Lampiran Korespondensi Proses Submit Publikasi Internasional

Judul Makalah: *"Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets"*
Nama Jurnal : **Journal of International Studies (JoIS)**
Reputasi : Terindeks Scopus – Q3

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Proses Korespondensi disajikan berikut ini:

1. Submission Letter, Selasa 18 September 2018, 9:30 AM (pagi)

Kepada: editor@jois.eu
Judul: Manuscript Submission
Selasa, 18 September 2018

Dear Editor in Chief, Journal of International Studies (JoIS)

We have read the information about the journal editorial from http://www.jois.eu/?en_home,26. Hence, we are interested to submit our paper to Journal of International Studies (JoIS). For that, we would like to send the manuscripts with the hope to be published in the journal:

1. Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets

We are waiting for further information.

Thank you

Best regards,
Najmudin

2. Jawaban: desk review, Rabu, 19 September, 2018, 02.08

Journal of International Studies <subjois@gmail.com>
Kepada:Najmudin M.Si
19 Sep jam 02.08

Dear Authors
confirm
I sent your paper for desk-review
--
dr hab. prof. US Yuriy Bilan,
University of Szczecin,
Faculty of Economics Science and Management,
Microeconomics Department, http://mikroekonomia.net/yuriy-bilan
Editor-in-Chief, Journal of International Studies (SCOPUS)
www.jois.eu

3. Email kedua, Selasa 19 September 2018, 10:00 (pagi)

Kepada: "Journal of International Studies" <subjois@gmail.com>
Judul: Re: manuscript submission

Dear Editor-in-Chief, Journal of International Studies (SCOPUS)
Thank you very much for your quickly confirmation.
We agree to your decision and will follow the process.
Thank you

Best regards,
Najmudin

4. Desk Review Result, Jumat, 21 September, 2018, 18.36

Journal of International Studies <subjois@gmail.com>
Kepada:Najmudin M.Si

Dear Authors

The text N619 is presented has been carefully considered by the in-house general reviewer responsible for the next issue placement.
We could accept your paper for review (5-6 months)

The fee is 580 Euros. It has to be paid after submitted paper is reviewed and accepted for publishing.

--
dr hab. prof. US Yuriy Bilan,
University of Szczecin,
Faculty of Economics Science and Management,
Microeconomics Department, http://mikroekonomia.net/yuriy-bilan
Editor-in-Chief, Journal of International Studies (SCOPUS)
www.jois.eu

5. RE: Desk review Result, Email ketiga, Jumat 21 September 2018

Kepada: "Journal of International Studies" <subjois@gmail.com>
Judul: Re: manuscript submission

Dear Editor-in-Chief, Journal of International Studies (SCOPUS)
OK. We agree the next process to review the paper N619.
We will to pay the publication fee 580 Euros after we receive acceptance information for publishing.

Thank you
Best regards,
Najmudin

6. Reviewer comments #1, Jawaban: Sabtu, 13 Oktober, 2018, 14.42

Journal of International Studies <subjois@gmail.com>
Kepada:Najmudin M.Si

Dear Authors,

please find attached the review

reference APA style

proofreading is needed,

Once ready, please, provide the final version in two formats - "clean" final and also the one with tracked changes in editing mode where all necessary changes are visible till the end of November

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Editor-in-Chief, Journal of International Studies (SCOPUS)
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REVIEW FORM

PART A: Editorial Office Only

SECTION I

Reviewer's Name:	
E-mail:	
Manuscript Number:	
Title:	Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets
Date Sent To Reviewer:	
Date Expected From Reviewer:	

PART B: Reviewer Only

SECTION II: Comments (Please give your critical comment for the deficiencies of each section of the manuscript).

General comment:	This paper explained volatility transmitted from world market to ten Asian and Eastern Europe stock markets and from major stock market in the region to the rest stock markets by considering their degree of integrations
Introduction:	Focus more on the objective of the paper, the importance of your study and results. Why did you choose countries from Asia and from Eastern Europe?
Methodology:	Specify the limits and the advantages of the methods.
Results:	Provide more economic comments on results and possible recommendations.
Discussion:	Interpretations of the results are not enough and a more critical position is required.
Bibliography/References:	
Other remarks:	The language could be improved.

Decision:	

SECTION III: Please rate the following: ***(1 = Excellent) (2 = Good) (3 = Fair) (4 = Poor).***

Originality:	**3**
Contribution to the Field:	**3**
Technical Quality:	**3**
Clarity of Presentation:	**3**
Depth of Research:	3

SECTION IV: Recommendation: (*Kindly Mark with an X*).

Accept **(if not, please, tick "X" in the appropriate box below)**	
Requires Minor Corrections:	
Requires Moderate Revision:	**X**
Requires Major Revision:	
Submit to another publication/journal such as:	
Reject (Please be Specific):	

SECTION V: Additional Comments (Please make suggestions to the authors).

Muharam, H., Wisnu, M., Arfinto, E. D., Najmudin. (2018). Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets. *Journal of International Studies, 11*(4), 277-293. doi:10.14254/2071-8330.2018……..

Journal of International Studies

Scientific Papers

Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets

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Abstract. This research aims to investigate volatility transmitted from world market to ten Asian and Eastern Europe stock markets and from major stock market in the region to the rest stock markets by considering their degree of integrations. To assess this purpose, we apply GARCH(p,q) model and involve the dynamic conditional correlation (DCC) model to generate the dynamic degree of integration. The monthly market indices data, over period from May 2002 to March 2018, are taken from eleven markets which consist of five Asian (China, Indonesia Malaysia, Pakistan, and Philippines), five Eastern Europe (Czech Republic, Poland, Romania, Russia, and Ukraine), and world markets. Furthermore, the volatility spillover was analyzed during the global financial crisis for period of 01:05:2008-29:05:2009. The finding shows that volatility spillovers from world and regional major markets to domestic stock markets are conditional on the degree of integrations. Specifically, there is no volatility spillover from world and regional major markets on segmented stock markets. In contrast, domestic stock markets which are integrated could experience in volatility

Received: September, 2018
1st Revision: October, 2018
Accepted: November, 2018

DOI: 10.14254/2071-8330.2018/……..

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spillover. Moreover, this finding exists in the crisis circumstance and overall period.

Keywords: volatility spillover, dynamic integration, GARCH model.

JEL Classification: F36, G15, C10

1. INTRODUCTION

Prior researches have investigated the integration among stock market classes or among stock market types, for instances between developed and developing stock markets or between conventional and Islamic stock markets (Al Nasser & Hajilee, 2016; Majdoub, Mansour, & Jouini, 2016). Nevertheless, the integration of the stock markets toward international market has not been revealed yet. Similarly, volatility spillover as an effect of integration discussed on the prior researches was analyzed only among countries bilaterally, e.g. the volatility is transmitted from a particular developed country to an emerging country (Neaime, 2012). However, the susceptible strength to volatility spillover from international market has not been disclosed yet. This paper expands both issues focusing on the causality of volatilities from world market to domestic markets through the explanation involving the market integration aspect. It refers to the international portfolio diversification framework which states that the financial assets comovement among stock markets has an important part in volatility change.

Furthermore, the existing studies examining on the presence of volatility spillover have controversial findings. On the one side, some studies conclude that there are volatility spillovers on stock markets, among others Dungey, Fry, González-Hermosillo, and Martin (2007); Rejeb and Boughrara (2015). On the other side, another study finds no evidence of volatility spillover (Majdoub & Mansour, 2014). In addition, Gebka and Serwa (2007) state that there is different evidence on volatility spillover among emerging stock markets in Latin America, East Asia and Eastern Europe. It is likely that the existing studies ignore the degree of integration among markets observed so that the findings of volatility spillover have dissimilar conclusion. This argument is supported by statement of Jebran, Chen, Ullah, and Mirza (2017). They acknowledge that the stock markets will be more vulnerable or contaminated by volatility from the other markets when they are integrated.

Some studies have discussed the transmission of volatility accompanied by the degree of financial integration simultaneously. For instance, Rejeb and Arfaoui (2016) argue that in the last decade, a number of studies have focused on analyzing the transmission of volatility among emerging markets with respect to the degree of financial integration after their liberalization process. Their statement confirms the opinion of Phylaktis and Ravazzolo (2002) and Bekaert and Harvey (1995) that financial liberalization makes financial markets more integrated into global financial movements and thus more sensitive to external shocks. The propagation of volatility is the consequence of financial interdependence across markets.

Although financial globalization and trade integration have enabled emerging countries to attain risk-sharing through better allocations of capital and thereby higher economic development, they also produced unwanted side-effects, including increased financial fragility and unstable long-

term growth. As emerging markets develop further and exhibit higher comovement with the mature markets, they automatically become more responsive to the volatility of stock markets elsewhere in the world. The detailed assessments of the level and the nature of financial integration among stock markets are thus necessary. Such analysis can shed light on the source of shock spillover across markets (Balli, Hajhoj, Basher, & Ghassan, 2015). Accordingly, we expect that the event of volatility spillover may occur only for the stock markets which have higher integration with world market and the major stock market in the region such as China in Asian or Russia in Eastern Europe stock markets.

To solve the issue, this paper contributes in the four ways related to the expansion in subject of analysis and analytical procedure. The first is variation in the degree of integration that links the world market index movement to the returns of each stock market for different regional markets. The second is variation in the volatility spillover that connects world market volatility to the volatility of each stock market for different regional markets. The third, this paper provides explanation on dissimilar findings of existing studies which attempts to investigate dynamic volatilities for emerging markets by considering their integration level toward world market. Moreover, this paper contributes on the existing literature by employing the recent data and comparing to the crisis circumstance. The finding of this paper has valuable information for international investors and policy makers on consequence of integrated domestic market. It could make their decision more efficient and effective in anticipating the events among stock markets.

The higher integration of international stock markets and correlated stock prices volatility would weaken the international portfolio diversification (Bekaert, Harvey, & Ng, 2005). The integration of a stock market to the global market is urgent to be disclosed because otherwise it would limit the opportunities for investors to benefit from their portfolio diversification and reduce the chances for a number of firms to obtain a lower cost of capital. Moreover, side-effect of the higher integration could generate the financial disturbances and shocks in a stock market. For instance, the global financial crisis overspreads and suppresses emerging stock markets and makes a rapid decline in the prices (Neaime, 2012).

The empirical study on volatility spillover from the global market to a stock market is an important aspect from the particular perspective of portfolio diversification and hedging strategies (Majdoub & Mansour, 2014). Understanding the volatility across markets is crucial to risk managers, decision makers, and hedgers, especially volatility due to the financial crisis. Studying spillover volatility has direct implication in designing optimal portfolios and building policies to prevent harmful shock transmission and to limit the propagation of financial crises across borders (BenSaïda, Litimi, & Abdallah, 2018). In addition, the advancement of analytical methods is necessary because of the consideration that risk premiums on equity, spillover volatility, and financial integration processes change over time due to the dynamic development of changing economic and business factors over time (Bekaert & Harvey, 1995; Kearney & Lucey, 2004).

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2. LITERATURE REVIEW

There is a wide variety of literature on stock market integration and volatilty across markets. Some studies have discussed only returns spillover, while some other studies have looked at both the first and the second moments of equity prices to discuss the cross-border spillover. We

investigate, as the second category of the studies, the volatility spillover from international market and the major stock markets regionally to emerging stock markets by considering their dynamic integrations. The literature provides diverse definitions of financial integration. According to the law of one price, Chen and Knez (1995) define integrated markets as markets where investors can, in one country, buy and sell without restriction equities that are issued in another country and as a result, identical securities are issued and traded at the same price across markets after adjustment for foreign exchange rates.

Stock market integration is the situations where markets have higher and stable relationship due to their stock prices move together in similar period and direction. It could be defined as a unification of a number of separate stock markets operationally in the mechanisms, activities, characteristics of the instruments and interactions of the participants. The markets in which its assets require the same expected returns regardless of its trading location are said to be integrated. While the markets where the expected returns of an asset depends on its location are said to be segmented (Arouri, Nguyen, & Pukthuanthong, 2012; Bekaert & Harvey, 2003).

Attention to stock market integration arises mainly because of financial theory which states that integrated stock markets will be more efficient than segmented stock markets. When the stock market was integrated, investors from all countries will be able to allocate their capital to the most productive locations. With more flow of cross-border funds, additional trade in any securities may increase the liquidity of stock market. In addition, it could make the cost of capital to fall on companies that are looking for capital and make the transaction costs incurred by investors to be lower. It indicates a more efficient capital allocation (Click & Plummer, 2005).

Financial markets in most developed countries have grown rapidly over the past decade due to various factors such as deregulation, globalization and advances in information technology. There are no restrictions such as regulatory restrictions, transaction costs, taxes, and tariffs on foreign asset trading or portfolio equity flow mobility. The integration of financial markets around the world also appears to grow among them (Marashdeh dan Shrestha, 2010). In recent years, most of studies found that stock markets observed had higher integration level, for instance between Germany and emerging markets (Al Nasser & Hajilee, 2016) and among Malaysia, Indonesia, and Turkey stock markets (Arshad, 2017). Employing international CAPM method, Najmudin, Syarif, Wahyudi, and Muharam (2017) find that there is higher integration on the UK, Japan, Malaysia, Thailand, Indonesia, and Singapore stock markets.

Return volatility in economics and finance field reflects the degree of variation for the returns of a financial asset such as stock, market index, or exchange rate. The standard deviation and variance of returns are the most common measures of volatility returns. The standard deviation is used in studies which assume that volatility is constant time-series, whereas dynamic conditional variance or residual is used in studies which assume that volatility varies over time. Financial assets that have higher volatility indicate that the assets have higher risk (Kočenda, 2017). Economic and especially financial time series are prone to exhibit periods of high and low volatility. Therefore, it is often misleading to measure volatility by a static standard deviation or unconditional variance. However, exactly such pattern can be modelled using conditional heteroskedastic disturbances. The solution to this problem can be found in the conditional heteroskedasticity models.

The studies on volatility in many stock markets had grown by expanding the issue of how volatility of return in a stock market is contagious and affects the volatility of return in another stock market, also known as volatility spillover. In other words, volatility spillover is a change in volatility of returns in one market because of the transmission of market-specific information from other markets. Cross market linkages in the conditional second moments of stock return is another important topic of international financial relations. In addition to various domestic and global factors, return volatility of major stock market is one of the important factors of stock return volatility in a stock market (Mukherjee & Mishra, 2010).

Volatility spillover has been examined by Ng (2000) who investigates the magnitude and changing characteristics from the US and Japan. The evidence suggests that the significant factors of market volatility are regional and international variables. Similarly, Dungey et al. (2007) report developed market has important role in transmitting volatility to emerging market and there is volatility spillover among regions. Furthermore, Rejeb and Boughrara (2015) conclude that there is a volatility transmission across financial markets; geographical proximity is essential factor in enlarging volatility transmission; and the liberalization contributes significantly in enlarging international volatility transmission. Applying GARCH model on India, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, and Thailand stock markets, Mukherjee and Mishra (2010) suggest that return spillovers between India and its Asian counterparts are found to be positively significant and bidirectional. Contemporaneous spillover of intraday volatility is stronger from other foreign markets to India. However, transmission of information lagged by one day is not found to be stronger.

A number of studies are still interested to examine on volatility spillover in the last years, Gencer and Hurata (2017); Jebran et al. (2017); Bajo-Rubio, Berke, and McMillan (2017), among others. Using multivariate BEKK-GARCH model, Gencer and Hurata (2017) conclude that there is a significant shock and volatility transmission from the S&P 500 to the other stock markets while the opposite, from the others to the US, is also observed for some market-pairs under investigation. In similar conclusion, Jebran et al. (2017) report that there is bidirectional volatility spillover between stock market of India and Sri Lanka in both sub-periods. Employing the weekly data starting from 1999 until the 12th of March 2015, Bajo-Rubio et al. (2017) state that Spillovers are largely between the same asset classes over the dotcom period. After 2006, the extent of spillovers increases.

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3. METHODOLOGY

The data are obtained from the websites of stooq.com, msci.com, yahoo.finance.com, and the other relevant publications. The first data set covers stock market indices of China, Indonesia Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, Ukraine, and world markets. MSCI ACWI is used as a proxy for world market index. All data have the same time period from May 2002 to March 2018 on monthly basis. The second data set covers on daily basis during the global financial crisis for period of 01:05:2008-29:05:2009.

The data which consist of five Asian, five Eastern Europe, and world market indices are used to calculate the returns on each market and then used to find the dynamic conditional correlation (DCC) of returns among world market and the ten stock markets, and among a dominant stock market and

the four rests in the region. The return of time t for the sample of stock market index i ($R_{i,t}$) is the difference between the natural logarithm of the index price at the current time ($P_{i,t}$) and the natural logarithm of the index price at previous time (ln $P_{i,t-1}$). The formula is expressed as follows $R_{i,t} = \ln P_{i,t} - \ln P_{i,t-1}$.

The objectives of this research are specifically as follows. The first objective is to analyze the strength of a stock market as recipient against the volatility spillover from international and regional markets as senders. The second is to analyze the dynamic integration of each stock market in both Asian and Eastern European markets toward international and regional markets. The third is to analyze the existence of volatility spillover involving its explanation with the dynamic degree of integration.

To achieve the first objective we adopt the framework of Balli et al. (2015) as well as Mukherjee and Mishra (2010); Ng (2000); Bekaert and Harvey (1997) in working the volatility spillover models for the equity returns from the originator world market to the ten recipient stock markets. The effects of volatility spillover from major stock markets regionally, China in Asian markets and Russia in Eastern Europe markets, to the rest four stock markets are also taken into consideration to formulate their respective univariate AR-GARCH-M(p,q) models.

The volatility of stock return series is time varying so that this paper examines the spillover of the conditional second moments across markets allowing for changing the variances. The generalized autoregressive conditional heteroscedasticity (GARCH) model proposed by Engle (1982) and developed by Bollerslev (1986) has been employed to account for the time-variant conditional variances (Mukherjee & Mishra, 2010). The mean and variance equations of ARCH(p) and GARCH(p,q) models respectively are generally expressed as follow:

Mean equation: $Y_t = c + \varepsilon_t, \varepsilon_t^2 \mid I_{t-1} \sim N(0, \sigma_t^2)$ (1)

Variance equations:

ARCH(p) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2$ (2)

GARCH(p,q) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \ldots + \lambda_q \sigma_{t-q}^2$ (3)

Where Y_t is the individual returns at time t, c is a specific mean, ε_t is the error term, I_t denotes the information available at time t and σ_t^2 is the conditional variance of the error term at time t and a function of both ε_{t-1}^2 (the squared error term in the previous time) and σ_{t-1}^2 (conditional variance in the previous time).

Our empirical approach to achieve the first objective comprises the following steps. The first step, we estimate the volatility of world market and major stock markets in each region as the senders, namely China in Asian markets and Russia in Eastern Europe markets. To obtain the return volatility for each world, China, and Russia market, respectively, as determinants of the rest eight stock markets volatilities, we perform volatility modeling steps by following the AR-GARCH(1,1) model. The mean equations of AR-GARCH(1,1) model for the three markets are expressed as follow:

$R_{WI,t} = \alpha + \beta_1 R_{W,t-1} + \varepsilon_t$ World (4)

$R_{CN,t} = \alpha + \beta_1 R_{CN,t-1} + \varepsilon_t$ China (5)

$R_{RS,t} = \alpha + \beta_1 R_{RS,t-1} + \varepsilon_t$ Russia (6)

Where $R_{WI,t}$, $R_{CN,t}$, and $R_{RS,t}$ are market returns of world market, China, and Russia stock markets at time t, respectively; and ε_t is error term at time t.

The second step, we estimate how the returns volatilities of the three sender markets are contagious and affect the returns volatility in another stock market as recipient. In order to investigate this volatility spillovers, we apply AR-GARCH-M(p,q) model. Unlike in simple GARCH model, the GARCH-M or GARCH-in-Mean model includes the conditional variance or its square root in the conditional mean equation along with other explanatory variables. Conditional variances or GARCH variance series resulted from estimations of AR-GARCH(1,1) model, as in Eqs. (4) – (6), are then used to estimate volatility series as inputs for AR-GARCH-M(p,q) model. The model is estimated using the maximum likelihood procedure applying the Berndt–Hall–Hall–Hausman (BHHH) algorithm.

