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VOLATILITY SPILLOVERS FROM US TO EMERGING SEVEN STOCK MARKETS: PRE & POST ANALYSIS OF GFC

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Abstract

This study is conducted to check volatility spillovers from the US to Emerging seven stock markets before and after the Global Financial Crisis through the VAR-GARCH model. The pre The Global Financial Crisis (GFC) sub-sample data ranges from January 8, 2002 to June 29, 2007 and Post GFC data starts from July 4, 2009 to December 28, 2014. The outcomes of the VAR-GARCH model show that there are significant volatility spillovers from US stock market to emerging seven stock markets in most cases. The correlations reveal that the US stock market is strongly correlated with the Brazilian stock exchange, Mexican stock exchange and Russian stock exchange. These findings suggest that investors may consider geographical proximity into consideration. The empirical results also mention that the Chinese stock market, the Indonesian stock market and Indian stock market have less effect by the volatility spillovers from the US stock market. The findings also demonstrate that the Brazilian, Mexican and Russian stock markets observed a rapid increase in the CCC with the US market.

Keywords: Volatility Spillover, Global Financial Crisis, Emerging Seven, US, VAR-GARCH Model.

JEL Code: C32, C51, C58, F3, G010, G15

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1. Introduction

Co-movement of stock markets amid the globalization depend on numerous factors. Chan, Gup and Pan (1997) studied the eighteen national equity market indices and found the support for the market segmentation hypothesis. The globalization and coherence among the stock market has significantly reduced the problem of asymmetric information signifying the Efficient Market Hypothesis. This financial integration helps in drawing foreign direct investment and diverse investment strategies. Since, the effects of financial integration trickle down to the emerging markets as well so, there are risks and opportunities associated with this financial globalization of capital markets. One of the major threats associated with this financial integration is the Volatility spillover. It is commonly used to refer to the transmission of risks from one stock market to the other. Akca and Ozturk, (2016) consider volatility as the transmission of market risk from one capital market to another. This correlation between the capital markets can trigger the collective sharp decline in the stock returns as experienced in the event of recent global financial crises. The cycle of volatility spillover has garnered the interest of investors and portfolio managers over the year. Their investment and diversification strategies revolve around the concern of volatility spillover. The financial integration and globalization have significantly changed the international finance and hence diversification schemes.

The Global Financial Crisis (Hereafter GFC) of 2007-2009 was the most evident example of volatility spillover. This financial crisis originated in the USA transmitted its risks and volatility to the other developed capital markets and from there on it was spread from developed to emerging markets. The financial integration among the stock markets was the prime reason why this volatility was transferred from developed to emerging markets and affected the global economy. However, the shock waves went through the emerging markets but developed economies suffered the most due to the originator of the trigger. This crisis was long felt by both developed and emerging markets. Emerging Markets are increasingly dependent on the developed markets with respect to the external financing and foreign direct investment and diversification. This has increased the correlation among the developed and emerging markets. Emerging Seven (E-7), in particular, have drawn considerable attention in lieu of their integration with the mature markets. Pricewaterhouse Coopers, (2015) predicted that within the next five years E7 economies will surpass the G7 markets in terms of their share in the global economy. This magnitude of the financial integration between E7 and developed markets prompted us to investigate it.

In this research article, we used the VAR-GARCH methodology which was developed by Ling and McAleer (2003). We have taken the daily data of USA and emerging seven stock market indices. Data is divided in two sub samples. One part of the data accounts for the volatility transmission pre GFC and the other part considers the volatility spillover effect post GFC from USA to E7. Syripolous et al., (2015) investigated the spillover transmission between US and BRIC whereas

Singh et al., (2010) studies the volatility spillover for European countries. Majdoub and Mansour, (2014) studied how the conditional volatility is transmitted among the Asian markets. The aim of this research is to investigate how the volatility spillover is transmitted from the USA stock market to Emerging Seven stock markets before and after the GFC.

