0.26	5.12	116.40	-24.17
Volatility	SSE	-0.03	0.68	-0.87	0.16	0.36	6.81	367.39	-25.52
	Nikkei225	0.00	0.83	-0.54	0.12	1.06	10.49	1476.16	-25.11
	HSI	0.01	0.36	-0.32	0.09	0.09	4.53	58.00	-24.20
	DAX	0.00	0.47	-0.42	0.12	0.23	4.13	36.48	-23.59
	KOSPI	0.00	0.17	-0.23	0.05	-0.20	4.30	45.37	-24.33
	S&P 500	-0.01	0.32	-0.26	0.07	0.37	4.82	94.23	-23.74

Notes: SSE=China, KOSPI=South Korea, S&P 500= United States, DAX=Germany, HK=Hong Kong, Nikkei=Japan. All statistics are significant at 1% level of significance

The descriptive analysis for volatilities shows the presence of negative mean volatilities for SSE and S&P 500 indices. The minimum, maximum and standard deviation statistics indicate that SSE prices are more volatile than other stock markets included in the analysis during the sample period. The distributions of the stock markets' volatilities exhibit the presence of fat tail as indicated by excess kurtosis value. This evidence is also supported by the Jarque-Bera statistics, which indicate that the distributions are not normally distributed. The ADF statistics are significant for all

series, showing that all volatility series are stationary.

5. Results and Discussion

5.1 Return and volatility spillover indices

The average return and volatility spillover results are presented in the form of tables. Table 2 depicts the average return spillover among SSE and the stock indices of its major trading partner, whereas Table 3 depicts the average volatility spillover between SSE and Stock indices of its major trading partner. The findings indicate that return spillover (42.7%) over the sample period is higher than the volatility spillover (18.7%) between SSE and the stock indices of its major trading partners. This finding is in line with findings of Yarovaya et al., (2016), who also found return spillover to be higher than the volatility spillover among the stock and future indices of emerging and developed economies. Whereas, Diebold and Yilmaz (2009) concluded that the return and volatility spillover were of the same magnitude.

The "From others" column in the tables indicates the amount of average return and volatility transmitted to a particular stock market from all other stock markets during the sample period. The findings indicate that HSI has been the highest recipient of return (53.48) and volatility (26.87) spillover from all other stock indices during the sampled period. The highest return (12.75) and volatility (11.87) spillover to HSI comes from KOSPI and SSE respectively. This finding indicates that HSI is the most sensitive market to external shocks from other markets in the sample, especially to Asian stock markets. This finding is line with Paramati, Roca, and Gupta (2016), which identified geographical proximity as a significant factor for enhancing stock market integration among Australia and its MTPs. It is also identified that the sensitivity of HSI is more to external shocks coming from Emerging Asian economies of Korea and China. This finding is inline with Yarovaya et al., (2016) indicated that emerging and developed Asian markets are more integrated with emerging and developed economies from the same region. During the sample period SSE has been the lowest recipient of return spillover (29.35) and DAX has been the lowest recipient of volatility spillover (7.59) from all other stock indices during the analysed period. The highest return and volatility spillover to DAX comes from S&P 500. The high level of integration among the U.S.A. and the developed European economies is also found by the previous published literature (Yarovaya et al., 2016; Rapah, Strauss & Zhou, 2013).

The "Contribution to others" row indicates the average return and volatility spillover transmitted from each stock index to all other stock indices during the sample period. S&P 500 index has been the highest transmitter of return spillover (62.93) to other stock indices, with highest return spillover to DAX (21.17). Whereas HSI has

been the highest transmitter of volatility spillover to all other stock markets in the sample, with highest spillover to SSE (13.08). In terms of return spillover, S&P 500 has been the most influential market in the sampled markets. Rapah, Strauss and Zhou (2013) also identified USA to the most influential market, endorsing our findings regarding return spillover. Moreover, the highest influence of USA market is shown on German market, showing that level of integration among USA and developed European economies is higher than level of integration among USA and developed and emerging Asian economies. The HSI return (16.66) and volatility (13.08) spillover to SSE are concurrent with the findings by Rapah, Strauss and Zhou (2013), which endorse the integration among emerging and developed Asian economies to be higher than integration between developed and emerging Asian economies with USA and European emerging and developed economies. This finding endorse the high level of integration among the SSE and HSI stock exchanges.

The findings also indicate that own return and volatility spillover for each market is higher than total return and volatility spillover from other markets in the sample period. The highest own return spillover is indicated by SSE (70.65) and the lowest own return spillover in the sample is indicated by HSI (46.52). This indicates that SSE is least prone to external shocks whereas HSI is the most vulnerable to external in terms of return spillover. On the other hand, in terms of volatility spillover, DAX has the highest own volatility spillover (92.41) and HSI has the least own volatility spillover (73.13), indicating lowest and highest vulnerability of DAX and HSI to external volatility shocks during the sample period.