The first equation, called as mean equation, of AR-GARCH-M(p,q) model for the recipient domestic stock market i is expressed as follows:

$$R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t. \quad (7)$$

The second equation, called as variance equation, is expressed as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{j,t}. \quad (8)$$

Where $R_{i,t}$ is returns of recipient domestic stock market i at time t; $\sigma_{i,t}$ is the square root of conditional variance on stock market i at time t; ε_t is error term at time t; $\sigma_{i,t}^2$ is the conditional variance of the error term at time t; ε_{t-p}^2 is the squared error term at time t-p; σ_{t-q}^2 is conditional variance at time t-q; and $V_{j,t}$ is volatilities of sender market j at time t.

To achieve the second objective we apply the DCC (dynamic conditional correlation) approach as developed by Engle (2002) and worked by Majdoub and Mansour (2014). We estimate the conditional relationship of returns among world market and ten selected stock markets. The principal advantage of this model is that while it retains the main features of standard GARCH models, it allows us to model explicitly time variation in the conditional covariance and correlation matrix.

DCC model can be described briefly as follows. In the DCC-GARCH(1,1) model, the conditional variance–covariance matrix is defined by $H_t = D_t R_t D_t$, where H_t takes the following formulation:

$$H_t = \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \begin{bmatrix} 1 & \rho_{12,t} \\ \rho_{21,t} & 1 \end{bmatrix} \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \quad (9)$$

D_t is a (n x n) diagonal matrix of time-varying standard deviations from univariate GARCH models with $(h_{ii,t})^{1/2}$ on the ith diagonal, i = 1, 2, …, n; R_t is the (n x n) time-varying correlation matrix and R_t is conditional correlation matrix:

$$R_t = (\text{diag}(Q_t)^{-1/2} Q_t (\text{diag}(Q_t))^{-1/2} \quad (10)$$

The evolution of the correlation in DCC model is given by:

$$Q_t = \bar{Q}(1 - \alpha - \beta) + \alpha \varepsilon_{t-1} \varepsilon'_{t-1} + \beta Q_{t-1} \quad (11)$$

Where $\bar{Q}$ is the unconditional correlation matrix of the epsilons; $Q_t = (q_{ii,t})$ is the (n x n) time-varying covariance matrix of ε_t; α and β are non-negative scalar parameters satisfying $(\alpha + \beta) < 1$.

In the empirical methodology, Arouri and Nguyen (2010) convey that conditional correlation coefficient ϱ_{ij} between two markets i and j at time t is then expressed by the following equation:

$$\rho_{ijt} = \frac{(1-\alpha-\beta)\bar{q}_{ij} + \alpha\mu_{i,t-1}\mu_{j,t-1} + \beta q_{i,t-1}}{\left((1-\alpha-\beta)\bar{q}_{ii} + \alpha\mu_{i,t-1}^2 + \beta q_{ii,t-1}\right)^{1/2}\left((1-\alpha-\beta)\bar{q}_{jj} + \alpha\mu_{j,t-1}^2 + \beta q_{jj,t-1}\right)^{1/2}} \quad (12)$$

Where q_{ij} refers to the element located in the *i*th row and *j*th column of the matrix Q_t.

DCC-GARCH model as described above is estimated using a two-stage procedure. In the first stage, a univariate GARCH(1,1) model is estimated for each return series included in the multivariate system. During the second stage, the transformed residuals from the first stage, namely the estimated residuals standardized by their conditional standard deviations, are used to infer the conditional correlation estimators.

The Log likelihood for this estimator can be expressed as:

$$L = -\frac{1}{2}\sum(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon_t) \quad (13)$$

To achieve the third objective we relate the patterns of volatility spillover across markets to the patterns of the degree of integration among those markets. This analysis could confirm the statement that a stock market which has higher comovement with the other stock markets would automatically become more responsive to the volatility of those stock markets. Therefore, in order to understand the patterns of volatility spillover across markets, it is necessary to assess the level and the nature of integration among those markets (Balli et al., 2015).

4. EMPIRICAL RESULTS AND DISCUSSION

We examine volatility spillover accros stock markets and the degree of markets integration by employing the data of market indices during period from May 2002 to March 2018 monthly totaling 191 observations and during sub-period from May 1, 2008 to May 29, 2009 on daily basis. We consider the stationarity pattern of data to analyze furthermore all variables and to draw an inference from statistical ways. To test the stationarity, we apply one of unit root methods, namely ADF (Augmented Dickey-Fuller) Test. According to unit root test, the result shows that stationer patterns in the level form appear on all observed market returns data. This conclusion prevails on the data for overall sample period (monthly) and for sub-sampel period of global financial crisis (daily). Therefore, it is not necessary to transform or differentiate the data of those eleven markets returns.

Commented [M4]: Describe more the dataset.

The variance equation of the AR-GARCH-M(p,q) model for this research is written in general as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p\, \varepsilon_{i,t-p}^2 + \lambda_q\, \sigma_{i,t-q}^2 + \Sigma\delta_n\, V_{i,t}.$$

The variance equation above becomes operational guidelines to interpret generally the volatililty transmission from one market to the volatility of another market. Table 1 contains the results of ten estimate models for each recipient stock market. These ten estimate models are the best fit regression models which are selected through iteration process from various models, such as ARCH(p,q), GARCH(p,q), ARCH-M(p,q), and GARCH-M(p,q).

The model specifications in variance equation using overall sample period for each ten recipient stock market are expressed as follow:

$\sigma_{CN,t}^2$ = ***28.129 + ***0.341 $\varepsilon_{CN,t-1}^2$ + **0.999 V_WI_t — China

$\sigma_{ID,t}^2$ = 7.132 + **0.278 $\varepsilon_{ID,t-1}^2$ – 0.174 $\sigma_{ID,t-1}^2$ + 0.132 V_CN_t + *0.791 V_WI_t — Indonesia

$\sigma_{MY,t}^2$ = ***3.821 + 0.053 $\varepsilon_{MY,t-1}^2$ + **0.052 V_CN_t + ***0.216 V_WI_t — Malaysia

$\sigma_{PK,t}^2$ = ***43.073 – 0.006 $\varepsilon_{PK,t-1}^2$ – ***0.698 $\sigma_{PK,t-1}^2$ + 0.271 V_CN_t + 0.680 V_WI_t — Pakistan

$\sigma^2_{PH,t}$ = ***13.817 – ***0.156 $\varepsilon^2_{PH,t-1}$ + 0.095 V_CN$_t$ + ***0.417 V_WI$_t$ Philippines

$\sigma^2_{CZ,t}$ = ***10.975 – 0.079 $\varepsilon^2_{CZ,t-1}$ + ***0.345 V_RS$_t$ + ***1.176 V_WI$_t$ Czech R.

$\sigma^2_{PL,t}$ = ***16.684 + 0.096 $\varepsilon^2_{PL,t-1}$ + ***0.281 V_RS$_t$ + ***0.622 V_WI$_t$ Poland

$\sigma^2_{RM,t}$ = ***41.223 – 0.177 $\sigma^2_{RM,t-1}$ + ***0.755 V_RS$_t$ + ***1.815 V_WI$_t$ Romania

$\sigma^2_{RS,t}$ = **72.584 – 0.563 $\sigma^2_{RS,t-1}$ + **2.838 V_WI$_t$ Russia

$\sigma^2_{UR,t}$ = ***71.994 – 0.031 $\varepsilon^2_{UR,t-1}$ + 0.829 V_RS$_t$ + **2.642 V_WI$_t$ Ukraine

The model specifications in variance equation above, as presented in Table 1, inform that conditional variance of world market (V_WI) has positive effect on conditional variances of China, Indonesia, Malaysia, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine stock markets. It is indicated by the significant coefficients of V_WI statistically amount of 0.999, 0.791, 0.216, 0.417, 1.176, 0.622, 1.815, 2.838, and 2.642, respectively. Conversely, conditional variance of world market has no effect on conditional variance of Pakistan stock market which is indicated by the insignificant coefficient of V_WI statistically amount of 0.680. These results suggest that there are volatility spillovers from world market to nine observed stock markets and there is no volatility spillover on Pakistan stock market.

Regionally, the results of estimate on Asian stock markets inform that conditional variance of China stock market (V_CN) has positive effect on conditional variance of Malaysia stock market. It is indicated by the significant coefficient of V_CN amount of 0.052 at the 5% level. In contrast, conditional variance of China has no effect on conditional variances of Indonesia, Malaysia, and Philippines stock markets. It is indicated by the insignificant coefficients of V_CN amount of 0.132, 0.271, and 0.095, respectively. These evidences suggest that the volatility spillover in Asian region from China stock market only occurs on Malaysia stock market.

Table 1

Estimates of GARCH-M(p,q) model for overall period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.659	*-0.444	**-0.684	-0.597	-0.588		
C	-0.250	***1.360	**0.536	5.997	***3.089	***4.084	**4.060	**5.449	0.535	1.207
$R_{i,t-1}$	**0.184	0.095	0.051	0.093	0.009	0.079	0.028	0.127	**0.174	***0.297
Conditional Variance ($\sigma_{i,t}^2$)										
C	***28.129	7.132	***3.821	***43.073	***13.817	***10.975	***16.684	***41.223	**72.584	***71.994
$\varepsilon_{i,t-1}^2$	***0.341	**0.278	0.053	-0.006	***-0.156	-0.079	0.096			-0.031
$\sigma_{i,t-1}^2$		-0.174		***-0.698				-0.177	-0.563	
V_CN		0.132	**0.052	0.271	0.095					
D(V_RS)						***0.345	***0.281	***0.755		0.829
V_WI	**0.999	*0.791	***0.216	0.680	***0.417	***1.176	***0.622	***1.815	**2.838	**2.642
R^2	0.005	0.034	0.007	0.064	0.016	0.035	0.014	0.034	0.058	0.082
N	189	189	189	182	189	188	188	188	189	188

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for overall period. The first equation, called as mean equation, is $R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t$. The second equation, called as variance equation, is $\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{i,t}$. In addition, V_CN, D(V_RS), and V_WI in variance equation stand for returns volatility of China, Russia, and world markets, respectively. The volatility of Russia stock market partially was performed in transformation form, i.e., in first difference form D(V_RS), due to multicollinearity problem with volatility of the world market index (V_WI). The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

Table 2

Estimates of GARCH-M(p,q) model for global financial crisis period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.091				-0.209		
C	-0.122	-0.083	**-0.145	0.007	0.050	**-0.268	-0.135	0.376	-0.213	**-0.402
$R_{i,t-1}$	-0.052	***0.181	***0.130	***0.241	*0.162	0.106	**0.142	0.079	**0.146	***0.224
Conditional Variance ($\sigma_{i,t}^2$)										
C	***5.384	0.228	***0.211	***2.527	0.183	0.223	***0.051	***8.886	0.279	***0.377
$\varepsilon_{i,t-1}^2$	0.069	0.039	***-0.101	***0.186	*0.127		***-0.066		-0.049	
$\sigma_{i,t-1}^2$			***0.779	***0.446	**0.597	***0.661	***1.025	***-0.968		***0.951
V_CN		0.081	0.005	-0.144	0.037					
D(V_RS)						***0.840	***0.139	**0.292		***0.909
V_WI	0.071	***0.975	***0.029	-0.155	0.104	***0.556	**0.027	**1.051	***4.349	***0.068
R^2	0.002	0.050	0.029	0.069	0.029	0.001	0.020	0.013	0.018	0.019
N	247	247	247	246	247	256	256	257	258	257

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for each stock market for global financial crisis period.

In Eastern Europe, conditional variance, in first difference form, of Russia stock market D(V_RS) has significantly positive effect on conditional variances of Czech Republic, Poland, and Romania stock markets. It is indicated by the significant coefficients of D(V_RS) amount of 0.345, 0.281, and 0.755 at the 1% level, respectively. Conversely, conditional variance of Russia stock market has no effect on conditional variance of Ukraine stock market which is indicated by the insignificant coefficient of D(V_RS) amount of 0.829. These results inform that there are volatility spillovers from Russia as a major stock market to all stock markets observed in Eastern Europe region, except to Ukraine stock market.

The model specifications in variance equation using the GFC sample period for each ten recipient stock market, as presented in Table 2, are expressed as follow:

$\sigma^2_{CN,t}$ = ***5.384 + 0.069 $\varepsilon^2_{CN,t-1}$ + 0.071 V_WI_t China

$\sigma^2_{ID,t}$ = 0.228 + 0.039 $\varepsilon^2_{ID,t-1}$ + 0.081 V_CN_t + ***0.975 V_WI_t Indonesia

$\sigma^2_{MY,t}$ = ***0.21 – ***0.10 $\varepsilon^2_{MY,t-1}$ + ***0.779 $\sigma^2_{MY,t-1}$ + 0.005 V_CN_t + ***0.03 V_WI_t Malaysia

$\sigma^2_{PK,t}$ = ***2.527 + ***0.186 $\varepsilon^2_{PK,t-1}$ + ***0.446 $\sigma^2_{PK,t-1}$ – 0.144 V_CN_t – 0.155 V_WI_t Pakistan

$\sigma^2_{PH,t}$ = 0.183 + *0.127 $\varepsilon^2_{PH,t-1}$ + **0.597 $\sigma^2_{PH,t-1}$ + 0.037 V_CN_t + 0.104 V_WI_t Philippines

$\sigma^2_{CZ,t}$ = 0.223 + ***0.661 $\sigma^2_{CZ,t-1}$ + ***0.840 V_RS_t + ***0.556 V_WI_t Czech R.

$\sigma^2_{PL,t}$ = ***0.05 – ***0.07 $\varepsilon^2_{PL,t-1}$ + ***1.025 $\sigma^2_{PL,t-1}$ + ***0.14 V_RS_t + **0.03 V_WI_t Poland

$\sigma^2_{RM,t}$ = ***8.886 – ***0.968 $\sigma^2_{RM,t-1}$ + **0.292 V_RS_t + **1.051 V_WI_t Romania

$\sigma^2_{RS,t}$ = 0.279 – 0.049 $\varepsilon^2_{RS,t-1}$ + ***4.349 V_WI_t Russia

$\sigma^2_{UR,t}$ = ***0.377 + ***0.951 $\sigma^2_{UR,t-1}$ + ***0.909 V_RS_t + ***0.068 V_WI_t Ukraine

Volatility spillover is the causality in variance among markets (BenSaïda et al., 2018). The results from causality analyses of volatilities using overall sample period are not distantly different with the results using the GFC sample period. The differences are as follow. Volatility of world market has no effect on volatilities of China and Philippines stock markets; volatility of China stock market has no effect on volatility of Malaysia stock market; and volatility of Russia stock market has positive effect on volatility of Ukraine stock market. The findings of this paper on the existence of volatility spillover are consistent with studies of Abbas, Khan, and Shah (2013); Mukherjee and Mishra (2010); Balli et al. (2015); Rejeb and Boughrara (2015).

Table 3 presents pairwaise dynamic conditional correlation (DCC) among market indices returns in average values. More specific, it was divided into two part sub-sample periods: overall sample period in Panel A and global financial crisis sample period in Panel B. Furthermore, Table 3 Panel A exhibits eighteen average series of stock market pairs monthly among the world market and ten stock markets in Asian and Eastern Europe regions, namely China, Indonesia Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine.

The pairs of R_CN vs R_PK and R_WI vs R_PK, as presented in Panel A, appear the lowest average dynamic correlation amount to -0.02 and 0.02, respectively. They are followed by the pairs of R_CN-R_ID and R_CN-R_PH amount to 0.22 and 0.23, respectively. This information suggests that Pakistan stock market has lowest degree of integration in observed markets pairs with world market and major markets in its region. In additon, the pairs of world market with all markets in Eastern Europe have strong average dynamic correlation from 0.43 with Ukraine to 0.65 with Czech Republic and Poland stock markets, respectively. This evidence indicates that the degree of

integrations among world market and five stock markets in Eastern Europe region in a whole are higher.

In Asian region, only the pair of China and Malaysia stock markets which has strong average dynamic correlation amount to 0.31. In Eastern Europe region, the pairs of Russia with the four rests stock markets have strong average dynamic correlations from 0.46 with Ukraine stock market to 0.54 with Poland stock market. This fact informs that China has higher degree of integration only with Malaysia stock market in Asian region and Russia has higher degree of integration with entire stock markets in Eastern Europe region. The results generally do not support the conclusion of Naranjo and Porter (2007) which state that returns in emerging markets appear very low correlation with returns in developed markets. Moreover, It was partly similar to conclusion of Lean and Smyth (2014) which report that relationship among the major markets and between major market and emerging market have increased over time.

Table 3

Average dynamic correlations among market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
R_CN		0.22	0.31	-0.02	0.23					
R_RS						0.53	0.54	0.52		0.46
R_WI	0.37	0.54	0.58	0.02	0.50	0.65	0.65	0.49	0.61	0.43
Panel B. Global Financial Crisis Period (Daily)										
R_CN		0.30	0.33	0.08	0.28					
R_RS						0.61	0.57	0.44		0.51
R_WI	0.19	0.39	0.38	0.04	0.23	0.62	0.59	0.44	0.52	0.40

This table reports pairwaise cross-market returns correlation. R_CN, R_ID, R_MY, R_PK, and R_PH stand for indices returns of China, Indonesia Malaysia, Pakistan, and Philippines stock markets, respectively. R_CZ, R_PL, R_RM, R_RS, and R_UR stand for indices returns of Czech Republic, Poland, Romania, Russia, and Ukraine stock markets, respectively. R_WI is world market returns of MSCI AC World Index.

Table 3 Panel B, which contains observations during GFC period, provides confirmation against previous information interpreted from Panel A. It differs to observations for overall sample period in average dynamic correlations only for pairs of R_WI vs R_CN and R_WI vs R_PH. The values of average dynamic correlations between world market and China market returns and between world market and Philippines market returns in the later sample observations are 0.19 and 0.23, respectively. These values are lower than the values of average dynamic correlations for overall sample period observations amount to 0.37 and 0.50, respectively. Therefore, the interpretation of the data at Panel B has much similarity with the interpretation from Panel A.

The volatility transmission from one stock market to other stock markets found in the investigation of this research has a pattern that is almost similar to the pattern occurring at the level of integration among those stock markets. The returns volatility of world market affects returns volatilities of all observed stock markets, except for the volatility of Pakistan stock market. Similarly, world market also has a higher degree of integration with all observed stock markets,

except with Pakistan stock market. These patterns indicate that the volatility from world market would be sent under condition that the level of integration with its recipient stock market is higher.

In addition, China stock market as a dominant stock market in the Asian region only sends its returns volatility to Malaysia stock market. Similar pattern suggests that China stock market also has a higher degree of integration only with Malaysia stock market. This evidence indicates that volatilty transmission from China would happen by the condition of higher degree of integration with Malaysia stock market. Furthermore, the returns volatility of Russia stock market as a dominant stock market in Eastern Europe only affects the volatilities of Czech Republic, Romania, and Poland stock markets. On the other hand, the Russia stock market also has a higher degree of integration with these three stock markets. These two corresponding proofs indicate that volatilty delivery from Russia would happen on condition that the level of integration with each of the three stock markets is higher.

According to the results of volatility spillover and market integration that have been examined, it can be argued that the volatility of stock market affected by the volatility of other stock market occurs when both stock markets have a higher degree of integration. In short, the recipient of volatilty is integrated with the sender. In contrast, the volatilty of a domestic stock market which is segmented toward world or regional market would not change. These empirical evidences corroborate the conseptual framework of Bekaert and Harvey (1995); Phylaktis and Ravazzolo (2002); Rejeb and Boughrara (2015); Rejeb and Arfaoui (2016); Baumöhl, Kočenda, Lyócsa, and Výrost (2018).

5. CONCLUSION

We investigate volatility transmissions from world market to the ten stock markets in Asian and Eastern Europe regions, and from major stock market in the region to the four rests stock markets. For overall sample period, the results suggest that spreading of volatility from world market as a sender generally occurs on the whole stock markets, except to Pakistan; spreading of volatility in Asian region from China only occurs on Malaysia stock market; and spreading of volatility in Eastern Europe region from Russia occurs on Czech Republic, Poland, and Romania stock markets. These results differ from the findings during the global financial crisis which suggest that spreading of volatility from world market does not occur on China, Pakistan, and Philippines stock markets; spreading of volatility from China does not occur on the whole stock markets in Asian region; conversely, spreading of volatility from Russia occurs on the whole stock markets in Eastern Europe region.