While there are few studies in the literature that have studied the spillover effect, this study contributes to the literature the pre and post GFC impact of volatility spillover. Moreover, quite a few studies have taken into account the transmission of conditional volatility from the USA market to emerging seven markets. This research is combining all the elements of volatility spillover from US to E7, pre and post GFC. Another important thing to mention is that the estimation of transmission of conditional volatility is conducted by using the VAR-GARCH model. The daily prices of the respective stock market indices are taken pre and post GFC window. The significance of this study can be explained by the fact that it allows the individual investors, portfolio managers, and policymakers to gauge the financial integration of the said markets and make the diversification strategies accordingly. This study also provides fruitful insights for the academicians and portfolio managers for better managing their investments.

This article has five sections which are organized as follows; Section Two highlights the literature review. Section Three explains data and methodology and Section Four exhibits the empirical results and discussion. Section Five provides the concluding remarks.

2. Literature Review:

There have been a lot of studies on volatility spillover in the past in which researchers have used different methods, tools, techniques and come up with different conclusions. Some have discussed the volatility spillover in terms of methodology, some in terms of region, some in terms of the trade relations between countries, some in terms of time span (Lee, 2009; Korkmaz, Çevik and Atukeren, 2012; Louzis, 2015; Syriopoulos, Makram and Boubaker, 2015; Shu and Chang, 2019). Yilmaz (2010) used the volatility spillover index on the East Asian countries and concluded that return and volatility have different behaviors over time. Volatility spillover effect from Chinese stock market to emerging seven and global seven stock markets of the world by employing the generalized vector autoregressive model throughout 1995 to 2015 and they are in the view that there is a strong evidence of volatility spillover from Chinese stock exchange to other stock markets especially which are geographically in the same region (Uludag and Khurshid, 2019),

In addition, Barunik, Kocenda and Vacha (2016) have examined volatility spillover on the stock market of the United States by using the seven most liquid sectors and they have found that different sectors are influenced due to spillovers over time. Kurshid and Uludag (2017) have examined volatility spillover among different Balkan stock markets and oil markets by using a dataset over the period

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of 2000 to 2016 and concluded that there are significant volatility spillovers among Balkan stock markets and oil market. Louzis (2015) examined the volatility spillovers among foreign exchange market, bond market and different markets of the world by using Diebold and Yilmaz approach and they found significant volatility spillovers. Hammoudeh, Yuan and McAleer (2009) have applied VAR(1)–GARCH(1,1) model on three sectors of the four economies of Gulf Cooperation Council and they are in view that past volatilities are more important than past shocks.

Some studies have also addressed volatility spillover during the global financial crisis (Dufrenot and Keddad, 2014; Akca and Ozturk, 2016). Moreover, Zhou, Zhang and Zhang (2012) have also used volatility spillover index by Diebold and Yilmaz on Chinese and some world stock markets and they found that there is a positive impact of volatility of Chinese stock market on other stock markets during the subprime crisis.Barunik and Vacha (2013) have inspected the impact of global financial crisis by employing the wavelet approach on central and eastern European stock markets and the study found a significant impact of global financial crisis on these stock markets of European countries. Similarly, Sugimoto, Matsuki and Yoshida (2014) also have discussed the GFC and European sovereign debt crisis by using Diebold and Yilmaz model. They have also investigated European and African markets and they concluded that African stock markets were affected severely during global financial crisis.

Most recently, Gulzar, Kayani, Xiaofeng, Ayub and Rafique (2019) conducted a study to examine the volatility spillover effect from global crisis by focusing the emerging Asian stock markets and they applied GARCH-BEKK model. They divided the crisis in three phases and they concluded that there are significant spillovers towards the selected stock exchanges during the global financial crisis. Abdeelkefi and Khoufi (2015) have applied bivariate BEKK GARCH and DCC model to investigate the volatility spillover during the Global Financial Crisis by distributing it into three stages and found the volatility spillovers between the concerned variables. The above discussed literature highlights that volatility spillovers during the global financial crisis have been studied in different ways. The previous studies have discussed different methodologies, approaches, techniques and regions. Therefore, this study aims to study the volatility spillover from US to emerging seven stock markets during global financial crisis.