The findings regarding the return and volatility between SSE and stock indices of its MTPs provide interesting results. It is evident from the findings that out of the total return (29.35) and volatility (18.01) spillover from others to SSE, the major contribution comes from HSI, with return spillover of 16.66 and volatility spillover of 13.08. The lowest return and volatility from others to SSE comes from DAX with return spillover of 2.46 and volatility spillover 0.27. The return spillover to SSE from S&P 500, KOSPI and Nikkei 225 are 4.31, 2.23 and 2.70 respectively. The volatility spillover to SSE from KOSPI, Nikkei 225 and S&P 500 are 2.21, 1.91 and 0.53 respectively. The findings also indicate that average total return and volatility spillover transmitted from SSE to other 17.33 and 16.63 respectively. The highest return (10.77) and volatility (11.87) spillover from SEE occurred to HSI, whereas the lowest return (0.87) and volatility (0.04) spillover from SSE occurred to DAX. The return spillover from SSE to S&P 500, Nikkei 225 and KOSPI were 2.11, 1.89 and 1.68 respectively. The volatility spillover from SSE to S&P 500, Nikkei 225 and KOSPI were 0.49, 1.73 and 2.50 respectively. The findings also indicate a difference in the magnitude and patterns of return and volatility spillover among SSE and stock indices of its major

trading partners. Return spillover is found to be higher in magnitude than volatility spillover among the sampled stock indices.

Table 2: Average Return Spillover

	SSE	Nikkei225	HSI	DAX	KOSPI	S&P 500	From Others
SSE	70.65	2.70	16.66	2.46	3.23	4.31	29.35
Nikkei225	1.89	50.58	9.49	12.50	11.23	14.30	49.42
HSI	10.77	7.89	46.52	10.56	12.75	11.50	53.48
DAX	0.87	3.98	8.83	60.46	4.69	21.17	39.54
KOSPI	1.68	10.82	13.84	10.38	51.64	11.65	48.36
S&P 500	2.11	2.91	5.28	20.75	5.17	63.78	36.22
Contribution to others	17.33	28.30	54.10	56.65	37.07	62.93	256.37
Contribution including own	87.97	78.88	100.62	117.11	88.71	126.71	42.7%

Notes: SSE=China, KOSPI=South Korea, S&P 500= United States, DAX=Germany, HSI=Hong Kong, Nikkei 225=Japan.

Table 3: Average Volatility Spillover

	SSE	Nikkei225	HSI	DAX	KOSPI	S&P 500	From Others
SSE	81.99	1.91	13.08	0.27	2.21	0.53	18.01
Nikkei225	1.73	75.39	6.94	1.16	11.69	3.08	24.61
HSI	11.87	6.74	73.13	0.13	7.20	0.92	26.87
DAX	0.04	1.03	0.53	92.41	1.03	4.96	7.59
KOSPI	2.50	12.59	6.92	0.48	76.15	1.36	23.85
S&P 500	0.49	3.65	1.17	4.36	1.55	88.77	11.23
Contribution to others	16.63	25.93	28.65	6.41	23.68	10.86	112.16
Contribution including own	98.62	101.32	101.78	98.82	99.83	99.63	18.7%

Notes: SSE=China, KOSPI=South Korea, S&P 500= United States, DAX=Germany, HSI=Hong Kong, Nikkei 225=Japan.

5.2. Rolling window analysis – Return and volatility spillover

The rolling window analysis (Figure 1 and Figure 2) captures the boom and burst in both the return and volatility spillover that could not be captured by the static spillover index tables.

The return spillover (Figure 1) is higher among the sampled economies as compared to the volatility spillover (Figure 2). Starting below 30% in June 2015, the return spillover increased drastically with start of the SSE crash, eventually reaching a high above 45% during August 2015. The return spillover among the SSE and the stock indices of its major trading partners remained above 40% for the entire analysed period. The second phase of boom in the return spillover is indicated in January 2016 that continued until May 2016. The third phase of increased return spillover started in June 2016 and continued till the end of the sampled period, November 2016, with eventual spikes in response to domestic and global events affecting the financial markets.

The volatility spillover (Figure 2) showed a late response to the SSE crash as compared to the return spillover. Starting with a low of below 15% the volatility spillover started increasing in June 2015, reaching a high of above 23% during August 2015. Declining afterward till December 2015, a sharp rise in the volatility spillover is depicted from January 2016 till April 2016. The third phase of boom in the volatility spillover among the SSE and its major trading partners is depicted from June to August 2016. After August 2016 the volatility spillover among SSE and its major trading partners depict a declining trend till the end of the sample period.