Analysis of the volatility transmission was accompanied by observing its degree of integration. The findings on the degree of integrations among world market and ten selected stock markets show that world market has very low degree of integration only with Pakistan stock market; China has higher degree of integration only with Malaysia stock market; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. In addition, for the global financial crisis period, world market has lower degree of integration with China, Pakistan, and Philippines stock markets; China has higher degree of integration with Indonesia and Malaysia stock markets; and Russia has higher degree of integration with entire stock markets in Eastern Europe region.

When the existence of volatility spillover is involved to its degree of integration, the findings appear that in general there is synchronous pattern on both aspects. We have notion that volatility spillovers are conditional on their degree of integrations. Specifically, domestic stock markets which have higher (lower) degree of integration would (not) receive volatility spillover from world market and major stock markets in their region. This phenomenon happened not only for overall period but also during financial crisis period. Stock market which is more integrated toward international financial movements would be more sensitive against external shock. Moreover, propagation of volatility is the consequence of financial interdependence across stock markets.

The findings indicate that volatility of financial asset which is integrated across borders could potentially be a source of vulnerability for financial asset in national stock market. The implication for decision arising from the findings is that as emerging stock markets become more integrated with world market and major stock market regionally, the market participants should strengthen prudential regulations and actions to prevent harmful shock spillover and to limit the propagation of financial crises across borders. Moreover, according to the findings, risk managers, decision makers, and hedgers should redesign their optimal portfolios and rebuild their policies to prevent rising risks of financial transmission.

Commented [M5]: Limits of your research? Future directions of research?

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7. RE: Agree to make revision, Selasa, 16 Oktober 2018, 8:38

Kepada: "Journal of International Studies" <subjois@gmail.com>
Judul: Re: manuscript submission

Dear Editor-in-Chief, Journal of International Studies (SCOPUS)
I am very grateful for the information about the progress of my paper.
Thank you for your kindness of reviewing my paper No 619 entitled "Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets".
For next process, we are attempting to make revision the files from reviewers and to finalize before the end of November.

Thank you

Best regards,
Najmudin

8. Revision Submission, Rabu, 24 October 2018, 23:10

Kepada: "Journal of International Studies" <subjois@gmail.com>
Judul: Re: manuscript submission

Dear Editor-in-Chief, Journal of International Studies (SCOPUS)
Thank you for your kindness of reviewing my paper No 619 entitled "Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets".
To fulfil the review, we send three files:
a. Clean final paper
b. Changes in editing process due to revision and addition (the text highlight color)
c. Answer to the review form
We are waiting for your information about the publishing process and its fee.

Thank you

Best regards,
Najmudin

ANSWER TO THE REVIEW FORM

REVIEW FORM

PART A: Editorial Office Only

SECTION I

Reviewer's Name:	
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Title:	Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets
Date Sent To Reviewer:	
Date Expected From Reviewer:	

PART B: Reviewer Only

SECTION II: Comments (Please give your critical comment for the deficiencies of each section of the manuscript).

General comment:	This paper explained volatility transmitted from world market to ten Asian and Eastern Europe stock markets and from major stock market in the region to the rest stock markets by considering their degree of integrations
Introduction:	Focus more on the objective of the paper, the importance of your study and results. Why did you choose countries from Asia and from Eastern Europe? We choose the countries from both regions because the stock markets in both Asian and Eastern European countries have heterogeneous characteristics. There are emerging and developed stock markets in both regions which potentially could be classified into integrated and segmented stock markets. Variation in the type of integration on observed stock markets is required in this study.

Methodology:	Specify the limits and the advantages of the methods. 1. The limits and advantages of GARCH (p,q) method The limits: GARCH(p,q) method used to analyze the volatility spillover was less sophisticated than the other recent methods. In addition, this method does not consider the other factors, such as asymmetric factor as found in the recent ARCH(p,q) family, for instances EGARCH, TGARCH, QGARCH, and various other non-linear GARCH models. The advantages: This method is simpler and more considers the parsimony principle so then easy to be applied and adopted. GARCH(1,1) method is the most popular in ARCH family. The standard deviation was used in some studies which assume that volatility is constant time-series, whereas dynamic conditional variance or residual was used in other studies which assume that volatility varies over time. Economic and especially financial time series are prone to exhibit periods of high and low volatility. Therefore, it is often misleading to measure volatility by a static standard deviation or unconditional variance. However, exactly such pattern can be modeled using conditional heteroskedastic disturbances. The solution to this problem can be found in the conditional heteroskedasticity models (Page 4). Returns volatility in the time series model considered as a more sophisticated measure is the ARCH family. Bollerslev, Chou, and Kroner (1992) and Bera and Higgins (1993) extensively review this ARCH family. Moreover, Engle (1982) propose ARCH(q) model to formulate the returns conditional variance. In addition, Bollerslev (1986) propose GARCH(p,q) model. GARCH is a more parsimony model than ARCH, and GARCH(1,1) is the most popular structure in most financial time series data. 2. The limits and advantages of dynamic conditional correlation (DCC) method The limits: The analysis using DCC method was less suitable to interprate the results in the long term context and does not consider the asymmetric condition. The advantages: One of the latest technique in determining the integration degree of capital market is the DCC proposed by Engle (2002). This technique overcomes the weaknesses in Pearson's static correlation technique because the recent empirical studies show that the correlation among equity returns changes over time or is dynamic. 3. The limits of this research method and recommendation for future research Analysis to generate this finding was very simple that only linking the patterns of volatility spillover to the patterns of dynamic degree of integration among markets. For future research, it would be better to expand this issue by utilizing the various causality methods that examine the effect of market integration on volatility spillover. To apply such

	methods, however, the research should to create a measure for volatility spillover which acts as a dependent variable. Moreover, the challenges for future research are to explore the other factors influencing on volatility spillover and to investigate the consequence that could emerge from the volatility spillover among stock markets (as written in conclusion part at page 14).
Results:	Provide more economic comments on results and possible recommendations. OK. We provide it at page 11 – 13.
Discussion:	Interpretations of the results are not enough and a more critical position is required. OK. We present it at page 11 – 13.
Bibliography/References:	
Other remarks:	The language could be improved.
Decision:	

SECTION III: Please rate the following: ***(1 = Excellent) (2 = Good) (3 = Fair) (4 = Poor).***

Originality:	**3**
Contribution to the Field:	**3**
Technical Quality:	**3**
Clarity of Presentation:	**3**
Depth of Research:	3

SECTION IV: Recommendation: (*Kindly Mark with an X*).

Accept **(if not, please, tick "X" in the appropriate box below)**	
Requires Minor Corrections:	
Requires Moderate Revision:	**X**
Requires Major Revision:	
Submit to another publication/journal such as:	
Reject (Please be Specific):	

SECTION V: Additional Comments (Please make suggestions to the authors).

CHANGES IN EDITING PROCESS DUE TO REVISION AND ADDITION (THE TEXT HIGHLIGHT COLOR)

Muharam, H., Wisnu, M., Arfinto, E. D., Najmudin. (2018). Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets. *Journal of International Studies, 11*(4), 277-293. doi:10.14254/2071-8330.2018……..

Journal of International Studies

Scientific Papers

Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets

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Abstract. This research aims to investigate volatility transmitted from world market to ten Asian and Eastern Europe stock markets and from major stock market in the region to the rest stock markets by considering their degree of integrations. To assess this purpose, we apply GARCH(p,q) model and involve the dynamic conditional correlation (DCC) model to generate the dynamic degree of integration. The monthly market indices data, over period from May 2002 to March 2018, are taken from eleven markets which consist of five Asian (China, Indonesia Malaysia, Pakistan, and Philippines), five Eastern Europe (Czech Republic, Poland, Romania, Russia, and Ukraine), and world markets. Furthermore, the volatility spillover was analyzed during the global financial crisis for period of 01:05:2008-29:05:2009. The finding shows that volatility spillovers from world and regional major markets to domestic stock markets are conditional

Received:
September, 2018
1st Revision:
October, 2018
Accepted:
November, 2018

DOI:
10.14254/2071-8330.2018/……..

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on the degree of integrations. Specifically, there is no volatility spillover from world and regional major markets on segmented stock markets. In contrast, domestic stock markets which are integrated could experience in volatility spillover. Moreover, this finding exists in the crisis circumstance and overall period.

Keywords: volatility spillover, dynamic integration, GARCH model.

JEL Classification: F36, G15, C10

1. INTRODUCTION

Prior researches have investigated the integration among stock market classes or among stock market types, for instances between developed and developing stock markets or between conventional and Islamic stock markets (Al Nasser & Hajilee, 2016; Majdoub, Mansour, & Jouini, 2016). Nevertheless, the integration of the stock markets toward international market has not been revealed yet. Similarly, volatility spillover as an effect of integration discussed on the prior researches was analyzed only among countries bilaterally, e.g. the volatility is transmitted from a particular developed country to an emerging country (Neaime, 2012). However, the susceptible strength to volatility spillover from international market has not been disclosed yet. This paper expands both issues focusing on the causality of volatilities from world market to domestic markets through the explanation involving the market integration aspect. It refers to the international portfolio diversification framework which states that the financial assets comovement among stock markets has an important part in volatility change.

Furthermore, the existing studies examining on the presence of volatility spillover have controversial findings. On the one side, some studies conclude that there are volatility spillovers on stock markets, among others Dungey, Fry, González-Hermosillo, and Martin (2007); Rejeb and Boughrara (2015). On the other side, another study finds no evidence of volatility spillover (Majdoub & Mansour, 2014). In addition, Gebka and Serwa (2007) state that there is different evidence on volatility spillover among emerging stock markets in Latin America, East Asia and Eastern Europe. It is likely that the existing studies ignore the degree of integration among markets observed so that the findings of volatility spillover have dissimilar conclusion. This argument is supported by statement of Jebran, Chen, Ullah, and Mirza (2017). They acknowledge that the stock markets will be more vulnerable or contaminated by volatility from the other markets when they are integrated.

Some studies have discussed the transmission of volatility accompanied by the degree of financial integration simultaneously. For instance, Rejeb and Arfaoui (2016) argue that in the last decade, a number of studies have focused on analyzing the transmission of volatility among emerging markets with respect to the degree of financial integration after their liberalization process. Their statement confirms the opinion of Phylaktis and Ravazzolo (2002) and Bekaert and Harvey (1995) that financial liberalization makes financial markets more integrated into global financial movements and thus more sensitive to external shocks. The propagation of volatility is the consequence of financial interdependence across markets.

Although financial globalization and trade integration have enabled emerging countries to attain risk-sharing through better allocations of capital and thereby higher economic development, they also produced unwanted side-effects, including increased financial fragility and unstable long-term growth. As emerging markets develop further and exhibit higher comovement with the mature markets, they automatically become more responsive to the volatility of stock markets elsewhere in the world. The detailed assessments of the level and the nature of financial integration among stock markets are thus necessary. Such analysis can shed light on the source of shock spillover across markets (Balli, Hajhoj, Basher, & Ghassan, 2015). Accordingly, we expect that the event of volatility spillover may occur only for the stock markets which have higher integration with world market and the major stock market in the region such as China in Asian or Russia in Eastern Europe stock markets.

To solve the issue, this paper contributes in the four ways related to the expansion in subject of analysis and analytical procedure. The first is variation in the degree of integration that links the world market index movement to the returns of each stock market for different regional markets. The second is variation in the volatility spillover that connects world market volatility to the volatility of each stock market for different regional markets. The third, this paper provides explanation on dissimilar findings of existing studies which attempts to investigate dynamic volatilities for emerging markets by considering their integration level toward world market. Moreover, this paper contributes on the existing literature by employing the recent data and comparing to the crisis circumstance. The finding of this paper has valuable information for international investors and policy makers on consequence of integrated domestic market. It could make their decision more efficient and effective in anticipating the events among stock markets.

The higher integration of international stock markets and correlated stock prices volatility would weaken the international portfolio diversification (Bekaert, Harvey, & Ng, 2005). The integration of a stock market to the global market is urgent to be disclosed because otherwise it would limit the opportunities for investors to benefit from their portfolio diversification and reduce the chances for a number of firms to obtain a lower cost of capital. Moreover, side-effect of the higher integration could generate the financial disturbances and shocks in a stock market. For instance, the global financial crisis overspreads and suppresses emerging stock markets and makes a rapid decline in the prices (Neaime, 2012).

The empirical study on volatility spillover from the global market to a stock market is an important aspect from the particular perspective of portfolio diversification and hedging strategies (Majdoub & Mansour, 2014). Understanding the volatility across markets is crucial to risk managers, decision makers, and hedgers, especially volatility due to the financial crisis. Studying spillover volatility has direct implication in designing optimal portfolios and building policies to prevent harmful shock transmission and to limit the propagation of financial crises across borders (BenSaïda, Litimi, & Abdallah, 2018). In addition, the advancement of analytical methods is necessary because of the consideration that risk premiums on equity, spillover volatility, and financial integration processes change over time due to the dynamic development of changing economic and business factors over time (Bekaert & Harvey, 1995; Kearney & Lucey, 2004).

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2. LITERATURE REVIEW

There is a wide variety of literature on stock market integration and volatilty across markets. Some studies have discussed only returns spillover, while some other studies have looked at both the first and the second moments of equity prices to discuss the cross-border spillover. We investigate, as the second category of the studies, the volatility spillover from international market and the major stock markets regionally to emerging stock markets by considering their dynamic integrations. The literature provides diverse definitions of financial integration. According to the law of one price, Chen and Knez (1995) define integrated markets as markets where investors can, in one country, buy and sell without restriction equities that are issued in another country and as a result, identical securities are issued and traded at the same price across markets after adjustment for foreign exchange rates.

Stock market integration is the situations where markets have higher and stable relationship due to their stock prices move together in similar period and direction. It could be defined as a unification of a number of separate stock markets operationally in the mechanisms, activities, characteristics of the instruments and interactions of the participants. The markets in which its assets require the same expected returns regardless of its trading location are said to be integrated. While the markets where the expected returns of an asset depends on its location are said to be segmented (Arouri, Nguyen, & Pukthuanthong, 2012; Bekaert & Harvey, 2003).

Attention to stock market integration arises mainly because of financial theory which states that integrated stock markets will be more efficient than segmented stock markets. When the stock market was integrated, investors from all countries will be able to allocate their capital to the most productive locations. With more flow of cross-border funds, additional trade in any securities may increase the liquidity of stock market. In addition, it could make the cost of capital to fall on companies that are looking for capital and make the transaction costs incurred by investors to be lower. It indicates a more efficient capital allocation (Click & Plummer, 2005).

Financial markets in most developed countries have grown rapidly over the past decade due to various factors such as deregulation, globalization and advances in information technology. There are no restrictions such as regulatory restrictions, transaction costs, taxes, and tariffs on foreign asset trading or portfolio equity flow mobility. The integration of financial markets around the world also appears to grow among them (Marashdeh dan Shrestha, 2010). In recent years, most of studies found that stock markets observed had higher integration level, for instance between Germany and emerging markets (Al Nasser & Hajilee, 2016) and among Malaysia, Indonesia, and Turkey stock markets (Arshad, 2017). Employing international CAPM method, Najmudin, Syarif, Wahyudi, and Muharam (2017) find that there is higher integration on the UK, Japan, Malaysia, Thailand, Indonesia, and Singapore stock markets.

Return volatility in economics and finance field reflects the degree of variation for the returns of a financial asset such as stock, market index, or exchange rate. The standard deviation and variance of returns are the most common measures of volatility returns. The standard deviation is used in studies which assume that volatility is constant time-series, whereas dynamic conditional variance or residual is used in studies which assume that volatility varies over time. Financial assets that have higher volatility indicate that the assets have higher risk (Kočenda, 2017). Economic and especially financial time series are prone to exhibit periods of high and low volatility. Therefore, it

is often misleading to measure volatility by a static standard deviation or unconditional variance. However, exactly such pattern can be modelled using conditional heteroskedastic disturbances. The solution to this problem can be found in the conditional heteroskedasticity models.

The studies on volatility in many stock markets had grown by expanding the issue of how volatility of return in a stock market is contagious and affects the volatility of return in another stock market, also known as volatility spillover. In other words, volatility spillover is a change in volatility of returns in one market because of the transmission of market-specific information from other markets. Cross market linkages in the conditional second moments of stock return is another important topic of international financial relations. In addition to various domestic and global factors, return volatility of major stock market is one of the important factors of stock return volatility in a stock market (Mukherjee & Mishra, 2010).

Volatility spillover has been examined by Ng (2000) who investigates the magnitude and changing characteristics from the US and Japan. The evidence suggests that the significant factors of market volatility are regional and international variables. Similarly, Dungey et al. (2007) report developed market has important role in transmitting volatility to emerging market and there is volatility spillover among regions. Furthermore, Rejeb and Boughrara (2015) conclude that there is a volatility transmission across financial markets; geographical proximity is essential factor in enlarging volatility transmission; and the liberalization contributes significantly in enlarging international volatility transmission. Applying GARCH model on India, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, and Thailand stock markets, Mukherjee and Mishra (2010) suggest that return spillovers between India and its Asian counterparts are found to be positively significant and bidirectional. Contemporaneous spillover of intraday volatility is stronger from other foreign markets to India. However, transmission of information lagged by one day is not found to be stronger.

A number of studies are still interested to examine on volatility spillover in the last years, Gencer and Hurata (2017); Jebran et al. (2017); Bajo-Rubio, Berke, and McMillan (2017), among others. Using multivariate BEKK-GARCH model, Gencer and Hurata (2017) conclude that there is a significant shock and volatility transmission from the S&P 500 to the other stock markets while the opposite, from the others to the US, is also observed for some market-pairs under investigation. In similar conclusion, Jebran et al. (2017) report that there is bidirectional volatility spillover between stock market of India and Sri Lanka in both sub-periods. Employing the weekly data starting from 1999 until the 12th of March 2015, Bajo-Rubio et al. (2017) state that Spillovers are largely between the same asset classes over the dotcom period. After 2006, the extent of spillovers increases.

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OK. We only write the concepts and prior reseaches on integration, returns volatility, and volatility spillover

3. METHODOLOGY

The data are obtained from the websites of stooq.com, msci.com, yahoo.finance.com, and the other relevant publications. The first data set covers stock market indices of China, Indonesia Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, Ukraine, and world markets. MSCI ACWI is used as a proxy for world market index. All data have the same time period from May 2002 to March 2018 on monthly basis. The second data set covers on daily basis during the global financial crisis for period of 01:05:2008-29:05:2009.

The data which consist of five Asian, five Eastern Europe, and world market indices are used to calculate the returns on each market and then used to find the dynamic conditional correlation (DCC) of returns among world market and the ten stock markets, and among a dominant stock market and the four rests in the region. The return of time t for the sample of stock market index i ($R_{i,t}$) is the difference between the natural logarithm of the index price at the current time ($P_{i,t}$) and the natural logarithm of the index price at previous time ($\ln P_{i,t-1}$). The formula is expressed as follows $R_{i,t} = \ln P_{i,t} - \ln P_{i,t-1}$.

The objectives of this research are specifically as follows. The first objective is to analyze the strength of a stock market as recipient against the volatility spillover from international and regional markets as senders. The second is to analyze the dynamic integration of each stock market in both Asian and Eastern European markets toward international and regional markets. The third is to analyze the existence of volatility spillover involving its explanation with the dynamic degree of integration.

To achieve the first objective we adopt the framework of Balli et al. (2015) as well as Mukherjee and Mishra (2010); Ng (2000); Bekaert and Harvey (1997) in working the volatility spillover models for the equity returns from the originator world market to the ten recipient stock markets. The effects of volatility spillover from major stock markets regionally, China in Asian markets and Russia in Eastern Europe markets, to the rest four stock markets are also taken into consideration to formulate their respective univariate AR-GARCH-M(p,q) models.

The volatility of stock return series is time varying so that this paper examines the spillover of the conditional second moments across markets allowing for changing the variances. The generalized autoregressive conditional heteroscedasticity (GARCH) model proposed by Engle (1982) and developed by Bollerslev (1986) has been employed to account for the time-variant conditional variances (Mukherjee & Mishra, 2010). The mean and variance equations of ARCH(p) and GARCH(p,q) models respectively are generally expressed as follow:

Mean equation: $Y_t = c + \varepsilon_t, \varepsilon_t^2 \mid I_{t-1} \sim N(0, \sigma_t^2)$ (1)

Variance equations:

ARCH(p) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2$ (2)

GARCH(p,q) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \ldots + \lambda_q \sigma_{t-q}^2$ (3)

Where Y_t is the individual returns at time t, c is a specific mean, ε_t is the error term, I_t denotes the information available at time t and σ_t^2 is the conditional variance of the error term at time t and a function of both ε_{t-1}^2 (the squared error term in the previous time) and σ_{t-1}^2 (conditional variance in the previous time).