3. Methodology

In this study we have considered leading seven emerging markets and USA. The emerging markets are Brazil, China, India, Indonesia, Mexico, Russia and Turkey. The daily closing price of their respective stock market indices has been considered. The stock market indices of E7 are BOVESPA (Brazil), S and P BSE 100 (India), IPC BOLSA (Mexico), JSX Composite (Indonesia), Shanghai Composite index (China), RTS (Russia) and BIST 100 (Turkey). Data is collected from Thomson Reuters Eikon Data Stream. To conduct the analysis and investigate the volatility spillover effect from USA stock market to Emerging Seven Stock markets, Pre and Post GFC, data has been divided into two sub-samples in accordance with recent studies (Louzis, 2015; Akca and Ozturk, 2016). The pre-GFC sub sample data ranges from January 8, 2002 to June 29, 2007 and Post GFC data starts from July 4, 2009 to December 28, 2014. Any missing data has been excluded.

Authors have used a variety of methods to capture the volatility spillover effects on the stock markets notably VAR, ARCH-GARCH, EGARCH, and MGARCH (Nazlioglu, Erdem & Soytas, 2013; Drachal, 2017; Abdulkarim, Akinlaso, Hamid & Ali, 2020). To find out the linear interdependence on the multiple time series, VAR is commonly employed. It is applied to calculate the mean equation of the subsamples and full sample.

In this study, we have applied VAR-GARCH (1, 1) model which basically captures the transmission of volatility spillover effect from the USA to the E7 markets. This model was constructed on the base of CCC-GARCH model which is a combination of multivariate GARCH and VAR model (Bollerslev, 1990). However, certain other statistical measures are also available in existing literature such as; DCC GARCH (Dynamic Conditional Correlation Generalize Autoregressive Hetroscadicticty Model) perhaps, the aforesaid tool does not combine multivariate GARCH process and a VAR model as well. Moreover, the VAR-GARCH model is advantageous due to several grounds, formally, the said technique is estimated with lesser model parameters. Prominently, the aforesaid estimation allows the multiple cross series effects while seeking spillover. Finally, the VAR-GARCH model inheritably avoids complicity while tendering the extent of unknown parameters.

The significance of VAR-GARCH model can be observed by exploring the conditional volatility and conditional correlation cross effects. It is used to estimate meaningful results and parameters. This model is useful to measure the effect of past shocks. Furthermore, this model restricts and overcomes the computational problems of unknown parameters. The VAR-GARCH was applied in many studies to capture cross-market volatility in different stock markets (Arouri et al, 2011; Mensi et al, 2014).

The following equations are used to measure mean and conditional variance for the return:

$$R_t = \mu + \Phi R_{t-1} + \varepsilon_t \tag{1}$$

$$\varepsilon_t = H_t^{1/2} \eta_t \tag{2}$$

In the equations (1) and (2), R_t exhibits returns of the index, ε_t shows the error term, η_t means the random vectors and H_t is the conditional variance

$$h_{it} = \omega_i + \sum_{j=1}^{r} \alpha_{ij} \varepsilon_{i,t-j}^2 + \sum_{j=1}^{s} \beta_{ij} h_{i,t-j} \tag{3}$$

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In the equation (3), α_{ij} shows ARCH term and β_{ij} reflects GARCH term.

The CC matrix is defined as $\Gamma = D_t^{-1} Q_t D_t^{-1}$, and each CCC is constructed from the standardized residuals. For the interdependencies, Ling and McAleer (2003) provided a VARMA specification of the conditional mean and conditional variance:

$$H_t = W + \sum_{i=1}^{r} A_i \vec{\varepsilon}_{t-i} + \sum_{j=1}^{s} B_j H_{t-j} \tag{4}$$

$$h_t^{E7} = C_{E7} + \alpha_{E7}(\varepsilon_{t-1}^{E7})^2 + \beta_{E7} h_{t-1}^{E7} + \alpha_{G7}(\varepsilon_{t-1}^{US})^2 + \beta_{G7} h_{t-1}^{US} \tag{5}$$

$$h_t^{US} = C_{US} + \alpha_{G7}(\varepsilon_{t-1}^{US})^2 + \beta_{G7} h_{t-1}^{US} + \alpha_{E7}(\varepsilon_{t-1}^{E7})^2 + \beta_{E7} h_{t-1}^{E7} \tag{6}$$

These equations represent the transmission of volatility from one stock exchange to other stock exchange. The error terms represent the shock transmission in returns at time (t-1). The volatility is ascertained by h_{t-1}^{US} and h_{t-1}^{E7}. To detect the stationarity of the sample data, the equation [I_2-AL-BL] = 0 must be outside the unit circle.