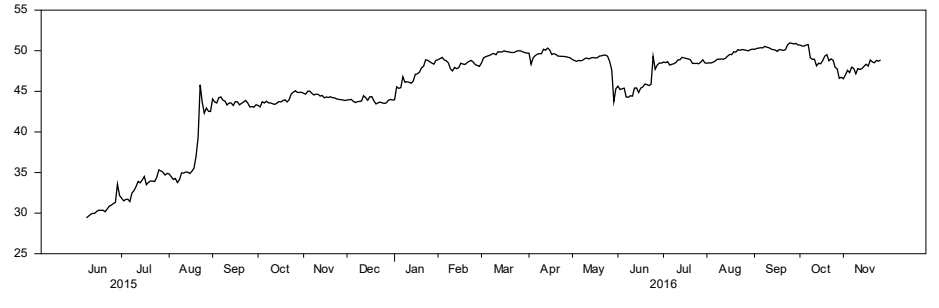

Figure 1: Rolling window analysis - Return spillover among China and its MTP stock exchanges

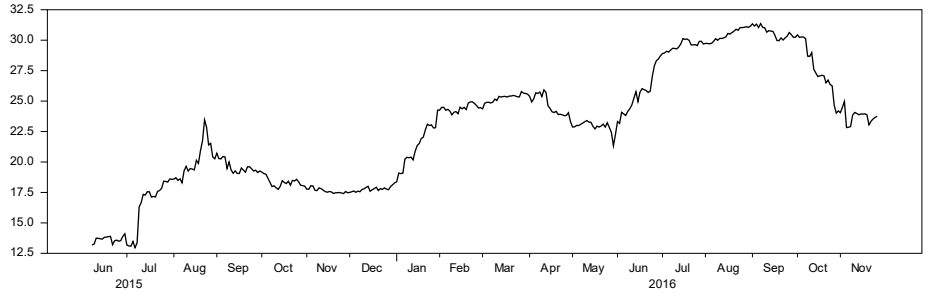

Figure 2: Rolling window analysis - Volatility spillover among China and its MTP stock exchanges

6. Conclusion

This study analysis returns and volatility spillover between stock exchanges of China and its major trading partners by applying Diebold and Yilmaz (2012) spillover index methodology. Stock indices included in the analysis are: SSE (China), KOSPI (South Korea), S&P 500 (U.S.A.), DAX (Germany), HIS (Hong Kong) and Nikkei 225 (Japan). The sample period for the analysis range from September 1, 2014 till November 25, 2016, including the entire period of turbulence in SSE. The study has also employed rolling window analysis to analyse the time varying patterns of return and volatility spillover over the sample period.

Major findings of the static and rolling window analysis suggest that volatility spillovers due to crash of SSE have enhanced the volatility in the stock markets of its major trading partners with highest effect on Hong Kong stock exchange and least effect on German stock exchange. This enhances the evidence on high level of integration between stock markets of China and Hong Kong. Another interesting insight is provided by the estimates of high bi-directional return and volatility spillover SSE-HSI and S&P 500-DAX pairs, as compared to other markets in the sample. This evidence supports the findings of the previous research regarding high intra-region integration among the developed and emerging Asian economies. The markets of Asia have high intra-region integration, whereas U.S.A. market's integration is more with the German market. Trade has been identified a major driver of economic integration among economies, with geographical proximity playing a significant role in enhancing the effects (Danareksa Research Institute, 2004; Kawai, 2005; Aviat & Coeurdacier, 2007; Jacks, O'Rourke, & Williamson, 2011). Danareksa Research Institute (2004) identified increase in cross border trade activities as a major driver of integration among the Asian economies. Similarly, Kawai (2005) identified FDI-driven trade as the basic driver of integration among the East Asian economies. Supporting evidence was found by Aviat and Coeurdacier (2007) who identified the existence of strong

correlation between trade and financial integration.

We suggest that analysis of trade relations as a source of financial markets integration provide practical implication for formulating investment diversification strategies. The findings of the study provide new insight into the inter-market integration between China and its major trading partners. As discussed earlier that findings of this study provides useful implication for the international investors in making rational decisions regarding portfolio diversification in the country of their own choice. The findings of study hold relevance not only to researchers, but also academician and policy makers. We suggest further investigation into the spillover effects of SSE crash on other global financial markets, in order to fully analyse the integration level of Chinese financial markets with global financial system.

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