Our empirical approach to achieve the first objective comprises the following steps. The first step, we estimate the volatility of world market and major stock markets in each region as the senders, namely China in Asian markets and Russia in Eastern Europe markets. To obtain the return volatility for each world, China, and Russia market, respectively, as determinants of the rest eight stock markets volatilities, we perform volatility modeling steps by following the AR-GARCH(1,1) model. The mean equations of AR-GARCH(1,1) model for the three markets are expressed as follow:

$R_{WI,t} = \alpha + \beta_1 R_{W,t-1} + \varepsilon_t$ World (4)

$R_{CN,t} = \alpha + \beta_1 R_{CN,t-1} + \varepsilon_t$ China (5)

$$R_{RS,t} = \alpha + \beta_1 R_{RS,t-1} + \varepsilon_t \text{ Russia} \quad (6)$$

Where $R_{WI,t}$, $R_{CN,t}$, and $R_{RS,t}$ are market returns of world market, China, and Russia stock markets at time t, respectively; and ε_t is error term at time t.

The second step, we estimate how the returns volatilities of the three sender markets are contagious and affect the returns volatility in another stock market as recipient. In order to investigate this volatility spillovers, we apply AR-GARCH-M(p,q) model. Unlike in simple GARCH model, the GARCH-M or GARCH-in-Mean model includes the conditional variance or its square root in the conditional mean equation along with other explanatory variables. Conditional variances or GARCH variance series resulted from estimations of AR-GARCH(1,1) model, as in Eqs. (4) – (6), are then used to estimate volatility series as inputs for AR-GARCH-M(p,q) model. The model is estimated using the maximum likelihood procedure applying the Berndt–Hall–Hall–Hausman (BHHH) algorithm.

The first equation, called as mean equation, of AR-GARCH-M(p,q) model for the recipient domestic stock market i is expressed as follows:

$$R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t. \quad (7)$$

The second equation, called as variance equation, is expressed as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{j,t}. \quad (8)$$

Where $R_{i,t}$ is returns of recipient domestic stock market i at time t; $\sigma_{i,t}$ is the square root of conditional variance on stock market i at time t; ε_t is error term at time t; $\sigma_{i,t}^2$ is the conditional variance of the error term at time t; ε_{t-p}^2 is the squared error term at time t-p; σ_{t-q}^2 is conditional variance at time t-q; and $V_{j,t}$ is volatilities of sender market j at time t.

To achieve the second objective we apply the DCC (dynamic conditional correlation) approach as developed by Engle (2002) and worked by Majdoub and Mansour (2014). We estimate the conditional relationship of returns among world market and ten selected stock markets. The principal advantage of this model is that while it retains the main features of standard GARCH models, it allows us to model explicitly time variation in the conditional covariance and correlation matrix.

DCC model can be described briefly as follows. In the DCC-GARCH(1,1) model, the conditional variance–covariance matrix is defined by $H_t = D_t R_t D_t$, where H_t takes the following formulation:

$$H_t = \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \begin{bmatrix} 1 & \rho_{12,t} \\ \rho_{21,t} & 1 \end{bmatrix} \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \quad (9)$$

D_t is a (n x n) diagonal matrix of time-varying standard deviations from univariate GARCH models with $(h_{ii,t})^{1/2}$ on the *i*th diagonal, i = 1, 2, …, n; R_t is the (n x n) time-varying correlation matrix and R_t is conditional correlation matrix:

$$R_t = (\text{diag}(Q_t)^{-1/2} Q_t (\text{diag}(Q_t))^{-1/2} \quad (10)$$

The evolution of the correlation in DCC model is given by:

$$Q_t = \bar{Q}(1 - \alpha - \beta) + \alpha \varepsilon_{t-1} \varepsilon'_{t-1} + \beta Q_{t-1} \quad (11)$$

Where $\bar{Q}$ is the unconditional correlation matrix of the epsilons; $Q_t = (q_{ii,t})$ is the (n x n) time-varying covariance matrix of ε_t; α and β are non-negative scalar parameters satisfying $(\alpha + \beta) < 1$.

In the empirical methodology, Arouri and Nguyen (2010) convey that conditional correlation coefficient ϱ_{ij} between two markets i and j at time t is then expressed by the following equation:

$$\rho_{ijt} = \frac{(1-\alpha-\beta)\bar{q}_{ij}+\alpha\mu_{i,t-1}\mu_{j,t-1}+\beta q_{i,t-1}}{\left((1-\alpha-\beta)\bar{q}_{ii}+\alpha\mu^2_{i,t-1}+\beta q_{ii,t-1}\right)^{1/2}\left((1-\alpha-\beta)\bar{q}_{jj}+\alpha\mu^2_{j,t-1}+\beta q_{jj,t-1}\right)^{1/2}} \quad (12)$$

Where q_{ij} refers to the element located in the *i*th row and *j*th column of the matrix Q_t.

DCC-GARCH model as described above is estimated using a two-stage procedure. In the first stage, a univariate GARCH(1,1) model is estimated for each return series included in the multivariate system. During the second stage, the transformed residuals from the first stage, namely the estimated residuals standardized by their conditional standard deviations, are used to infer the conditional correlation estimators.

The Log likelihood for this estimator can be expressed as:

$$L = -\frac{1}{2}\sum(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon_t) \quad (13)$$

To achieve the third objective we relate the patterns of volatility spillover across markets to the patterns of the degree of integration among those markets. This analysis could confirm the statement that a stock market which has higher comovement with the other stock markets would automatically become more responsive to the volatility of those stock markets. Therefore, in order to understand the patterns of volatility spillover across markets, it is necessary to assess the level and the nature of integration among those markets (Balli et al., 2015).

4. EMPIRICAL RESULTS AND DISCUSSION

We examine volatility spillover accros stock markets and the degree of markets integration by employing the data of market indices during period from May 2002 to March 2018 monthly totaling 191 observations and during sub-period from May 1, 2008 to May 29, 2009 on daily basis. We consider the stationarity pattern of data to analyze furthermore all variables and to draw an inference from statistical ways. To test the stationarity, we apply one of unit root methods, namely ADF (Augmented Dickey-Fuller) Test. According to unit root test, the result shows that stationer patterns in the level form appear on all observed market returns data. This conclusion prevails on the data for overall sample period (monthly) and for sub-sampel period of global financial crisis (daily). Therefore, it is not necessary to transform or differentiate the data of those eleven markets returns.

Commented [M9]: Describe more the dataset.
OK. We insert Table 1 (descriptive statistics) and its interpretation

The variance equation of the AR-GARCH-M(p,q) model for this research is written in general as follows:

$$\sigma^2_{i,t} = \alpha_0 + \alpha_p\, \varepsilon^2_{i,t-p} + \lambda_q\, \sigma^2_{i,t-q} + \Sigma\delta_n\, V_{i,t}.$$

The variance equation above becomes operational guidelines to interpret generally the volatililty transmission from one market to the volatility of another market. Table 1 contains the results of ten estimate models for each recipient stock market. These ten estimate models are the best fit regression models which are selected through iteration process from various models, such as ARCH(p,q), GARCH(p,q), ARCH-M(p,q), and GARCH-M(p,q).

The model specifications in variance equation using overall sample period for each ten recipient stock market are expressed as follow:

$\sigma^2_{CN,t}$ = ***28.129 + ***0.341 $\varepsilon^2_{CN,t-1}$ + **0.999 V_WI$_t$ China

$\sigma^2_{ID,t}$ = 7.132 + **0.278 $\varepsilon^2_{ID,t-1}$ – 0.174 $\sigma^2_{ID,t-1}$ + 0.132 V_CN$_t$ + *0.791 V_WI$_t$ Indonesia

$\sigma^2_{MY,t}$ = ***3.821 + 0.053 $\varepsilon^2_{MY,t-1}$ + **0.052 V_CN$_t$ + ***0.216 V_WI$_t$ Malaysia

$\sigma^2_{PK,t}$ = ***43.073 – 0.006 $\varepsilon^2_{PK,t-1}$ – ***0.698 $\sigma^2_{PK,t-1}$ + 0.271 V_CN$_t$ + 0.680 V_WI$_t$ Pakistan

$\sigma^2_{PH,t}$ = ***13.817 – ***0.156 $\varepsilon^2_{PH,t-1}$ + 0.095 V_CN$_t$ + ***0.417 V_WI$_t$ Philippines

$\sigma^2_{CZ,t}$ = ***10.975 – 0.079 $\varepsilon^2_{CZ,t-1}$ + ***0.345 V_RS$_t$ + ***1.176 V_WI$_t$ Czech R.

$\sigma^2_{PL,t}$ = ***16.684 + 0.096 $\varepsilon^2_{PL,t-1}$ + ***0.281 V_RS$_t$ + ***0.622 V_WI$_t$ Poland

$\sigma^2_{RM,t}$ = ***41.223 – 0.177 $\sigma^2_{RM,t-1}$ + ***0.755 V_RS$_t$ + ***1.815 V_WI$_t$ Romania

$\sigma^2_{RS,t}$ = **72.584 – 0.563 $\sigma^2_{RS,t-1}$ + **2.838 V_WI$_t$ Russia

$\sigma^2_{UR,t}$ = ***71.994 – 0.031 $\varepsilon^2_{UR,t-1}$ + 0.829 V_RS$_t$ + **2.642 V_WI$_t$ Ukraine

The model specifications in variance equation above, as presented in Table 1, inform that conditional variance of world market (V_WI) has positive effect on conditional variances of China, Indonesia, Malaysia, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine stock markets. It is indicated by the significant coefficients of V_WI statistically amount of 0.999, 0.791, 0.216, 0.417, 1.176, 0.622, 1.815, 2.838, and 2.642, respectively. Conversely, conditional variance of world market has no effect on conditional variance of Pakistan stock market which is indicated by the insignificant coefficient of V_WI statistically amount of 0.680. These results suggest that there are volatility spillovers from world market to nine observed stock markets and there is no volatility spillover on Pakistan stock market.

Regionally, the results of estimate on Asian stock markets inform that conditional variance of China stock market (V_CN) has positive effect on conditional variance of Malaysia stock market. It is indicated by the significant coefficient of V_CN amount of 0.052 at the 5% level. In contrast, conditional variance of China has no effect on conditional variances of Indonesia, Malaysia, and Philippines stock markets. It is indicated by the insignificant coefficients of V_CN amount of 0.132, 0.271, and 0.095, respectively. These evidences suggest that the volatility spillover in Asian region from China stock market only occurs on Malaysia stock market.

Table 1

Estimates of GARCH-M(p,q) model for overall period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.659	*-0.444	**-0.684	-0.597	-0.588		
C	-0.250	***1.360	**0.536	5.997	***3.089	***4.084	**4.060	**5.449	0.535	1.207
$R_{i,t-1}$	**0.184	0.095	0.051	0.093	0.009	0.079	0.028	0.127	**0.174	***0.297
Conditional Variance ($\sigma_{i,t}^2$)										
C	***28.129	7.132	***3.821	***43.073	***13.817	***10.975	***16.684	***41.223	**72.584	***71.994
$\varepsilon_{i,t-1}^2$	***0.341	**0.278	0.053	-0.006	***-0.156	-0.079	0.096			-0.031
$\sigma_{i,t-1}^2$		-0.174		***-0.698				-0.177	-0.563	
V_CN		0.132	**0.052	0.271	0.095					
D(V_RS)						***0.345	***0.281	***0.755		0.829
V_WI	**0.999	*0.791	***0.216	0.680	***0.417	***1.176	***0.622	***1.815	**2.838	**2.642
R^2	0.005	0.034	0.007	0.064	0.016	0.035	0.014	0.034	0.058	0.082
N	189	189	189	182	189	188	188	188	189	188

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for overall period. The first equation, called as mean equation, is $R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t$. The second equation, called as variance equation, is $\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{j,t}$. In addition, V_CN, D(V_RS), and V_WI in variance equation stand for returns volatility of China, Russia, and world markets, respectively. The volatility of Russia stock market partially was performed in transformation form, i.e., in first difference form D(V_RS), due to multicollinearity problem with volatility of the world market index (V_WI). The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

Table 2

Estimates of GARCH-M(p,q) model for global financial crisis period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.091				-0.209		
C	-0.122	-0.083	**-0.145	0.007	0.050	**-0.268	-0.135	0.376	-0.213	**-0.402
$R_{i,t-1}$	-0.052	***0.181	***0.130	***0.241	*0.162	0.106	**0.142	0.079	**0.146	***0.224
Conditional Variance ($\sigma_{i,t}^2$)										
C	***5.384	0.228	***0.211	***2.527	0.183	0.223	***0.051	***8.886	0.279	***0.377
$\varepsilon_{i,t-1}^2$	0.069	0.039	***-0.101	***0.186	*0.127		***-0.066		-0.049	
$\sigma_{i,t-1}^2$			***0.779	***0.446	**0.597	***0.661	***1.025	***-0.968		***0.951
V_CN		0.081	0.005	-0.144	0.037					
D(V_RS)						***0.840	***0.139	**0.292		***0.909
V_WI	0.071	***0.975	***0.029	-0.155	0.104	***0.556	**0.027	**1.051	***4.349	***0.068
R^2	0.002	0.050	0.029	0.069	0.029	0.001	0.020	0.013	0.018	0.019
N	247	247	247	246	247	256	256	257	258	257

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for each stock market for global financial crisis period.

In Eastern Europe, conditional variance, in first difference form, of Russia stock market D(V_RS) has significantly positive effect on conditional variances of Czech Republic, Poland, and Romania stock markets. It is indicated by the significant coefficients of D(V_RS) amount of 0.345, 0.281, and 0.755 at the 1% level, respectively. Conversely, conditional variance of Russia stock market has no effect on conditional variance of Ukraine stock market which is indicated by the insignificant coefficient of D(V_RS) amount of 0.829. These results inform that there are volatility spillovers from Russia as a major stock market to all stock markets observed in Eastern Europe region, except to Ukraine stock market.

The model specifications in variance equation using the GFC sample period for each ten recipient stock market, as presented in Table 2, are expressed as follow:

$\sigma^2_{CN,t}$ = ***5.384 + 0.069 $\varepsilon^2_{CN,t-1}$ + 0.071 V_WI_t China

$\sigma^2_{ID,t}$ = 0.228 + 0.039 $\varepsilon^2_{ID,t-1}$ + 0.081 V_CN_t + ***0.975 V_WI_t Indonesia

$\sigma^2_{MY,t}$ = ***0.21 – ***0.10 $\varepsilon^2_{MY,t-1}$ + ***0.779 $\sigma^2_{MY,t-1}$ + 0.005 V_CN_t + ***0.03 V_WI_t Malaysia

$\sigma^2_{PK,t}$ = ***2.527 + ***0.186 $\varepsilon^2_{PK,t-1}$ + ***0.446 $\sigma^2_{PK,t-1}$ – 0.144 V_CN_t – 0.155 V_WI_t Pakistan

$\sigma^2_{PH,t}$ = 0.183 + *0.127 $\varepsilon^2_{PH,t-1}$ + **0.597 $\sigma^2_{PH,t-1}$ + 0.037 V_CN_t + 0.104 V_WI_t Philippines

$\sigma^2_{CZ,t}$ = 0.223 + ***0.661 $\sigma^2_{CZ,t-1}$ + ***0.840 V_RS_t + ***0.556 V_WI_t Czech R.

$\sigma^2_{PL,t}$ = ***0.05 – ***0.07 $\varepsilon^2_{PL,t-1}$ + ***1.025 $\sigma^2_{PL,t-1}$ + ***0.14 V_RS_t + **0.03 V_WI_t Poland

$\sigma^2_{RM,t}$ = ***8.886 – ***0.968 $\sigma^2_{RM,t-1}$ + **0.292 V_RS_t + **1.051 V_WI_t Romania

$\sigma^2_{RS,t}$ = 0.279 – 0.049 $\varepsilon^2_{RS,t-1}$ + ***4.349 V_WI_t Russia

$\sigma^2_{UR,t}$ = ***0.377 + ***0.951 $\sigma^2_{UR,t-1}$ + ***0.909 V_RS_t + ***0.068 V_WI_t Ukraine

Volatility spillover is the causality in variance among markets (BenSaïda et al., 2018). The results from causality analyses of volatilities using overall sample period are not distantly different with the results using the GFC sample period. The differences are as follow. Volatility of world market has no effect on volatilities of China and Philippines stock markets; volatility of China stock market has no effect on volatility of Malaysia stock market; and volatility of Russia stock market has positive effect on volatility of Ukraine stock market. The findings of this paper on the existence of volatility spillover are consistent with studies of Abbas, Khan, and Shah (2013); Mukherjee and Mishra (2010); Balli et al. (2015); Rejeb and Boughrara (2015).

Table 3 presents pairwaise dynamic conditional correlation (DCC) among market indices returns in average values. More specific, it was divided into two part sub-sample periods: overall sample period in Panel A and global financial crisis sample period in Panel B. Furthermore, Table 3 Panel A exhibits eighteen average series of stock market pairs monthly among the world market and ten stock markets in Asian and Eastern Europe regions, namely China, Indonesia Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine.

The pairs of R_CN vs R_PK and R_WI vs R_PK, as presented in Panel A, appear the lowest average dynamic correlation amount to -0.02 and 0.02, respectively. They are followed by the pairs of R_CN-R_ID and R_CN-R_PH amount to 0.22 and 0.23, respectively. This information suggests that Pakistan stock market has lowest degree of integration in observed markets pairs with world market and major markets in its region. In additon, the pairs of world market with all markets in Eastern Europe have strong average dynamic correlation from 0.43 with Ukraine to 0.65 with Czech Republic and Poland stock markets, respectively. This evidence indicates that the degree of

integrations among world market and five stock markets in Eastern Europe region in a whole are higher.

In Asian region, only the pair of China and Malaysia stock markets which has strong average dynamic correlation amount to 0.31. In Eastern Europe region, the pairs of Russia with the four rests stock markets have strong average dynamic correlations from 0.46 with Ukraine stock market to 0.54 with Poland stock market. This fact informs that China has higher degree of integration only with Malaysia stock market in Asian region and Russia has higher degree of integration with entire stock markets in Eastern Europe region. The results generally do not support the conclusion of Naranjo and Porter (2007) which state that returns in emerging markets appear very low correlation with returns in developed markets. Moreover, It was partly similar to conclusion of Lean and Smyth (2014) which report that relationship among the major markets and between major market and emerging market have increased over time.

Table 3

Average dynamic correlations among market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
R_CN		0.22	0.31	-0.02	0.23					
R_RS						0.53	0.54	0.52		0.46
R_WI	0.37	0.54	0.58	0.02	0.50	0.65	0.65	0.49	0.61	0.43
Panel B. Global Financial Crisis Period (Daily)										
R_CN		0.30	0.33	0.08	0.28					
R_RS						0.61	0.57	0.44		0.51
R_WI	0.19	0.39	0.38	0.04	0.23	0.62	0.59	0.44	0.52	0.40

This table reports pairwaise cross-market returns correlation. R_CN, R_ID, R_MY, R_PK, and R_PH stand for indices returns of China, Indonesia Malaysia, Pakistan, and Philippines stock markets, respectively. R_CZ, R_PL, R_RM, R_RS, and R_UR stand for indices returns of Czech Republic, Poland, Romania, Russia, and Ukraine stock markets, respectively. R_WI is world market returns of MSCI AC World Index.

Table 3 Panel B, which contains observations during GFC period, provides confirmation against previous information interpreted from Panel A. It differs to observations for overall sample period in average dynamic correlations only for pairs of R_WI vs R_CN and R_WI vs R_PH. The values of average dynamic correlations between world market and China market returns and between world market and Philippines market returns in the later sample observations are 0.19 and 0.23, respectively. These values are lower than the values of average dynamic correlations for overall sample period observations amount to 0.37 and 0.50, respectively. Therefore, the interpretation of the data at Panel B has much similarity with the interpretation from Panel A.

The volatility transmission from one stock market to other stock markets found in the investigation of this research has a pattern that is almost similar to the pattern occurring at the level of integration among those stock markets. The returns volatility of world market affects returns volatilities of all observed stock markets, except for the volatility of Pakistan stock market. Similarly, world market also has a higher degree of integration with all observed stock markets,

except with Pakistan stock market. These patterns indicate that the volatility from world market would be sent under condition that the level of integration with its recipient stock market is higher.