To calculate conditional covariance the following equation is used.

$$h_t^{E7,\ US} = \rho \times \sqrt{h_t^{E7} \times h_t^{US}} \tag{7}$$

In equation (7) , ρ provides coefficient of conditional correlation

The model provides conditional mean and volatility among E7 and US stock exchanges to measure the volatility spillover. The lag algorithm BFGS (1970) likelihood function L was applied for a sample of T observations.

$$L = \sum_{t=1}^{T} L_t\,, \quad L_t = \log(2\pi)n/2 - 1/2\log|H_t| - 1/2\varepsilon_t^{'} H_t^{-1}\varepsilon_t \tag{8}$$

4. Empirical Results

The descriptive analysis exhibits that returns of emerging seven stock markets and US stock market in Table 1. The table shows that stock returns of emerging markets are greater than the US stock market and the standard deviations of the emerging seven markets are also high that indicates these markets are more volatile and riskier than the US stock market.

Table 1: Descriptive Statistics for E7 and US Countries

Country	US	Brazil	China	India	Indonesia	Mexico	Russia	Turkey
Mean	0.0002	0.0009	0.0003	0.0010	0.0013	0.0010	0.0012	0.0010
Std. Dev.	0.0145	0.0211	0.0195	0.0177	0.0177	0.0158	0.0277	0.0229
Min	-0.1287	-0.1709	-0.1068	-0.1125	-0.1198	-0.1502	-0.3260	-0.3260
Max	0.0985	0.1159	0.1382	0.1713	0.1495	0.1068	0.3434	0.3434
# of Obs	2005	2005	2005	2005	2005	2005	2005	2005

The results of before GFC from January 8, 2002 to June 29, 2007 are given in Table 2 that represents that the returns of US stock market affect current returns of emerging seven markets except the stock returns of Indian and Mexican stock markets. The Table also mentions that emerging seven stock markets have a significant impact on the returns of US stock market except the stock exchange of Brazil and Mexico.

Furthermore, the variance equation shows that the coefficients are significant and there are bidirectional volatility spillovers between the US and emerging seven stock exchanges except the Mexican stock exchange. In addition, the study finds the significant impact of past shocks of US on the returns of E7 stock markets. Similarly, the past shocks of the Chinese, Indonesian Brazilian and Turkish stock markets affect the returns of US stock market. The table also indicates that CCC are positive which shows that the US and E7 stock markets move in the same direction.

Table 3 highlights the post period, July 4, 2009 to December 28, 2014, estimation of the VAR-GARCH model. According to the results of the VAR-GARCH model, the returns of US only affect the stock market of China and Mexico among the emerging seven stock markets which is an indication to predict the returns of these markets. On the contrary, returns of emerging seven stock markets exhibit a significant effect on the US stock market. The ARCH and GARCH coefficients are found statistically significant at various levels of 0%, 5% and 10%. The ARCH and GARCH coefficients measure the shock and volatility persistence and the outcomes of the study found the significant shock transmission in volatility from US stock market to the stock markets of Russia, Mexico and China. The results also indicate that these past shocks lead to increase the stock market volatility in emerging stock exchanges. The outcomes of the VAR-GARCH model also found significant past conditional volatility of US stock market, h_{t-1}^{US}, only for stock exchange of China which indicates that the Chinese stock market is influenced through the past volatility of US stock market. On the other side, the volatility cross effects transmit from most of the emerging seven stock exchanges to US stock exchange.