In addition, China stock market as a dominant stock market in the Asian region only sends its returns volatility to Malaysia stock market. Similar pattern suggests that China stock market also has a higher degree of integration only with Malaysia stock market. This evidence indicates that volatilty transmission from China would happen by the condition of higher degree of integration with Malaysia stock market. Furthermore, the returns volatility of Russia stock market as a dominant stock market in Eastern Europe only affects the volatilities of Czech Republic, Romania, and Poland stock markets. On the other hand, the Russia stock market also has a higher degree of integration with these three stock markets. These two corresponding proofs indicate that volatilty delivery from Russia would happen on condition that the level of integration with each of the three stock markets is higher.

According to the results of volatility spillover and market integration that have been examined, it can be argued that the volatility of stock market affected by the volatility of other stock market occurs when both stock markets have a higher degree of integration. In short, the recipient of volatilty is integrated with the sender. In contrast, the volatilty of a domestic stock market which is segmented toward world or regional market would not change. These empirical evidences corroborate the conseptual framework of Bekaert and Harvey (1995); Phylaktis and Ravazzolo (2002); Rejeb and Boughrara (2015); Rejeb and Arfaoui (2016); Baumöhl, Kočenda, Lyócsa, and Výrost (2018).

5. CONCLUSION

We investigate volatility transmissions from world market to the ten stock markets in Asian and Eastern Europe regions, and from major stock market in the region to the four rests stock markets. For overall sample period, the results suggest that spreading of volatility from world market as a sender generally occurs on the whole stock markets, except to Pakistan; spreading of volatility in Asian region from China only occurs on Malaysia stock market; and spreading of volatility in Eastern Europe region from Russia occurs on Czech Republic, Poland, and Romania stock markets. These results differ from the findings during the global financial crisis which suggest that spreading of volatility from world market does not occur on China, Pakistan, and Philippines stock markets; spreading of volatility from China does not occur on the whole stock markets in Asian region; conversely, spreading of volatility from Russia occurs on the whole stock markets in Eastern Europe region.

Analysis of the volatility transmission was accompanied by observing its degree of integration. The findings on the degree of integrations among world market and ten selected stock markets show that world market has very low degree of integration only with Pakistan stock market; China has higher degree of integration only with Malaysia stock market; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. In addition, for the global financial crisis period, world market has lower degree of integration with China, Pakistan, and Philippines stock markets; China has higher degree of integration with Indonesia and Malaysia stock markets; and Russia has higher degree of integration with entire stock markets in Eastern Europe region.

When the existence of volatility spillover is involved to its degree of integration, the findings appear that in general there is synchronous pattern on both aspects. We have notion that volatility spillovers are conditional on their degree of integrations. Specifically, domestic stock markets which have higher (lower) degree of integration would (not) receive volatility spillover from world market and major stock markets in their region. This phenomenon happened not only for overall period but also during financial crisis period. Stock market which is more integrated toward international financial movements would be more sensitive against external shock. Moreover, propagation of volatility is the consequence of financial interdependence across stock markets.

The findings indicate that volatility of financial asset which is integrated across borders could potentially be a source of vulnerability for financial asset in national stock market. The implication for decision arising from the findings is that as emerging stock markets become more integrated with world market and major stock market regionally, the market participants should strengthen prudential regulations and actions to prevent harmful shock spillover and to limit the propagation of financial crises across borders. Moreover, according to the findings, risk managers, decision makers, and hedgers should redesign their optimal portfolios and rebuild their policies to prevent rising risks of financial transmission.

Commented [M10]: Limits of your research? Future directions of research?
OK. We present the limit and recommendation for future research.

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Muharam, H., Wisnu, M., Arfinto, E. D., Najmudin. (2018). Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets. *Journal of International Studies, 11*(4), 277-293. doi:10.14254/2071-8330.2018……..

Journal of International Studies

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Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets

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Abstract. This research aims to investigate volatility transmitted from world market to ten Asian and Eastern Europe stock markets and from major stock market in the region to the rest stock markets by considering their degree of integrations. To assess this purpose, we apply GARCH(p,q) model and involve the dynamic conditional correlation (DCC) model to generate the dynamic degree of integration. The monthly market indices data, over period from May 2002 to March 2018, are taken from eleven markets which consist of five Asian (China, Indonesia, Malaysia, Pakistan, and Philippines), five Eastern Europe (Czech Republic, Poland, Romania, Russia, and Ukraine), and world markets. Furthermore, the volatility spillover was analysed during the global financial crisis for period of May 1, 2008 to May 29, 2009. The finding shows that volatility spillovers from world and regional major markets to domestic stock markets are conditional on the degree of integrations. Specifically, there is no volatility spillover from world and regional major markets on segmented stock markets. In

Received:
September, 2018
1st Revision:
October, 2018
Accepted:
November, 2018

DOI:
10.14254/2071-8330.2018/……..

contrast, domestic stock markets which are integrated could experience in volatility spillover. Moreover, this finding exists in the crisis circumstance and overall period.

Keywords: volatility spillover, dynamic integration, GARCH model.

JEL Classification: F36, G15, C10

1. INTRODUCTION

Prior researches have investigated the integration among stock market classes or among stock market types, for instances between developed and developing stock markets or between conventional and Islamic stock markets (Al Nasser & Hajilee, 2016; Majdoub et al., 2016). Nevertheless, the integration of the stock markets toward international market has not been revealed yet. Similarly, volatility spillover as an effect of integration discussed on the prior researches was analyzed only among countries bilaterally, e.g. the volatility is transmitted from a particular developed country to an emerging country (Neaime, 2012). However, the susceptible strength to volatility spillover from international market has not been disclosed yet. This paper expands both issues focusing on the causality of volatilities from world market to domestic markets through the explanation involving the market integration aspect. It refers to the international portfolio diversification framework which states that the financial assets comovement among stock markets has an important part in volatility change.

Furthermore, the existing studies examining on the presence of volatility spillover have controversial findings. On the one side, some studies conclude that there are volatility spillovers on stock markets, among others Dungey et al. (2007); Rejeb and Boughrara (2015). On the other side, another study finds no evidence of volatility spillover (Majdoub & Mansour, 2014). In addition, Gebka and Serwa (2007) state that there is different evidence on volatility spillover among emerging stock markets in Latin America, East Asia and Eastern Europe. It is likely that the existing studies ignore the degree of integration among markets observed so that the findings of volatility spillover have dissimilar conclusion. This argument is supported by statement of Jebran et al. (2017). They acknowledge that the stock markets will be more vulnerable or contaminated by volatility from the other markets when they are integrated.

Although financial globalization and trade integration have enabled emerging countries to attain risk-sharing through better allocations of capital and thereby higher economic development, they also produced unwanted side-effects, including increased financial fragility and unstable long-term growth. As emerging markets develop further and exhibit higher comovement with the mature markets, they automatically become more responsive to the volatility of stock markets elsewhere in the world. The detailed assessments of the level and the nature of financial integration among stock markets are thus necessary. Such analysis can shed light on the source of shock spillover across markets (Balli et al., 2015). Accordingly, we expect that the event of volatility spillover may occur only for the stock markets which have higher integration with world market and the major stock market in the region such as China in Asian or Russia in Eastern Europe stock markets.

To solve the issue, this paper contributes in the four ways related to the expansion in subject of analysis and analytical procedure. The first is variation in the degree of integration that links the world market index movement to the returns of each stock market for different regional markets. The second is variation in the volatility spillover that connects world market volatility to the volatility of each stock market for different regional markets. The third, this paper provides explanation on dissimilar findings of existing studies which attempts to investigate dynamic volatilities for emerging markets by considering their integration level toward world market. Moreover, this paper contributes on the existing literature by employing the recent data and comparing to the crisis circumstance. The finding of this paper has valuable information for international investors and policy makers on consequence of integrated domestic market. It could make their decision more efficient and effective in anticipating the events among stock markets.

The higher integration of international stock markets and correlated stock prices volatility would weaken the international portfolio diversification (Bekaert et al., 2005). The integration of a stock market to the global market is urgent to be disclosed because otherwise it would limit the opportunities for investors to benefit from their portfolio diversification and reduce the chances for a number of firms to obtain a lower cost of capital. Moreover, side-effect of the higher integration could generate the financial disturbances and shocks in a stock market. For instance, the global financial crisis overspreads and suppresses emerging stock markets and makes a rapid decline in the prices (Neaime, 2012).

2. LITERATURE REVIEW

There is a wide variety of literature on stock market integration and volatilty across markets. Some studies have discussed only returns spillover, while some other studies have looked at both the first and the second moments of equity prices to discuss the cross-border spillover. We investigate, as the second category of the studies, the volatility spillover from international market and the major stock markets regionally to emerging stock markets by considering their dynamic integrations. The literature provides diverse definitions of financial integration. According to the law of one price, Chen and Knez (1995) define integrated markets as markets where investors can, in one country, buy and sell without restriction equities that are issued in another country and as a result, identical securities are issued and traded at the same price across markets after adjustment for foreign exchange rates.

Stock market integration is the situation when the markets have higher and stable relationship due to their stocks prices move together in similar direction for similar period. It could be defined as a unification of a number of separate stock markets operationally in the mechanisms, activities, characteristics of the instruments and interactions of the participants. The markets in which the assets require the same expected returns regardless of the trading locations are said to be integrated. While the markets where the expected returns of an asset depends on its location are said to be segmented (Arouri et al., 2012; Bekaert & Harvey, 2003).

Attention to stock market integration arises mainly because the financial theory states that integrated stock markets will be more efficient than segmented stock markets. When the stock market was integrated, investors from all countries will be able to allocate their capital to the most productive locations. With more flow of cross-border funds, additional trade in any securities may

increase the liquidity of stock market. In addition, it could make the cost of capital to fall on companies that are looking for capital and make the transaction costs incurred by investors to be lower. It indicates a more efficient capital allocation (Click & Plummer, 2005).

Financial markets in most developed countries have grown rapidly over the past decade due to various factors such as deregulation, globalization and advances in information technology. There are no restrictions such as regulatory restrictions, transaction costs, taxes, and tariffs on foreign asset trading or portfolio equity flow mobility. The integration of financial markets around the world also appears to grow among them (Marashdeh dan Shrestha, 2010). In recent years, most of studies found that stock markets observed had higher integration level, for instance between Germany and emerging markets (Al Nasser & Hajilee, 2016) and among Malaysia, Indonesia, and Turkey stock markets (Arshad, 2017). Employing international CAPM method, Najmudin et al. (2017) find that there is higher integration on the UK, Japan, Malaysia, Thailand, Indonesia, and Singapore stock markets.

Returns volatility in economics and finance field reflects the degree of variation for the returns of a financial asset such as stock, market index, or exchange rate. The standard deviation and variance of returns are the most common measures of returns volatility. The standard deviation is used in studies which assume that volatility is constant time-series, whereas dynamic conditional variance or residual is used in studies which assume that volatility varies over time. Financial assets that have higher volatility indicate that the assets have higher risk (Kočenda, 2017). Economic and especially financial time series are prone to exhibit periods of high and low volatility. Therefore, it is often misleading to measure volatility by a static standard deviation or unconditional variance. However, exactly such pattern can be modelled using conditional heteroskedastic disturbances. The solution to this problem can be found in the conditional heteroskedasticity models.

The studies on volatility in many stock markets had grown by expanding the issue of how volatility of return in a stock market is contagious and affects the volatility of return in another stock market, also known as volatility spillover. In other words, volatility spillover is a change in volatility of returns in one market because of the transmission of market-specific information from other markets. Cross market linkages in the conditional second moments of stock return is another important topic of international financial relations. In addition to various domestic and global factors, returns volatility of major stock market is one of the important factors of stock returns volatility in a stock market (Mukherjee & Mishra, 2010).

Volatility spillover has been examined by Ng (2000) who investigates the magnitude and changing characteristics from the US and Japan. The evidence suggests that the significant factors of market volatility are regional and international variables. Similarly, Dungey et al. (2007) report developed market has important role in transmitting volatility to emerging market and there is volatility spillover among regions. Furthermore, Rejeb and Boughrara (2015) conclude that there is a volatility transmission across financial markets; geographical proximity is essential factor in enlarging volatility transmission; and the liberalization contributes significantly in enlarging international volatility transmission. Applying GARCH model on India, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, and Thailand stock markets, Mukherjee and Mishra (2010) suggest that return spillovers between India and its Asian counterparts are found to be positively significant and bidirectional.

Contemporaneous spillover of intraday volatility is stronger from other foreign markets to India. However, transmission of information lagged by one day is not found to be stronger.

3. METHODOLOGY

The data are obtained from the websites of stooq.com, msci.com, yahoo.finance.com, and the other relevant publications. The first data set covers stock market indices of China, Indonesia, Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, Ukraine, and world markets. MSCI ACWI is used as a proxy for world market index. All data have the same time period from May 2002 to March 2018 on monthly basis. The second data set covers on daily basis during the global financial crisis during period from May 1, 2008 to May 29, 2009.

The data which consist of five Asian, five Eastern Europe, and world market indices are used to calculate the returns on each market and then used to find the dynamic conditional correlation (DCC) of returns among world market and the ten stock markets, and among a dominant stock market and the four rests in the region. The return of time t for the sample of stock market index i ($R_{i,t}$) is the difference between the natural logarithm of the index price at the current time ($P_{i,t}$) and the natural logarithm of the index price at previous time ($\ln P_{i,t-1}$). The formula is expressed as follows $R_{i,t} = \ln P_{i,t} - \ln P_{i,t-1}$.

The objectives of this research are specifically as follows. The first objective is to analyze the strength of a stock market as recipient against the volatility spillover from international and regional markets as senders. The second is to analyze the dynamic integration of each stock market in both Asian and Eastern European markets toward international and regional markets. The third is to analyze the existence of volatility spillover involving its explanation with the dynamic degree of integration.

To achieve the first objective we adopt the framework of Balli et al. (2015) as well as Mukherjee and Mishra (2010); Ng (2000); Bekaert and Harvey (1997) in working the volatility spillover models for the equity returns from the originator world market to the ten recipient stock markets. The effects of volatility spillover from major stock markets regionally, China in Asian markets and Russia in Eastern Europe markets, to the rest four stock markets are also taken into consideration to formulate their respective univariate AR-GARCH-M(p,q) models.

The volatility of stock return series is time varying so that this paper examines the spillover of the conditional second moments across markets allowing for changing the variances. The generalized autoregressive conditional heteroscedasticity (GARCH) model proposed by Engle (1982) and developed by Bollerslev (1986) has been employed to account for the time-variant conditional variances (Mukherjee & Mishra, 2010). The mean and variance equations of ARCH(p) and GARCH(p,q) models respectively are generally expressed as follow:

Mean equation: $Y_t = c + \varepsilon_t, \varepsilon_t^2 \mid I_{t-1} \sim N(0, \sigma_t^2)$ (1)

Variance equations:

ARCH(p) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2$ (2)

GARCH(p,q) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \ldots + \lambda_q \sigma_{t-q}^2$ (3)

Where Y_t is the individual returns at time t, c is a specific mean, ε_t is the error term, I_t denotes the information available at time t and σ_t^2 is the conditional variance of the error term at time t and a

function of both ε_{t-1}^2 (the squared error term in the previous time) and σ_{t-1}^2 (conditional variance in the previous time).

Our empirical approach to achieve the first objective comprises the following steps. The first step, we estimate the volatility of world market and major stock markets in each region as the senders, namely China in Asian markets and Russia in Eastern Europe markets. To obtain the returns volatility for each world, China, and Russia market, respectively, as determinants of the rest eight stock markets volatilities, we perform volatility modeling steps by following the AR-GARCH(1,1) model. The mean equations of AR-GARCH(1,1) model for the three markets are expressed as follow:

$$R_{WI,t} = \alpha + \beta_1 R_{W,t-1} + \varepsilon_t \text{ World} \quad (4)$$

$$R_{CN,t} = \alpha + \beta_1 R_{CN,t-1} + \varepsilon_t \text{ China} \quad (5)$$

$$R_{RS,t} = \alpha + \beta_1 R_{RS,t-1} + \varepsilon_t \text{ Russia} \quad (6)$$

Where $R_{WI,t}$, $R_{CN,t}$, and $R_{RS,t}$ are market returns of world market, China, and Russia stock markets at time t, respectively; and ε_t is error term at time t.

The second step, we estimate how the returns volatilities of the three sender markets are contagious and affect the returns volatility in another stock market as recipient. In order to investigate this volatility spillovers, we apply AR-GARCH-M(p,q) model. Unlike in simple GARCH model, the GARCH-M or GARCH-in-Mean model includes the conditional variance or its square root in the conditional mean equation along with other explanatory variables. Conditional variances or GARCH variance series resulted from estimations of AR-GARCH(1,1) model, as in Eqs. (4) – (6), are then used to estimate volatility series as inputs for AR-GARCH-M(p,q) model. The model is estimated using the maximum likelihood procedure applying the Berndt–Hall–Hall–Hausman (BHHH) algorithm.

The first equation, called as mean equation, of AR-GARCH-M(p,q) model for the recipient domestic stock market i is expressed as follows:

$$R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t. \quad (7)$$

The second equation, called as variance equation, is expressed as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{j,t}. \quad (8)$$

Where $R_{i,t}$ is returns of recipient domestic stock market i at time t; $\sigma_{i,t}$ is the square root of conditional variance on stock market i at time t; ε_t is error term at time t; $\sigma_{i,t}^2$ is the conditional variance of the error term at time t; ε_{t-p}^2 is the squared error term at time t-p; σ_{t-q}^2 is conditional variance at time t-q; and $V_{j,t}$ is volatilities of sender market j at time t.

To achieve the second objective we apply the DCC (dynamic conditional correlation) approach as developed by Engle (2002) and worked by Majdoub and Mansour (2014). We estimate the conditional relationship of returns among world market and ten selected stock markets. The principal advantage of this model is that while it retains the main features of standard GARCH models, it allows us to model explicitly time variation in the conditional covariance and correlation matrix.

DCC model can be described briefly as follows. In the DCC-GARCH(1,1) model, the conditional variance–covariance matrix is defined by $H_t = D_t R_t D_t$, where H_t takes the following formulation:

$$H_t = \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \begin{bmatrix} 1 & \rho_{12,t} \\ \rho_{21,t} & 1 \end{bmatrix} \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \quad (9)$$

D_t is a (n x n) diagonal matrix of time-varying standard deviations from univariate GARCH models with $(h_{ii,t})^{1/2}$ on the *i*th diagonal, i = 1, 2, …, n; R_t is the (n x n) time-varying correlation matrix and R_t is conditional correlation matrix:

$$R_t = (\text{diag}(Q_t)^{-1/2}\, Q_t\, (\text{diag}(Q_t))^{-1/2} \quad (10)$$

The evolution of the correlation in DCC model is given by:

$$Q_t = \bar{Q}(1 - \alpha - \beta) + \alpha\, \varepsilon_{t-1}\, \varepsilon'_{t-1} + \beta Q_{t-1} \quad (11)$$

Where $\bar{Q}$ is the unconditional correlation matrix of the epsilons; $Q_t = (q_{ii,t})$ is the (n x n) time-varying covariance matrix of ε_t; α and β are non-negative scalar parameters satisfying $(\alpha + \beta) < 1$.

In the empirical methodology, Arouri and Nguyen (2010) convey that conditional correlation coefficient ρ_{ij} between two markets i and j at time t is then expressed by the following equation:

$$\rho_{ijt} = \frac{(1-\alpha-\beta)\bar{q}_{ij} + \alpha\mu_{i,t-1}\mu_{j,t-1} + \beta q_{i,t-1}}{\left((1-\alpha-\beta)\bar{q}_{ii} + \alpha\mu^2_{i,t-1} + \beta q_{ii,t-1}\right)^{1/2}\left((1-\alpha-\beta)\bar{q}_{jj} + \alpha\mu^2_{j,t-1} + \beta q_{jj,t-1}\right)^{1/2}} \quad (12)$$

Where q_{ij} refers to the element located in the *i*th row and *j*th column of the matrix Q_t.

DCC-GARCH model as described above is estimated using a two-stage procedure. In the first stage, a univariate GARCH(1,1) model is estimated for each return series included in the multivariate system. During the second stage, the transformed residuals from the first stage, namely the estimated residuals standardized by their conditional standard deviations, are used to infer the conditional correlation estimators.