The table also provides the constant conditional correlation among emerging seven stock exchanges and US stock market. According to the table, there is a positive correlation between US and E7 markets. The table shows that there is high correlation between the US market and the Mexican stock market (0.750) and the second-highest correlation was observed between US and Brazilian stock exchanges (0.727). The high constant conditional correlations between US and emerging stock markets indicate that emerging seven stock markets observed high integration with US stock market. The results also mention that there are limited diversification opportunities for investors during the crisis. However, the results show that investors may get diversification opportunities by investing in the Chinese and Indonesian stock markets. The study reveals that there exists bidirectional volatility spillover before and after the GFC but high conditional correlations was experienced during the global financial crisis.

Table 2: Outcomes of VAR (1)-GARCH (1) model (Before GFC period)

	Brazil		China		India		Indonesia		Mexico		Russia		Turkey	
Mean Eq	US	Brazil	US	China	US	India	US	Indo	US	Mexico	US	Russia	US	Turkey
US (1)	-0.070* *(0.054)*	-0.024** *(0.035)*	-0.083*** *(0.000)*	0.010* *(0.080)*	-0.076** *(0.031)*	-0.003 *(0.857)*	-0.070*** *(0.000)*	-0.059*** *(0.000)*	-0.070* *(0.055)*	-0.012 *(0.611)*	-0.062*** *(0.000)*	-0.026*** *(0.000)*	-0.030 *(0.311)*	-0.025** *(0.041)*
E7(1)	-0.027 *(0.704)*	-0.030 *(0.359)*	0.032*** *(0.001)*	-0.019 *(0.565)*	0.151*** *(0.000)*	0.080** *(0.017)*	0.307*** *(0.000)*	0.134*** *(0.000)*	0.047 *(0.248)*	0.012 *(0.743)*	0.296*** *(0.000)*	0.041*** *(0.000)*	0.443*** *(0.000)*	-0.031 *(0.311)*
Variance Equation														
C (10) [4]	-0.324*** *(0.000)*	0.255*** *(0.000)*	0.175*** *(0.000)*	1.164*** *(0.000)*	0.0231*** *(0.002)*	0.274*** *(0.000)*	0.028*** *(0.000)*	0.067*** *(0.000)*	0.042** *(0.047)*	0.345*** *(0.001)*	0.544*** *(0.000)*	2.145*** *(0.000)*	-0.924 *(0.118)*	0.116*** *(0.007)*
$(\varepsilon_{t-1}^{US})^2$	0.045*** *(0.000)*	-0.009*** *(0.000)*	0.113*** *(0.000)*	0.025*** *(0.000)*	0.047*** *(0.000)*	*0.007*** *(0.029)*	0.283*** *(0.000)*	0.030*** *(0.000)*	0.051*** *(0.000)*	*0.004* *(0.560)*	0.105*** *(0.000)*	-0.004*** *(0.000)*	-0.017 *(0.234)*	-0.0005 *(0.727)*
$(\varepsilon_{t-1}^{E7})^2$	0.184*** *(0.000)*	-0.004 *(0.192)*	-0.028*** *(0.000)*	0.144*** *(0.000)*	0.004 *(0.682)*	0.181*** *(0.000)*	0.203*** *(0.000)*	0.199*** *(0.000)*	-0.026 *(0.222)*	0.148*** *(0.000)*	0.013 *(0.410)*	0.079*** *(0.000)*	0.828*** *(0.004)*	0.021 *(0.248)*
h_{t-1}^{US}	0.740*** *(0.000)*	0.151*** *(0.000)*	0.855****(0.* *000)*	-0.071*** *(0.000)*	0.941*** *(0.000)*	-0.011** *(0.025)*	0.713*** *(0.000)*	-0.103*** *(0.000)*	0.938*** *(0.000)*	-0.016 *(0.315)*	0.477*** *(0.000)*	-0.015*** *(0.000)*	0.758*** *(0.000)*	0.066** *(0.026)*
h_{t-1}^{E7}	-0.085*** *(0.009)*	0.913*** *(0.000)*	-0.087*** *(0.000)*	0.488*** *(0.000)*	-0.040** *(0.038)*	0.727*** *(0.000)*	-0.131*** *(0.000)*	0.433*** *(0.000)*	0.032 *(0.331)*	0.658*** *(0.000)*	-0.092*** *(0.000)*	0.441*** *(0.000)*	1.710*** *(0.000)*	0.283** *(0.042)*
CCC US and E7	0.616*** *(0.000)*		0.109*** *(0.000)*		0.204*** *(0.000)*		0.204*** *(0.000)*		0.652*** *(0.000)*		0.202*** *(0.000)*		0.194*** *(0.000)*	
Log Like	6306.87		5229.43		6123.72		6129.31		6458.76		5639.53		5644.31	
AIC	13.486		13.419		13.588		13.798		13.351		13.067		13.832	
H-Q	13.482		13.416		13.577		13.779		13.342		13.056		13.801	