The Log likelihood for this estimator can be expressed as:

$$L = -\frac{1}{2}\sum(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon'_t R_t^{-1}\varepsilon_t) \quad (13)$$

To achieve the third objective we relate the patterns of volatility spillover across markets to the patterns of the degree of integration among those markets. This analysis could confirm the statement that a stock market which has higher comovement with the other stock markets would automatically become more responsive to the volatility of those stock markets. Therefore, in order to understand the patterns of volatility spillover across markets, it is necessary to assess the level and the nature of integration among those markets (Balli et al., 2015).

4. EMPIRICAL RESULTS AND DISCUSSION

We examine volatility spillover accros stock markets and the degree of markets integration by employing the data of market indices during period from May 2002 to March 2018 monthly totaling 191 observations and during sub-period from May 1, 2008 to May 29, 2009 on daily basis. Table 1 exhibits descriptive statistics for ten observed market returns, namely China (CN), Indonesia (ID), Malaysia (MY), Pakistan (PK), Philippines (PH), Czech Republic (CZ), Poland (PL), Romania (RM), Russia (RS), and Ukraine (UR). It consists of mean, deviation standard, maximum, and minimum values for overall and global financial crisis (GFC) sample periods.

Table 1

Descriptive statistics of market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
Mean	0.39	1.29	0.48	1.58	0.95	0.48	0.69	1.02	0.61	1.26
St. Dev	8.08	6.13	3.58	7.15	5.32	5.97	5.91	8.34	9.56	11.63
Max.	24.25	18.34	12.70	20.23	13.95	17.11	18.84	25.72	26.68	44.51
Min.	–28.28	–37.72	–16.51	–44.88	–27.54	–31.65	–27.45	–41.42	–44.91	–35.26
Panel B. Global Financial Crisis Period (Daily)										
Mean	–0.10	–0.06	–0.09	–0.30	0.04	–0.25	–0.17	–0.28	–0.18	–0.22
St. Dev	2.50	2.33	1.12	2.01	1.86	3.17	2.13	3.24	4.43	3.61
Max.	9.03	7.36	4.06	8.25	7.06	12.36	6.08	12.85	20.20	11.67
Min.	–8.04	–10.95	–3.68	–5.13	–5.32	–16.19	–8.29	–11.82	–21.20	–13.21

This table reports the mean, standard deviation, and the minimum and maximum values of market indices returns for overall sample period (monthly) and global financial crisis period (daily) for China (CN), Indonesia (ID), Malaysia (MY), Pakistan (PK), Philippines (PH), Czech Republic (CZ), Poland (PL), Romania (RM), Russia (RS), and Ukraine (UR) stock markets.

For all sample period, Pakistan is the stock market which provides the highest average returns amount to 1.58 percent. This interesting value, however, was accompanied by the higher risk measured by the standard deviation of returns (7.15) and the spread of returns (65.11 percent) ranging from maximum value (20.23 percent) to minimum value (–44.88 percent). In contrast, China has the lowest average returns (0.39 percent) followed by Malaysia stock market (0.48 percent) and yet investors in China stock market bear the highest risk in Asian region with standard deviation amount of 8.08.

The lowest risk in Asian region appears in Malaysia stock market with standard deviation and spread of returns are 3.58 and 29.21 percent, respectively. Similar position is found on Poland stock market in Eastern European region with standard deviation and spread of returns are 5.91 and 46.29 percent, respectively. Moreover, Malaysia stock market is the only one stock market that has the lower risk than the world market returns. Standard deviation and spread of returns for world market are 4.50 and 33.07 percent, respectively.

In Eastern European region, Czech Republic stock market has the lowest average returns (0.48 percent) and has lower risk indicated by the standard deviation and spread of returns in this market amount of 5.97 and 48.75 percent, respectively. Conversely, Ukraine stock market has the highest average returns in the region followed by the highest risk. This information was presented by the average returns, standard deviation, and spread of returns for this market which are 1.26 percent, 11.63, and 79.77 percent, respectively.

For the GFC period, the highest standard deviation and spread values in Eastern Europe region are found in Ukraine stock market amount of 4.43 and 41.40 percent, respectively. This

phenomenon on Ukraine stock market for the GFC period is similar with condition for all sample period. In Asian region, such phenomenon on Ukraine stock market is found in China stock market that has the highest standard deviation for the GFC period (2.50) and for all sample period (8.08) in the region. In general, the data of all stock markets inform that each stock market has a difference characteristic or heterogeneous in rate of returns and its risk.

We consider the stationarity pattern of data to analyze furthermore all variables and to draw an inference from statistical ways. To test the stationarity, we apply one of unit root methods, namely ADF (Augmented Dickey-Fuller) Test. According to unit root test, the result shows that stationer patterns in the level form appear on all observed market returns data. This conclusion prevails on the data for overall sample period (monthly) and for sub-sampel period of global financial crisis (daily). Therefore, it is not necessary to transform or differentiate the data of those eleven markets returns.

The variance equation of the AR-GARCH-M(p,q) model for this research is written in general as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p\, \varepsilon_{i,t-p}^2 + \lambda_q\, \sigma_{i,t-q}^2 + \Sigma\delta_n\, V_{j,t}.$$

The variance equation above becomes operational guidelines to interpret generally the volatililty transmission from one market to the volatility of another market. Table 2 contains the results of ten estimate models for each recipient stock market. These ten estimate models are the best fit regression models which are selected through iteration process from various models, such as ARCH(p,q), GARCH(p,q), ARCH-M(p,q), and GARCH-M(p,q).

The model specifications in variance equation using overall sample period for each ten recipient stock market are expressed as follow:

$\sigma_{CN,t}^2$ = ***28.129 + ***0.341 $\varepsilon_{CN,t-1}^2$ + **0.999 V_WI_t — China

$\sigma_{ID,t}^2$ = 7.132 + **0.278 $\varepsilon_{ID,t-1}^2$ – 0.174 $\sigma_{ID,t-1}^2$ + 0.132 V_CN_t + *0.791 V_WI_t — Indonesia

$\sigma_{MY,t}^2$ = ***3.821 + 0.053 $\varepsilon_{MY,t-1}^2$ + **0.052 V_CN_t + ***0.216 V_WI_t — Malaysia

$\sigma_{PK,t}^2$ = ***43.073 – 0.006 $\varepsilon_{PK,t-1}^2$ – ***0.698 $\sigma_{PK,t-1}^2$ + 0.271 V_CN_t + 0.680 V_WI_t — Pakistan

$\sigma_{PH,t}^2$ = ***13.817 – ***0.156 $\varepsilon_{PH,t-1}^2$ + 0.095 V_CN_t + ***0.417 V_WI_t — Philippines

$\sigma_{CZ,t}^2$ = ***10.975 – 0.079 $\varepsilon_{CZ,t-1}^2$ + ***0.345 V_RS_t + ***1.176 V_WI_t — Czech R.

$\sigma_{PL,t}^2$ = ***16.684 + 0.096 $\varepsilon_{PL,t-1}^2$ + ***0.281 V_RS_t + ***0.622 V_WI_t — Poland

$\sigma_{RM,t}^2$ = ***41.223 – 0.177 $\sigma_{RM,t-1}^2$ + ***0.755 V_RS_t + ***1.815 V_WI_t — Romania

$\sigma_{RS,t}^2$ = **72.584 – 0.563 $\sigma_{RS,t-1}^2$ + **2.838 V_WI_t — Russia

$\sigma_{UR,t}^2$ = ***71.994 – 0.031 $\varepsilon_{UR,t-1}^2$ + 0.829 V_RS_t + **2.642 V_WI_t — Uk

Table 2

Estimates of GARCH-M(p,q) model for overall period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.659	*-0.444	**-0.684	-0.597	-0.588		
C	-0.250	***1.360	**0.536	5.997	***3.089	***4.084	**4.060	**5.449	0.535	1.207
$R_{i,t-1}$	**0.184	0.095	0.051	0.093	0.009	0.079	0.028	0.127	**0.174	***0.297
Conditional Variance ($\sigma^2_{i,t}$)										
C	***28.129	7.132	***3.821	***43.073	***13.817	***10.975	***16.684	***41.223	**72.584	***71.994
$\varepsilon^2_{i,t-1}$	***0.341	**0.278	0.053	-0.006	***-0.156	-0.079	0.096			-0.031
$\sigma^2_{i,t-1}$		-0.174		***-0.698				-0.177	-0.563	
V_CN		0.132	**0.052	0.271	0.095					
D(V_RS)						***0.345	***0.281	***0.755		0.829
V_WI	**0.999	*0.791	***0.216	0.680	***0.417	***1.176	***0.622	***1.815	**2.838	**2.642
R^2	0.005	0.034	0.007	0.064	0.016	0.035	0.014	0.034	0.058	0.082
N	189	189	189	182	189	188	188	188	189	188

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for overall period. The first equation, called as mean equation, is $R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t$. The second equation, called as variance equation, is $\sigma^2_{i,t} = \alpha_0 + \alpha_p \varepsilon^2_{i,t-p} + \lambda_q \sigma^2_{i,t-q} + \Sigma\delta_n V_{j,t}$. In addition, V_CN, D(V_RS), and V_WI in variance equation stand for returns volatility of China, Russia, and world markets, respectively. The volatility of Russia stock market partially was performed in transformation form, i.e., in first difference form D(V_RS), due to multicollinearity problem with volatility of the world market index (V_WI). The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

Table 3

Estimates of GARCH-M(p,q) model for global financial crisis period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.091				-0.209		
C	-0.122	-0.083	**-0.145	0.007	0.050	**-0.268	-0.135	0.376	-0.213	**-0.402
$R_{i,t-1}$	-0.052	***0.181	***0.130	***0.241	*0.162	0.106	**0.142	0.079	**0.146	***0.224
Conditional Variance ($\sigma_{i,t}^2$)										
C	***5.384	0.228	***0.211	***2.527	0.183	0.223	***0.051	***8.886	0.279	***0.377
$\varepsilon_{i,t-1}^2$	0.069	0.039	***-0.101	***0.186	*0.127		***-0.066		-0.049	
$\sigma_{i,t-1}^2$			***0.779	***0.446	**0.597	***0.661	***1.025	***-0.968		***0.951
V_CN		0.081	0.005	-0.144	0.037					
D(V_RS)						***0.840	***0.139	**0.292		***0.909
V_WI	0.071	***0.975	***0.029	-0.155	0.104	***0.556	**0.027	**1.051	***4.349	***0.068
R^2	0.002	0.050	0.029	0.069	0.029	0.001	0.020	0.013	0.018	0.019
N	247	247	247	246	247	256	256	257	258	257

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for each stock market for global financial crisis period.

The model specifications in variance equation above, as presented in Table 2, inform that conditional variance of world market (V_WI) has positive effect on conditional variances of China, Indonesia, Malaysia, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine stock markets. It is indicated by the significant coefficients of V_WI statistically amount of 0.999, 0.791, 0.216, 0.417, 1.176, 0.622, 1.815, 2.838, and 2.642, respectively. Conversely, conditional variance of world market has no effect on conditional variance of Pakistan stock market which is indicated by the insignificant coefficient of V_WI statistically amount of 0.680. These results suggest that there are volatility spillovers for all sample period from world market to nine observed stock markets and there is no volatility spillover on Pakistan stock market.

Regionally, the results of estimate on Asian stock markets inform that conditional variance of China stock market (V_CN) has positive effect on conditional variance of Malaysia stock market. It is indicated by the significant coefficient of V_CN amount of 0.052 at the 5% level. In contrast, conditional variance of China has no effect on conditional variances of Indonesia, Malaysia, and Philippines stock markets. It is indicated by the insignificant coefficients of V_CN amount of 0.132, 0.271, and 0.095, respectively. These evidences suggest that the volatility spillover in Asian region from China stock market only occurs on Malaysia stock market.

In Eastern Europe, conditional variance, in first difference form, of Russia stock market D(V_RS) has significantly positive effect on conditional variances of Czech Republic, Poland, and Romania stock markets. It is indicated by the significant coefficients of D(V_RS) amount of 0.345, 0.281, and 0.755 at the 1% level, respectively. Conversely, conditional variance of Russia stock market has no effect on conditional variance of Ukraine stock market which is indicated by the insignificant coefficient of D(V_RS) amount of 0.829. These results inform that there are volatility spillovers from Russia as a major stock market to all stock markets observed in Eastern Europe region, except to Ukraine stock market.

The model specifications in variance equation using the GFC sample period for each ten recipient stock market, as presented in Table 3, are expressed as follow:

$\sigma^2_{CN,t}$ = ***5.384 + 0.069 $\varepsilon^2_{CN,t-1}$ + 0.071 V_WI$_t$ — China

$\sigma^2_{ID,t}$ = 0.228 + 0.039 $\varepsilon^2_{ID,t-1}$ + 0.081 V_CN$_t$ + ***0.975 V_WI$_t$ — Indonesia

$\sigma^2_{MY,t}$ = ***0.21 – ***0.10 $\varepsilon^2_{MY,t-1}$ + ***0.779 $\sigma^2_{MY,t-1}$ + 0.005 V_CN$_t$ + ***0.03 V_WI$_t$ — Malaysia

$\sigma^2_{PK,t}$ = ***2.527 + ***0.186 $\varepsilon^2_{PK,t-1}$ + ***0.446 $\sigma^2_{PK,t-1}$ – 0.144 V_CN$_t$ – 0.155 V_WI$_t$ — Pakistan

$\sigma^2_{PH,t}$ = 0.183 + *0.127 $\varepsilon^2_{PH,t-1}$ + **0.597 $\sigma^2_{PH,t-1}$ + 0.037 V_CN$_t$ + 0.104 V_WI$_t$ — Philippines

$\sigma^2_{CZ,t}$ = 0.223 + ***0.661 $\sigma^2_{CZ,t-1}$ + ***0.840 V_RS$_t$ + ***0.556 V_WI$_t$ — Czech R.

$\sigma^2_{PL,t}$ = ***0.05 – ***0.07 $\varepsilon^2_{PL,t-1}$ + ***1.025 $\sigma^2_{PL,t-1}$ + ***0.14 V_RS$_t$ + **0.03 V_WI$_t$ — Poland

$\sigma^2_{RM,t}$ = ***8.886 – ***0.968 $\sigma^2_{RM,t-1}$ + **0.292 V_RS$_t$ + **1.051 V_WI$_t$ — Romania

$\sigma^2_{RS,t}$ = 0.279 – 0.049 $\varepsilon^2_{RS,t-1}$ + ***4.349 V_WI$_t$ — Russia

$\sigma^2_{UR,t}$ = ***0.377 + ***0.951 $\sigma^2_{UR,t-1}$ + ***0.909 V_RS$_t$ + ***0.068 V_WI$_t$ — Ukraine

Volatility spillover is the causality in variance among markets (BenSaïda et al., 2018). The results from causality analyses of volatilities using overall sample period are not distantly different with the results using the GFC sample period. The differences are as follow: volatility of world market has no effect on volatilities of China and Philippines stock markets; volatility of China stock market has no effect on volatility of Malaysia stock market; and volatility of Russia stock market

has positive effect on volatility of Ukraine stock market. The findings of this paper on the existence of volatility spillover are consistent with studies of Abbas et al. (2013); Balli et al. (2015); Rejeb and Boughrara (2015).

This empirical study on volatility spillover from the global market to a stock market has an important role from the particular perspective of portfolio diversification and hedging strategies (Majdoub & Mansour, 2014). Moreover, studying spillover volatility has direct implication in designing optimal portfolios and building policies to prevent harmful shock transmission and to limit the propagation of financial crises across borders (BenSaïda et al., 2018). Therefore, understanding the volatility across markets is crucial for risk managers, hedgers, and policy makers, especially volatility spillover due to the financial crisis.

Table 4 presents pairwaise dynamic conditional correlation (DCC) among market indices returns in average values. More specific, it was divided into two part sub-sample periods: overall sample period in Panel A and global financial crisis sample period in Panel B. Furthermore, Table 4 Panel A exhibits eighteen average series of stock market pairs monthly among the world market and ten stock markets in Asian and Eastern Europe regions, namely China, Indonesia, Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine.

The pairs of R_CN vs R_PK and R_WI vs R_PK, as presented in Panel A, appear the lowest average dynamic correlation amount to -0.02 and 0.02, respectively. They are followed by the pairs of R_CN-R_ID and R_CN-R_PH amount to 0.22 and 0.23, respectively. This information suggests that Pakistan stock market has lowest degree of integration in observed markets pairs with world market and major markets in its region. In additon, the pairs of world market with all markets in Eastern Europe have strong average dynamic correlation from 0.43 with Ukraine to 0.65 with Czech Republic and Poland stock markets, respectively. This evidence indicates that the degree of integrations among world market and five stock markets in Eastern Europe region in a whole are higher.

In Asian region, only the pair of China and Malaysia stock markets which has strong average dynamic correlation amount to 0.31. In Eastern Europe region, the pairs of Russia with the four rests markets have strong average dynamic correlations from 0.46 with Ukraine to 0.54 with Poland stock market. This fact informs that China has higher degree of integration only with Malaysia stock market in Asian region and Russia has higher degree of integration with entire stock markets in Eastern Europe region. The results generally do not support the conclusion of Naranjo and Porter (2007) which state that returns in emerging markets appear very low correlation with returns in developed markets. Moreover, it was partly similar to conclusion of Lean and Smyth (2014) which report that relationship among the major markets and between major market and emerging market have increased over time.

Table 4 Panel B, which contains observations during GFC period, provides confirmation against previous information interpreted from Panel A. It differs to observations for overall sample period in average dynamic correlations only for pairs of R_WI vs R_CN and R_WI vs R_PH. The values of average dynamic correlations between world market and China market returns and between world market and Philippines market returns in the later sample observations are 0.19 and 0.23, respectively. These values are lower than the values of average dynamic correlations for overall sample period observations amount to 0.37 and 0.50, respectively. Therefore, the

interpretation of the data at Panel B has much similarity with the interpretation from Panel A. The result informs that in general there is opportunity for international investors to diversify internationally their fund by involving the stocks from China and Pakistan stock markets into their portfolio formation.

The volatility transmission from one stock market to other stock markets found in the investigation of this research has a pattern that is almost similar to the pattern occurring at the level of integration among those stock markets. The returns volatility of world market affects returns volatilities of all observed stock markets, except for the volatility of Pakistan stock market. Similarly, world market also has a higher degree of integration with all observed stock markets, except with Pakistan stock market. These patterns indicate that the volatility from world market would be sent under condition that the level of integration with its recipient stock market is higher.

Table 4

Average dynamic correlations among market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
R_CN		0.22	0.31	-0.02	0.23					
R_RS						0.53	0.54	0.52		0.46
R_WI	0.37	0.54	0.58	0.02	0.50	0.65	0.65	0.49	0.61	0.43
Panel B. Global Financial Crisis Period (Daily)										
R_CN		0.30	0.33	0.08	0.28					
R_RS						0.61	0.57	0.44		0.51
R_WI	0.19	0.39	0.38	0.04	0.23	0.62	0.59	0.44	0.52	0.40

This table reports pairwaise cross-market returns correlation. R_CN, R_ID, R_MY, R_PK, and R_PH stand for indices returns of China, Indonesia, Malaysia, Pakistan, and Philippines stock markets, respectively. R_CZ, R_PL, R_RM, R_RS, and R_UR stand for indices returns of Czech Republic, Poland, Romania, Russia, and Ukraine stock markets, respectively. R_WI is world market returns of MSCI AC World Index.

In addition, China stock market as a dominant stock market in the Asian region only sends its returns volatility to Malaysia stock market. Similar pattern suggests that China stock market also has a higher degree of integration only with Malaysia stock market. This evidence indicates that volatilty transmission from China would happen by the condition of higher degree of integration with Malaysia stock market. Furthermore, the returns volatility of Russia stock market as a dominant stock market in Eastern Europe only affects the volatilities of Czech Republic, Romania, and Poland stock markets. On the other hand, the Russia stock market also has a higher degree of integration with these three stock markets. These two corresponding proofs indicate that volatilty delivery from Russia would happen on condition that the level of integration with each of the three stock markets is higher.

According to the results of volatility spillover and market integration that have been examined, it can be argued that the volatility of stock market affected by the volatility of other stock market occurs when both stock markets have a higher degree of integration. In short, the recipient of volatilty is integrated with the sender. In contrast, the volatilty of a domestic stock market which

is segmented toward world or regional market would not change. These empirical evidences corroborate the conseptual framework, for instance, from Rejeb and Arfaoui (2016) who argue that in the last decade, a number of studies have focused on analyzing the transmission of volatility among emerging markets with respect to the degree of financial integration after their liberalization process. Their statement confirms the opinion of Phylaktis and Ravazzolo (2002) that financial liberalization makes financial markets more integrated into global financial movements and thus more sensitive to external shocks. The propagation of volatility is the consequence of financial interdependence across markets.

5. CONCLUSION

We investigate volatility transmissions from world market to the ten stock markets in Asian and Eastern Europe regions, and from major stock market in the region to the four rests stock markets. For overall sample period, the results suggest that spreading of volatility from world market as a sender generally occurs on the whole stock markets, except to Pakistan; spreading of volatility in Asian region from China only occurs on Malaysia stock market; and spreading of volatility in Eastern Europe region from Russia occurs on Czech Republic, Poland, and Romania stock markets. These results differ from the findings during the global financial crisis which suggest that spreading of volatility from world market does not occur on China, Pakistan, and Philippines stock markets; spreading of volatility from China does not occur on the whole stock markets in Asian region; conversely, spreading of volatility from Russia occurs on the whole stock markets in Eastern Europe region.

Stock markets that receive external volatility and were exposed against volatility transmissions from other stock markets reflect that investors in these stock markets face uncertainties in returns and higher risks in their securities. Such stock markets have stocks whose price movements are difficult for investors to predict so that they should redesign their portfolio formation with a larger number of stocks and longer analysis time and they could be inconvenient for this situation. In addition, such stocks could result in increased waiting time for transactions so that could reduce the trading liquidity.

Analysis of the volatility transmission was accompanied by observing its degree of integration. The findings on the degree of integrations among world market and ten selected stock markets show that world market has very low degree of integration only with Pakistan stock market; China has higher degree of integration only with Malaysia stock market; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. In addition, for the global financial crisis period, world market has lower degree of integration with China, Pakistan, and Philippines stock markets; China has higher degree of integration with Indonesia and Malaysia stock markets; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. From this finding, including the stocks from Pakistan stock market is the better design in international portfolio diversification to minimize the portfolio risk.

When the existence of volatility spillover is involved to its degree of integration, the findings appear that in general there is synchronous pattern on both aspects. We have notion that volatility spillovers are conditional on their degree of integrations. Specifically, domestic stock markets which have higher (lower) degree of integration would (not) receive volatility spillover from world market

and major stock markets in their region. This phenomenon happened not only for overall period but also during financial crisis period. Stock market which is more integrated toward international financial movements would be more sensitive against external shock. As the consequence, the volatility from the international market will be easier to transmit to the integrated stock market.

The finding indicates that volatility of financial asset which is integrated across borders could potentially be a source of vulnerability for financial asset in national stock market. Analysis to generate this finding was very simple that only linking the patterns of volatility spillover to the patterns of dynamic degree of integration among markets. For future research, it would be better to expand this issue by utilizing the various causality methods that examine the effect of market integration on volatility spillover. To apply such methods, however, the research should to create a measure for volatility spillover which acts as a dependent variable. Moreover, the challenges for future research are to explore the other factors influencing potentially on volatility spillover and to investigate the consequence that could emerge from the volatility spillover among stock markets.

The implication for decision arising from the findings is that as emerging stock markets become more integrated with world market and major stock market regionally, the market participants should strengthen prudential regulations and actions to prevent harmful shock spillover and to limit the propagation of financial crises across borders. Moreover, according to the findings, risk managers, decision makers, and hedgers should redesign their optimal portfolios and rebuild their policies to prevent rising risks of financial transmission.

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9. Feedback from reviewer: Sabtu, 3 November, 2018, 23.03

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Kepada:Najmudin M.Si
Judul: feedback from reviewer

Dear Authors,

The paper was improved. However, authors should focus more on the economic significance of their results with respect to previous studies from literature.

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10. Revision Submission #2, Sabtu, 18 November 2018, 01:10

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We send the 2nd revision particularly about economic significance of the results.
We send two files:
a. Clean final paper
b. Changes in editing process due to 2nd revision and addition (the text highlight color)
We are waiting for your information about the publishing process and its fee.

Thank you

Best regards,
Najmudin

CHANGES IN EDITING PROCESS DUE TO 2ND REVISION AND ADDITION (THE TEXT HIGHLIGHT COLOR)

Muharam, H., Wisnu, M., Arfinto, E. D., Najmudin. (2018). Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets. *Journal of International Studies, 11*(4), 277-293. doi:10.14254/2071-8330.2018……..

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Scientific Papers

Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets

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Abstract. This research aims to investigate volatility transmitted from world market to ten Asian and Eastern Europe stock markets and from major stock market in the region to the rest stock markets by considering their degree of integrations. To assess this purpose, we apply GARCH(p,q) model and involve the dynamic conditional correlation (DCC) model to generate the dynamic degree of integration. The monthly market indices data, over period from May 2002 to March 2018, are taken from eleven markets which consist of five Asian (China, Indonesia, Malaysia, Pakistan, and Philippines), five Eastern Europe (Czech Republic, Poland, Romania, Russia, and Ukraine), and world markets. Furthermore, the volatility spillover was analysed during the global financial crisis for period of May 1, 2008 to May 29, 2009. The finding shows that volatility spillovers from world and regional major markets to domestic stock markets are conditional on the degree of integrations. Specifically, there is no volatility

Received:
September, 2018
1st Revision:
October, 2018
Accepted:
November, 2018

DOI:
10.14254/2071-8330.2018/……..

spillover from world and regional major markets on segmented stock markets. In contrast, domestic stock markets which are integrated could experience in volatility spillover. Moreover, this finding exists in the crisis circumstance and overall period.

Keywords: volatility spillover, dynamic integration, GARCH model.

JEL Classification: F36, G15, C10

1. INTRODUCTION

Prior researches have investigated the integration among stock market classes or among stock market types, for instances between developed and developing stock markets or between conventional and Islamic stock markets (Al Nasser & Hajilee, 2016; Majdoub et al., 2016). Nevertheless, the integration of the stock markets toward international market has not been revealed yet. Similarly, volatility spillover as an effect of integration discussed on the prior researches was analyzed only among countries bilaterally, e.g. the volatility is transmitted from a particular developed country to an emerging country (Neaime, 2012). However, the susceptible strength to volatility spillover from international market has not been disclosed yet. This paper expands both issues focusing on the causality of volatilities from world market to domestic markets through the explanation involving the market integration aspect. It refers to the international portfolio diversification framework which states that the financial assets comovement among stock markets has an important part in volatility change.

Furthermore, the existing studies examining on the presence of volatility spillover have controversial findings. On the one side, some studies conclude that there are volatility spillovers on stock markets, among others Dungey et al. (2007); Rejeb and Boughrara (2015). On the other side, another study finds no evidence of volatility spillover (Majdoub & Mansour, 2014). In addition, Gebka and Serwa (2007) state that there is different evidence on volatility spillover among emerging stock markets in Latin America, East Asia and Eastern Europe. It is likely that the existing studies ignore the degree of integration among markets observed so that the findings of volatility spillover have dissimilar conclusion. This argument is supported by statement of Jebran et al. (2017). They acknowledge that the stock markets will be more vulnerable or contaminated by volatility from the other markets when they are integrated.

Although financial globalization and trade integration have enabled emerging countries to attain risk-sharing through better allocations of capital and thereby higher economic development, they also produced unwanted side-effects, including increased financial fragility and unstable long-term growth. As emerging markets develop further and exhibit higher comovement with the mature markets, they automatically become more responsive to the volatility of stock markets elsewhere in the world. The detailed assessments of the level and the nature of financial integration among stock markets are thus necessary. Such analysis can shed light on the source of shock spillover across markets (Balli et al., 2015). Accordingly, we expect that the event of volatility spillover may occur only for the stock markets which have higher integration with world market

and the major stock market in the region such as China in Asian or Russia in Eastern Europe stock markets.

To solve the issue, this paper contributes in the four ways related to the expansion in subject of analysis and analytical procedure. The first is variation in the degree of integration that links the world market index movement to the returns of each stock market for different regional markets. The second is variation in the volatility spillover that connects world market volatility to the volatility of each stock market for different regional markets. The third, this paper provides explanation on dissimilar findings of existing studies which attempts to investigate dynamic volatilities for emerging markets by considering their integration level toward world market. Moreover, this paper contributes on the existing literature by employing the recent data and comparing to the crisis circumstance. The finding of this paper has valuable information for international investors and policy makers on consequence of integrated domestic market. It could make their decision more efficient and effective in anticipating the events among stock markets.

The higher integration of international stock markets and correlated stock prices volatility would weaken the international portfolio diversification (Bekaert et al., 2005). The integration of a stock market to the global market is urgent to be disclosed because otherwise it would limit the opportunities for investors to benefit from their portfolio diversification and reduce the chances for a number of firms to obtain a lower cost of capital. Moreover, side-effect of the higher integration could generate the financial disturbances and shocks in a stock market. For instance, the global financial crisis overspreads and suppresses emerging stock markets and makes a rapid decline in the prices (Neaime, 2012).

2. LITERATURE REVIEW

There is a wide variety of literature on stock market integration and volatility across markets. Some studies have discussed only returns spillover, while some other studies have looked at both the first and the second moments of equity prices to discuss the cross-border spillover. We investigate, as the second category of the studies, the volatility spillover from international market and the major stock markets regionally to emerging stock markets by considering their dynamic integrations. The literature provides diverse definitions of financial integration. According to the law of one price, Chen and Knez (1995) define integrated markets as markets where investors can, in one country, buy and sell without restriction equities that are issued in another country and as a result, identical securities are issued and traded at the same price across markets after adjustment for foreign exchange rates.

Stock market integration is the situation when the markets have higher and stable relationship due to their stocks prices move together in similar direction for similar period. It could be defined as a unification of a number of separate stock markets operationally in the mechanisms, activities, characteristics of the instruments and interactions of the participants. The markets in which the assets require the same expected returns regardless of the trading locations are said to be integrated. While the markets where the expected returns of an asset depends on its location are said to be segmented (Arouri et al., 2012; Bekaert & Harvey, 2003).

Attention to stock market integration arises mainly because the financial theory states that integrated stock markets will be more efficient than segmented stock markets. When the stock

market was integrated, investors from all countries will be able to allocate their capital to the most productive locations. With more flow of cross-border funds, additional trade in any securities may increase the liquidity of stock market. In addition, it could make the cost of capital to fall on companies that are looking for capital and make the transaction costs incurred by investors to be lower. It indicates a more efficient capital allocation (Click & Plummer, 2005).

Financial markets in most developed countries have grown rapidly over the past decade due to various factors such as deregulation, globalization and advances in information technology. There are no restrictions such as regulatory restrictions, transaction costs, taxes, and tariffs on foreign asset trading or portfolio equity flow mobility. The integration of financial markets around the world also appears to grow among them (Marashdeh dan Shrestha, 2010). In recent years, most of studies found that stock markets observed had higher integration level, for instance between Germany and emerging markets (Al Nasser & Hajilee, 2016) and among Malaysia, Indonesia, and Turkey stock markets (Arshad, 2017). Employing international CAPM method, Najmudin et al. (2017) find that there is higher integration on the UK, Japan, Malaysia, Thailand, Indonesia, and Singapore stock markets.

Returns volatility in economics and finance field reflects the degree of variation for the returns of a financial asset such as stock, market index, or exchange rate. The standard deviation and variance of returns are the most common measures of returns volatility. The standard deviation is used in studies which assume that volatility is constant time-series, whereas dynamic conditional variance or residual is used in studies which assume that volatility varies over time. Financial assets that have higher volatility indicate that the assets have higher risk (Kočenda, 2017). Economic and especially financial time series are prone to exhibit periods of high and low volatility. Therefore, it is often misleading to measure volatility by a static standard deviation or unconditional variance. However, exactly such pattern can be modelled using conditional heteroskedastic disturbances. The solution to this problem can be found in the conditional heteroskedasticity models.

The studies on volatility in many stock markets had grown by expanding the issue of how volatility of return in a stock market is contagious and affects the volatility of return in another stock market, also known as volatility spillover. In other words, volatility spillover is a change in volatility of returns in one market because of the transmission of market-specific information from other markets. Cross market linkages in the conditional second moments of stock return is another important topic of international financial relations. In addition to various domestic and global factors, returns volatility of major stock market is one of the important factors of stock returns volatility in a stock market (Mukherjee & Mishra, 2010).

Volatility spillover has been examined by Ng (2000) who investigates the magnitude and changing characteristics from the US and Japan. The evidence suggests that the significant factors of market volatility are regional and international variables. Similarly, Dungey et al. (2007) report developed market has important role in transmitting volatility to emerging market and there is volatility spillover among regions. Furthermore, Rejeb and Boughrara (2015) conclude that there is a volatility transmission across financial markets; geographical proximity is essential factor in enlarging volatility transmission; and the liberalization contributes significantly in enlarging international volatility transmission. Applying GARCH model on India, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, and

Thailand stock markets, Mukherjee and Mishra (2010) suggest that return spillovers between India and its Asian counterparts are found to be positively significant and bidirectional. Contemporaneous spillover of intraday volatility is stronger from other foreign markets to India. However, transmission of information lagged by one day is not found to be stronger.

3. METHODOLOGY

The data are obtained from the websites of stooq.com, msci.com, yahoo.finance.com, and the other relevant publications. The first data set covers stock market indices of China, Indonesia, Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, Ukraine, and world markets. MSCI ACWI is used as a proxy for world market index. All data have the same time period from May 2002 to March 2018 on monthly basis. The second data set covers on daily basis during the global financial crisis during period from May 1, 2008 to May 29, 2009.

The data which consist of five Asian, five Eastern Europe, and world market indices are used to calculate the returns on each market and then used to find the dynamic conditional correlation (DCC) of returns among world market and the ten stock markets, and among a dominant stock market and the four rests in the region. The return of time t for the sample of stock market index i ($R_{i,t}$) is the difference between the natural logarithm of the index price at the current time ($P_{i,t}$) and the natural logarithm of the index price at previous time ($\ln P_{i,t-1}$). The formula is expressed as follows $R_{i,t} = \ln P_{i,t} - \ln P_{i,t-1}$.

The objectives of this research are specifically as follows. The first objective is to analyze the strength of a stock market as recipient against the volatility spillover from international and regional markets as senders. The second is to analyze the dynamic integration of each stock market in both Asian and Eastern European markets toward international and regional markets. The third is to analyze the existence of volatility spillover involving its explanation with the dynamic degree of integration.

To achieve the first objective we adopt the framework of Balli et al. (2015) as well as Mukherjee and Mishra (2010); Ng (2000); Bekaert and Harvey (1997) in working the volatility spillover models for the equity returns from the originator world market to the ten recipient stock markets. The effects of volatility spillover from major stock markets regionally, China in Asian markets and Russia in Eastern Europe markets, to the rest four stock markets are also taken into consideration to formulate their respective univariate AR-GARCH-M(p,q) models.

The volatility of stock return series is time varying so that this paper examines the spillover of the conditional second moments across markets allowing for changing the variances. The generalized autoregressive conditional heteroscedasticity (GARCH) model proposed by Engle (1982) and developed by Bollerslev (1986) has been employed to account for the time-variant conditional variances (Mukherjee & Mishra, 2010). The mean and variance equations of ARCH(p) and GARCH(p,q) models respectively are generally expressed as follow:

Mean equation: $Y_t = c + \varepsilon_t, \varepsilon_t^2 \mid I_{t-1} \sim N(0, \sigma_t^2)$ (1)

Variance equations:

ARCH(p) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2$ (2)

GARCH(p,q) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \ldots + \lambda_q \sigma_{t-q}^2$ (3)

Where Y_t is the individual returns at time t, c is a specific mean, ε_t is the error term, I_t denotes the information available at time t and σ_t^2 is the conditional variance of the error term at time t and a function of both ε_{t-1}^2 (the squared error term in the previous time) and σ_{t-1}^2 (conditional variance in the previous time).

Our empirical approach to achieve the first objective comprises the following steps. The first step, we estimate the volatility of world market and major stock markets in each region as the senders, namely China in Asian markets and Russia in Eastern Europe markets. To obtain the returns volatility for each world, China, and Russia market, respectively, as determinants of the rest eight stock markets volatilities, we perform volatility modeling steps by following the AR-GARCH(1,1) model. The mean equations of AR-GARCH(1,1) model for the three markets are expressed as follow:

$$R_{WI,t} = \alpha + \beta_1 R_{W,t-1} + \varepsilon_t \text{ World} \quad (4)$$

$$R_{CN,t} = \alpha + \beta_1 R_{CN,t-1} + \varepsilon_t \text{ China} \quad (5)$$

$$R_{RS,t} = \alpha + \beta_1 R_{RS,t-1} + \varepsilon_t \text{ Russia} \quad (6)$$

Where $R_{WI,t}$, $R_{CN,t}$, and $R_{RS,t}$ are market returns of world market, China, and Russia stock markets at time t, respectively; and ε_t is error term at time t.

The second step, we estimate how the returns volatilities of the three sender markets are contagious and affect the returns volatility in another stock market as recipient. In order to investigate this volatility spillovers, we apply AR-GARCH-M(p,q) model. Unlike in simple GARCH model, the GARCH-M or GARCH-in-Mean model includes the conditional variance or its square root in the conditional mean equation along with other explanatory variables. Conditional variances or GARCH variance series resulted from estimations of AR-GARCH(1,1) model, as in Eqs. (4) – (6), are then used to estimate volatility series as inputs for AR-GARCH-M(p,q) model. The model is estimated using the maximum likelihood procedure applying the Berndt–Hall–Hall–Hausman (BHHH) algorithm.

The first equation, called as mean equation, of AR-GARCH-M(p,q) model for the recipient domestic stock market i is expressed as follows:

$$R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t. \quad (7)$$

The second equation, called as variance equation, is expressed as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{j,t}. \quad (8)$$

Where $R_{i,t}$ is returns of recipient domestic stock market i at time t; $\sigma_{i,t}$ is the square root of conditional variance on stock market i at time t; ε_t is error term at time t; $\sigma_{i,t}^2$ is the conditional variance of the error term at time t; ε_{t-p}^2 is the squared error term at time t-p; σ_{t-q}^2 is conditional variance at time t-q; and $V_{j,t}$ is volatilities of sender market j at time t.

To achieve the second objective we apply the DCC (dynamic conditional correlation) approach as developed by Engle (2002) and worked by Majdoub and Mansour (2014). We estimate the conditional relationship of returns among world market and ten selected stock markets. The principal advantage of this model is that while it retains the main features of standard GARCH models, it allows us to model explicitly time variation in the conditional covariance and correlation matrix.

DCC model can be described briefly as follows. In the DCC-GARCH(1,1) model, the conditional variance–covariance matrix is defined by $H_t = D_t R_t D_t$, where H_t takes the following formulation:

$$H_t = \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \begin{bmatrix} 1 & \rho_{12,t} \\ \rho_{21,t} & 1 \end{bmatrix} \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \quad (9)$$

D_t is a (n x n) diagonal matrix of time-varying standard deviations from univariate GARCH models with $(h_{ii,t})^{1/2}$ on the *i*th diagonal, i = 1, 2, …, n; R_t is the (n x n) time-varying correlation matrix and R_t is conditional correlation matrix:

$$R_t = (\text{diag}(Q_t)^{-1/2}\, Q_t\, (\text{diag}(Q_t))^{-1/2} \quad (10)$$

The evolution of the correlation in DCC model is given by:

$$Q_t = \bar{Q}(1 - \alpha - \beta) + \alpha\, \varepsilon_{t-1}\, \varepsilon'_{t-1} + \beta Q_{t-1} \quad (11)$$

Where $\bar{Q}$ is the unconditional correlation matrix of the epsilons; $Q_t = (q_{ii,t})$ is the (n x n) time-varying covariance matrix of ε_t; α and β are non-negative scalar parameters satisfying $(\alpha + \beta) < 1$.

In the empirical methodology, Arouri and Nguyen (2010) convey that conditional correlation coefficient ϱ_{ij} between two markets i and j at time t is then expressed by the following equation:

$$\rho_{ijt} = \frac{(1-\alpha-\beta)\bar{q}_{ij} + \alpha\mu_{i,t-1}\mu_{j,t-1} + \beta q_{i,t-1}}{\left((1-\alpha-\beta)\bar{q}_{ii} + \alpha\mu^2_{i,t-1} + \beta q_{ii,t-1}\right)^{1/2}\left((1-\alpha-\beta)\bar{q}_{jj} + \alpha\mu^2_{j,t-1} + \beta q_{jj,t-1}\right)^{1/2}} \quad (12)$$

Where q_{ij} refers to the element located in the *i*th row and *j*th column of the matrix Q_t.