*Note: The p values are given in parentheses. ***. ** and * denote coefficients are significant at 1%. 5% and 10% level respectively*

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	Brazil		China		India		Indonesia		Mexico		Russia		Turkey	
Mean Eq	US	Brazil	US	China	US	India	US	Indo	US	Mexico	US	Russia	US	Turkey
US (1)	-0.110** *(0.013)*	0.013 *(0.680)*	-0.084** *(0.012)*	0.047*** *(0.000)*	-0.084** *(0.021)*	-0.003 *(0.898)*	-0.074** *(0.049)*	-0.039 *(0.138)*	-0.204*** *(0.000)*	0.107*** *(0.002)*	-0.118*** *(0.001)*	0.018 *(0.350)*	-0.092** *(0.017)*	-0.005 *(0.825)*
E7(1)	0.057 *(0.335)*	-0.040 *(0.352)*	0.250*** *(0.000)*	-0.021 *(0.439)*	0.354*** *(0.000)*	-0.027 *(0.389)*	0.368*** *(0.000)*	-0.076** *(0.028)*	-0.090*** *(0.000)*	0.057 *(0.125)*	0.353*** *(0.000)*	-0.024 *(0.515)*	0.201*** *(0.000)*	-0.057 *(0.115)*
Variance Equation														
C (10) [4]	0.061*** *(0.003)*	0.114*** *(0.000)*	0.063*** *(0.000)*	0.017** *(0.013)*	0.056*** *(0.000)*	0.051*** *(0.001)*	0.063*** *(0.000)*	0.010 *(0.644)*	0.102*** *(0.000)*	-0.171*** *(0.000)*	0.051*** *(0.000)*	0.090** *(0.013)*	0.067*** *(0.003)*	0.119*** *(0.003)*
$(\varepsilon_{t-1}^{US})^2$	0.092*** *(0.000)*	0.011 *(0.263)*	0.117*** *(0.000)*	-0.012*** *(0.000)*	0.099*** *(0.000)*	*0.005* *(0.540)*	0.115*** *(0.000)*	*-0.009* *(0.126)*	0.073*** *(0.000)*	0.028*** *(0.000)*	0.095*** *(0.000)*	*0.006** *(0.099)*	0.094*** *(0.000)*	*0.008* *(0.261)*
$(\varepsilon_{t-1}^{E7})^2$	0.087*** *(0.004)*	0.053*** *(0.006)*	0.013** *(0.030)*	0.024*** *(0.000)*	0.059*** *(0.002)*	0.066*** *(0.000)*	0.016 *(0.210)*	0.180*** *(0.000)*	-0.079*** *(0.000)*	0.110*** *(0.000)*	0.109*** *(0.000)*	0.090*** *(0.000)*	0.066** *(0.016)*	0.059*** *(0.003)*
h_{t-1}^{US}	0.833*** *(0.000)*	0.018 *(0.335)*	0.848*** *(0.000)*	0.019*** *(0.000)*	0.871*** *(0.000)*	0.004 *(0.991)*	0.856*** *(0.000)*	0.012 *(0.162)*	0.848*** *(0.000)*	-0.001 *(0.804)*	0.881*** *(0.000)*	-0.004 *(0.371)*	0.874*** *(0.000)*	-0.005 *(0.706)*
h_{t-1}^{E7}	-0.154** *(0.011)*	0.960*** *(0.000)*	-0.014** *(0.039)*	0.970*** *(0.000)*	-0.061** *(0.023)*	0.923*** *(0.000)*	0.024 *(0.353)*	0.814*** *(0.000)*	0.603*** *(0.000)*	0.455*** *(0.000)*	-0.096** *(0.028)*	0.900*** *(0.000)*	-0.053 *(0.165)*	0.907*** *(0.000)*
CCC US and E7	0.727*** *(0.000)*		0.133*** *(0.000)*		0.325*** *(0.000)*		0.290*** *(0.000)*		0.750*** *(0.000)*		0.516*** *(0.000)*		0.472*** *(0.000)*	
Log Like	5714.02		5368.92		5516.16		5588.91		6042.60		5289.51		5437.87	
AIC	10.871		10.198		10.411		10.478		11.462		9.634		10.420	
H-Q	10.842		10.173		10.366		10.442		11.432		9.606		10.401	

Table 3: Estimates of VAR (1)-GARCH (1) model for US and E7 (After Global Financial Crisis period)

*Note: The p values are given in parentheses. ***. ** and * denote coefficients are significant at 1%. 5% and 10% level respectively.*

The table also provides the constant conditional correlation among emerging seven stock exchanges and US stock market. According to the table, there is a positive correlation between US and E7 markets. The table shows that there is high correlation between the US market and the Mexican stock market (0.750) and the second-highest correlation was observed between US and Brazilian stock exchanges (0.727). The high constant conditional correlations between US and emerging stock markets indicate that emerging seven stock markets observed high integration with US stock market. The results also mention that there are limited diversification opportunities for investors during the crisis. However, the results show that investors may get diversification opportunities by investing in the Chinese and Indonesian stock markets. The study reveals that there exists bidirectional volatility spillover before and after the GFC but high conditional correlations was experienced during the global financial crisis.

5. Conclusion

In this study, we investigated the volatility spillover effect from USA capital market to E7 capital markets by focusing the financial crisis of 2007-2009. The VAR–GARCH model has been applied to analyze the volatility transmission. The model concludes that post GFC shocks in USA affected the stock returns of Mexican, Chinese and Russian stock exchanges (Liow, 2015). Moreover, CCC have increased significantly among the US and Brazil, Mexican and Russian markets. This signifies that diversification strategies in these emerging markets are limited in their scope and benefits due to their strong financial integration with the USA stock markets. Moreover, a slight increase in CCC of Chinese Market is experienced after the GFC. This made the Chinese markets much more attractive with respect to portfolio diversification opportunities during the GFC.

Overall, the results indicate the significant volatility spillover effect between USA and E7 markets and if the markets are in the same geographical region then the correlation or financial integration between the markets increases. Among the Emerging Seven markets, India, China and Indonesia are partially integrated with the USA capital markets. This gives these emerging markets scale of immunity against the spillover effects of US markets. Gulzar et al., (2019) found the contradictory evidence in their study regarding China, Indonesia and India being less susceptible to volatility spillover from US stock markets.

Moreover, Brazilian and Mexican stock exchanges are highly correlated with the USA. The main reason is due to the same geographic area and amount of trade with these countries. Since both Brazil and Mexico are just right across the USA, hence they are more vulnerable to the amount of risks of US stock markets. Moreover, Mexico and Brazil also enjoy great trading relations with the USA. They are ranked third and twelfth respectively as trading partners to USA. These results have significant implications for the investors, portfolio managers and policy makers. The magnitude of correlation can allow investors and portfolio managers to manage and build an optimal portfolio. This result and knowledge also assist portfolio managers in estimating and predicting the stock return volatility. The

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financial integration between the markets and transmission of volatility spillover accordingly changes the diversification strategies while forming optimal portfolios.

Furthermore, the results suggest that stock markets in the same geographic region are more connected or integrated. Similarly, the trade volume also affects the correlation between the stock markets and hence volatility spillover. It is also worth mentioning the fact that in same region markets where cross market spillovers exist, it would be tricky for portfolio managers to gauge transitional risk factors such as; economic and market-based, separately. Finally, it is suggested that in the international arena where structural and volatility transmission spillovers are observed, an investor must consider long-term price relationship and multiple volatility spillover effect simultaneously while building optimal portfolios.

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