DCC-GARCH model as described above is estimated using a two-stage procedure. In the first stage, a univariate GARCH(1,1) model is estimated for each return series included in the multivariate system. During the second stage, the transformed residuals from the first stage, namely the estimated residuals standardized by their conditional standard deviations, are used to infer the conditional correlation estimators.

The Log likelihood for this estimator can be expressed as:

$$L = -\frac{1}{2}\sum(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon_t) \quad (13)$$

To achieve the third objective we relate the patterns of volatility spillover across markets to the patterns of the degree of integration among those markets. This analysis could confirm the statement that a stock market which has higher comovement with the other stock markets would automatically become more responsive to the volatility of those stock markets. Therefore, in order to understand the patterns of volatility spillover across markets, it is necessary to assess the level and the nature of integration among those markets (Balli et al., 2015).

4. EMPIRICAL RESULTS AND DISCUSSION

We examine volatility spillover accros stock markets and the degree of markets integration by employing the data of market indices during period from May 2002 to March 2018 monthly totaling 191 observations and during sub-period from May 1, 2008 to May 29, 2009 on daily basis. Table 1 exhibits descriptive statistics for ten observed market returns, namely China (CN), Indonesia (ID), Malaysia (MY), Pakistan (PK), Philippines (PH), Czech Republic (CZ), Poland (PL), Romania (RM), Russia (RS), and Ukraine (UR). It consists of mean, deviation standard, maximum, and minimum values for overall and global financial crisis (GFC) sample periods.

Table 1

Descriptive statistics of market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
Mean	0.39	1.29	0.48	1.58	0.95	0.48	0.69	1.02	0.61	1.26
St. Dev	8.08	6.13	3.58	7.15	5.32	5.97	5.91	8.34	9.56	11.63
Max.	24.25	18.34	12.70	20.23	13.95	17.11	18.84	25.72	26.68	44.51
Min.	–28.28	–37.72	–16.51	–44.88	–27.54	–31.65	–27.45	–41.42	–44.91	–35.26
Panel B. Global Financial Crisis Period (Daily)										
Mean	–0.10	–0.06	–0.09	–0.30	0.04	–0.25	–0.17	–0.28	–0.18	–0.22
St. Dev	2.50	2.33	1.12	2.01	1.86	3.17	2.13	3.24	4.43	3.61
Max.	9.03	7.36	4.06	8.25	7.06	12.36	6.08	12.85	20.20	11.67
Min.	–8.04	–10.95	–3.68	–5.13	–5.32	–16.19	–8.29	–11.82	–21.20	–13.21

This table reports the mean, standard deviation, and the minimum and maximum values of market indices returns for overall sample period (monthly) and global financial crisis period (daily) for China (CN), Indonesia (ID), Malaysia (MY), Pakistan (PK), Philippines (PH), Czech Republic (CZ), Poland (PL), Romania (RM), Russia (RS), and Ukraine (UR) stock markets.

For all sample period, Pakistan is the stock market which provides the highest average returns amount to 1.58 percent. This interesting value, however, was accompanied by the higher risk measured by the standard deviation of returns (7.15) and the spread of returns (65.11 percent) ranging from maximum value (20.23 percent) to minimum value (–44.88 percent). In contrast, China has the lowest average returns (0.39 percent) followed by Malaysia stock market (0.48 percent) and yet investors in China stock market bear the highest risk in Asian region with standard deviation amount of 8.08.

In Eastern European region, Czech Republic stock market has the lowest average returns (0.48 percent) and has lower risk indicated by the standard deviation and spread of returns in this market amount of 5.97 and 48.75 percent, respectively. Conversely, Ukraine stock market has the highest average returns in the region followed by the highest risk. This information was presented by the average returns, standard deviation, and spread of returns for this market which are 1.26 percent, 11.63, and 79.77 percent, respectively.

The lowest risk in Asian region appears in Malaysia stock market with standard deviation and spread of returns are 3.58 and 29.21 percent, respectively. Similar position is found on Poland stock market in Eastern European region with standard deviation and spread of returns are 5.91 and 46.29 percent, respectively. Moreover, Malaysia stock market is the only one stock market that has the lower risk than the world market returns. Standard deviation and spread of returns for world market are 4.50 and 33.07 percent, respectively.

For the GFC period, Russia stock market exhibits the highest standard deviation and spread values in both regions amount of 4.43 and 41.40 percent, respectively. This phenomenon for the

GFC period on Russia stock market was dissimilar with condition for all sample period which the highest risk was found on Ukraine stock market. In Asian region, such phenomenon appears on China stock market that has the highest standard deviation for the GFC period (2.50) and for all sample period (8.08) in the region. In general, the data of all stock markets inform that each stock market has a difference characteristic or heterogeneous in rate of returns and its risk.

We consider the stationarity pattern of data to analyze furthermore all variables and to draw an inference from statistical ways. To test the stationarity, we apply one of unit root methods, namely ADF (Augmented Dickey-Fuller) Test. According to unit root test, the result shows that stationer patterns in the level form appear on all observed market returns data. This conclusion prevails on the data for overall sample period (monthly) and for sub-sampel period of global financial crisis (daily). Therefore, it is not necessary to transform or differentiate the data of those eleven markets returns.

The variance equation of the AR-GARCH-M(p,q) model for this research is written in general as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p\, \varepsilon_{i,t-p}^2 + \lambda_q\, \sigma_{i,t-q}^2 + \Sigma\delta_n\, V_{j,t}.$$

The variance equation above becomes operational guidelines to interpret generally the volatililty transmission from one market to the volatility of another market. Table 2 contains the results of ten estimate models for each recipient stock market. These ten estimate models are the best fit regression models which are selected through iteration process from various models, such as ARCH(p,q), GARCH(p,q), ARCH-M(p,q), and GARCH-M(p,q).

The model specifications in variance equation using overall sample period for each ten recipient stock market are expressed as follow:

$\sigma_{CN,t}^2$ = ***28.129 + ***0.341 $\varepsilon_{CN,t-1}^2$ + **0.999 V_WI_t — China

$\sigma_{ID,t}^2$ = 7.132 + **0.278 $\varepsilon_{ID,t-1}^2$ – 0.174 $\sigma_{ID,t-1}^2$ + 0.132 V_CN_t + *0.791 V_WI_t — Indonesia

$\sigma_{MY,t}^2$ = ***3.821 + 0.053 $\varepsilon_{MY,t-1}^2$ + **0.052 V_CN_t + ***0.216 V_WI_t — Malaysia

$\sigma_{PK,t}^2$ = ***43.073 – 0.006 $\varepsilon_{PK,t-1}^2$ – ***0.698 $\sigma_{PK,t-1}^2$ + 0.271 V_CN_t + 0.680 V_WI_t — Pakistan

$\sigma_{PH,t}^2$ = ***13.817 – ***0.156 $\varepsilon_{PH,t-1}^2$ + 0.095 V_CN_t + ***0.417 V_WI_t — Philippines

$\sigma_{CZ,t}^2$ = ***10.975 – 0.079 $\varepsilon_{CZ,t-1}^2$ + ***0.345 V_RS_t + ***1.176 V_WI_t — Czech R.

$\sigma_{PL,t}^2$ = ***16.684 + 0.096 $\varepsilon_{PL,t-1}^2$ + ***0.281 V_RS_t + ***0.622 V_WI_t — Poland

$\sigma_{RM,t}^2$ = ***41.223 – 0.177 $\sigma_{RM,t-1}^2$ + ***0.755 V_RS_t + ***1.815 V_WI_t — Romania

$\sigma_{RS,t}^2$ = **72.584 – 0.563 $\sigma_{RS,t-1}^2$ + **2.838 V_WI_t — Russia

$\sigma_{UR,t}^2$ = ***71.994 – 0.031 $\varepsilon_{UR,t-1}^2$ + 0.829 V_RS_t + **2.642 V_WI_t — Ukraine

Table 2

Estimates of GARCH-M(p,q) model for overall period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.659	*-0.444	**-0.684	-0.597	-0.588		
C	-0.250	***1.360	**0.536	5.997	***3.089	***4.084	**4.060	**5.449	0.535	1.207
$R_{i,t-1}$	**0.184	0.095	0.051	0.093	0.009	0.079	0.028	0.127	**0.174	***0.297
Conditional Variance ($\sigma_{i,t}^2$)										
C	***28.129	7.132	***3.821	***43.073	***13.817	***10.975	***16.684	***41.223	**72.584	***71.994
$\varepsilon_{i,t-1}^2$	***0.341	**0.278	0.053	-0.006	***-0.156	-0.079	0.096			-0.031
$\sigma_{i,t-1}^2$		-0.174		***-0.698				-0.177	-0.563	
V_CN		0.132	**0.052	0.271	0.095					
D(V_RS)						***0.345	***0.281	***0.755		0.829
V_WI	**0.999	*0.791	***0.216	0.680	***0.417	***1.176	***0.622	***1.815	**2.838	**2.642
R^2	0.005	0.034	0.007	0.064	0.016	0.035	0.014	0.034	0.058	0.082
N	189	189	189	182	189	188	188	188	189	188

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for overall period. The first equation, called as mean equation, is $R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t$. The second equation, called as variance equation, is $\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{j,t}$. In addition, V_CN, D(V_RS), and V_WI in variance equation stand for returns volatility of China, Russia, and world markets, respectively. The volatility of Russia stock market partially was performed in transformation form, i.e., in first difference form D(V_RS), due to multicollinearity problem with volatility of the world market index (V_WI). The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

Table 3

Estimates of GARCH-M(p,q) model for global financial crisis period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.091				-0.209		
C	-0.122	-0.083	**-0.145	0.007	0.050	**-0.268	-0.135	0.376	-0.213	**-0.402
$R_{i,t-1}$	-0.052	***0.181	***0.130	***0.241	*0.162	0.106	**0.142	0.079	**0.146	***0.224
Conditional Variance ($\sigma_{i,t}^2$)										
C	***5.384	0.228	***0.211	***2.527	0.183	0.223	***0.051	***8.886	0.279	***0.377
$\varepsilon_{i,t-1}^2$	0.069	0.039	***-0.101	***0.186	*0.127		***-0.066		-0.049	
$\sigma_{i,t-1}^2$			***0.779	***0.446	**0.597	***0.661	***1.025	***-0.968		***0.951
V_CN		0.081	0.005	-0.144	0.037					
D(V_RS)						***0.840	***0.139	**0.292		***0.909
V_WI	0.071	***0.975	***0.029	-0.155	0.104	***0.556	**0.027	**1.051	***4.349	***0.068
R^2	0.002	0.050	0.029	0.069	0.029	0.001	0.020	0.013	0.018	0.019
N	247	247	247	246	247	256	256	257	258	257

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for each stock market for global financial crisis period.

The model specifications in variance equation above, as presented in Table 2, inform that conditional variance of world market (V_WI) has positive effect on conditional variances of China, Indonesia, Malaysia, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine stock markets. It is indicated by the significant coefficients of V_WI statistically amount of 0.999, 0.791, 0.216, 0.417, 1.176, 0.622, 1.815, 2.838, and 2.642, respectively. Conversely, conditional variance of world market has no effect on conditional variance of Pakistan stock market which is indicated by the insignificant coefficient of V_WI statistically amount of 0.680. These results suggest that there are volatility spillovers for all sample period from world market to nine observed stock markets and there is no volatility spillover on Pakistan stock market.

Regionally, the results of estimate on Asian stock markets inform that conditional variance of China stock market (V_CN) has positive effect on conditional variance of Malaysia stock market. It is indicated by the significant coefficient of V_CN amount of 0.052 at the 5% level. In contrast, conditional variance of China has no effect on conditional variances of Indonesia, Pakistan, and Philippines stock markets. It is indicated by the insignificant coefficients of V_CN amount of 0.132, 0.271, and 0.095, respectively. These evidences suggest that the volatility spillover in Asian region from China stock market only occurs on Malaysia stock market.

In Eastern Europe, conditional variance, in first difference form, of Russia stock market D(V_RS) has significantly positive effect on conditional variances of Czech Republic, Poland, and Romania stock markets. It is indicated by the significant coefficients of D(V_RS) amount of 0.345, 0.281, and 0.755 at the 1% level, respectively. Conversely, conditional variance of Russia stock market has no effect on conditional variance of Ukraine stock market which is indicated by the insignificant coefficient of D(V_RS) amount of 0.829. These results inform that there are volatility spillovers from Russia as a major stock market to all stock markets observed in Eastern Europe region, except to Ukraine stock market.

The model specifications in variance equation using the GFC sample period for each ten recipient stock market, as presented in Table 3, are expressed as follow:

$\sigma^2_{CN,t}$ = ***5.384 + 0.069 $\varepsilon^2_{CN,t-1}$ + 0.071 V_WI$_t$ — China

$\sigma^2_{ID,t}$ = 0.228 + 0.039 $\varepsilon^2_{ID,t-1}$ + 0.081 V_CN$_t$ + ***0.975 V_WI$_t$ — Indonesia

$\sigma^2_{MY,t}$ = ***0.21 – ***0.10 $\varepsilon^2_{MY,t-1}$ + ***0.779 $\sigma^2_{MY,t-1}$ + 0.005 V_CN$_t$ + ***0.03 V_WI$_t$ — Malaysia

$\sigma^2_{PK,t}$ = ***2.527 + ***0.186 $\varepsilon^2_{PK,t-1}$ + ***0.446 $\sigma^2_{PK,t-1}$ – 0.144 V_CN$_t$ – 0.155 V_WI$_t$ — Pakistan

$\sigma^2_{PH,t}$ = 0.183 + *0.127 $\varepsilon^2_{PH,t-1}$ + **0.597 $\sigma^2_{PH,t-1}$ + 0.037 V_CN$_t$ + 0.104 V_WI$_t$ — Philippines

$\sigma^2_{CZ,t}$ = 0.223 + ***0.661 $\sigma^2_{CZ,t-1}$ + ***0.840 V_RS$_t$ + ***0.556 V_WI$_t$ — Czech R.

$\sigma^2_{PL,t}$ = ***0.05 – ***0.07 $\varepsilon^2_{PL,t-1}$ + ***1.025 $\sigma^2_{PL,t-1}$ + ***0.14 V_RS$_t$ + **0.03 V_WI$_t$ — Poland

$\sigma^2_{RM,t}$ = ***8.886 – ***0.968 $\sigma^2_{RM,t-1}$ + **0.292 V_RS$_t$ + **1.051 V_WI$_t$ — Romania

$\sigma^2_{RS,t}$ = 0.279 – 0.049 $\varepsilon^2_{RS,t-1}$ + ***4.349 V_WI$_t$ — Russia

$\sigma^2_{UR,t}$ = ***0.377 + ***0.951 $\sigma^2_{UR,t-1}$ + ***0.909 V_RS$_t$ + ***0.068 V_WI$_t$ — Ukraine

Volatility spillover is the causality in variance among markets (BenSaïda et al., 2018). The results from causality analyses of volatilities using overall sample period are not distantly different with the results using the GFC sample period. The differences are as follow: volatility of world market has no effect on volatilities of China and Philippines stock markets; volatility of China stock market has no effect on volatility of Malaysia stock market; and volatility of Russia stock market

has positive effect on volatility of Ukraine stock market. The findings of this paper on the existence of volatility spillover are consistent with studies of Abbas et al. (2013); Balli et al. (2015); Rejeb and Boughrara (2015). For example, Balli et al. (2015) found that there is significant spillover effects from developed stock markets to emerging markets.

This empirical study on volatility spillover from the global market to a stock market has an important role from the particular perspective of portfolio diversification and hedging strategies (Majdoub & Mansour, 2014). Moreover, studying spillover volatility has direct implication in designing optimal portfolios and building policies to prevent harmful shock transmission and to limit the propagation of financial crises across borders (BenSaïda et al., 2018). Therefore, understanding the volatility across markets is crucial for risk managers, hedgers, and policy makers, especially volatility spillover due to the financial crisis.

Table 4 presents pairwaise dynamic conditional correlation (DCC) among market indices returns in average values. More specific, it was divided into two part sub-sample periods: overall sample period in Panel A and global financial crisis sample period in Panel B. Furthermore, Table 4 Panel A exhibits eighteen average series of stock market pairs monthly among the world market and ten stock markets in Asian and Eastern Europe regions.

Table 4

Average dynamic correlations among market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
R_CN		0.22	0.31	-0.02	0.23					
R_RS						0.53	0.54	0.52		0.46
R_WI	0.37	0.54	0.58	0.02	0.50	0.65	0.65	0.49	0.61	0.43
Panel B. Global Financial Crisis Period (Daily)										
R_CN		0.30	0.33	0.08	0.28					
R_RS						0.61	0.57	0.44		0.51
R_WI	0.19	0.39	0.38	0.04	0.23	0.62	0.59	0.44	0.52	0.40

This table reports pairwaise cross-market returns correlation. R_CN, R_ID, R_MY, R_PK, and R_PH stand for indices returns of China, Indonesia, Malaysia, Pakistan, and Philippines stock markets, respectively. R_CZ, R_PL, R_RM, R_RS, and R_UR stand for indices returns of Czech Republic, Poland, Romania, Russia, and Ukraine stock markets, respectively. R_WI is world market returns of MSCI AC World Index.

The pairs of R_CN vs R_PK and R_WI vs R_PK, as presented in Panel A, appear the lowest average dynamic correlation amount to -0.02 and 0.02, respectively. They are followed by the pairs of R_CN-R_ID and R_CN-R_PH amount to 0.22 and 0.23, respectively. This information suggests that Pakistan stock market has the lowest degree of integration in observed markets pairs with world market and major markets in its region. In additon, the pairs of world market with all markets in Eastern Europe have strong average dynamic correlation from 0.43 with Ukraine to 0.65 with Czech Republic and Poland stock markets, respectively. This evidence indicates that the degree of integrations among world market and five stock markets in Eastern Europe region in a whole are higher.

In Asian region, all pairs of China and the four rests markets have weak average correlations from –0.02 with Pakistan to 0.31 with Malaysia. In Eastern Europe region, the pairs of Russia with the four rests markets have strong average correlations from 0.46 with Ukraine to 0.54 with Poland stock market. This fact informs that China has lower degree of integration with entire stock market in Asian region and Russia has higher degree of integration with entire stock markets in Eastern Europe region. The results generally do not support the conclusion of Naranjo and Porter (2007) which state that returns in emerging markets appear very low correlation with returns in developed markets. Moreover, it was partly similar to conclusion of Lean and Smyth (2014) which report that relationship among the major markets and between major market and emerging market have increased over time. In addition, Arshad (2017) and Najmudin et al. (2017) conclude that Malaysia and Indonesia are classified as integrated stock markets.

Table 4 Panel B, which contains observations during GFC period, provides confirmation against previous information interpreted from Panel A. It differs to observations for overall sample period in average dynamic correlations only for pairs of R_WI vs R_CN and R_WI vs R_PH. The values of average dynamic correlations between world market and China market returns and between world market and Philippines market returns in the later sample observations are 0.19 and 0.23, respectively. These values are lower than the values of average dynamic correlations for overall sample period observations amount to 0.37 and 0.50, respectively. Therefore, the interpretation of the data at Panel B has much similarity with the interpretation from Panel A. In general, the result informs that there is opportunity for international investors to diversify internationally their fund by involving the stocks from China and Pakistan stock markets into their portfolio formation.

This research shows that stocks in the Asian market region have varied characteristics and are not identical as a whole with the world market stock prices that do not move in the same direction. By contrast, stocks in the Eastern Europe market region have the same expected returns which the investors could trade at any location in this region. The empirical evidence leads to an economic highlight that a segmented stock market could be stronger from the propagation of external volatility such as Pakistan for both the sample periods as well as China and Philippines for the GFC sample period. Conversely, all stock markets in Eastern Europe have a higher level of integration with the world market. Such markets are susceptible to be contaminated by the returns volatility from world market as a result of trade transactions by international investors. This fact was proven in this research which shows that returns volatilities of all stock markets in Eastern Europe are influenced by returns volatility of world market.

The volatility transmission from one stock market to other stock markets found in the investigation of this research has a pattern that is almost similar to the pattern occurring at the level of integration among those stock markets. The returns volatility of world market affects returns volatilities of all observed stock markets, except for the volatility of Pakistan stock market. Similarly, world market also has a higher degree of integration with all observed stock markets, except with Pakistan stock market. These patterns indicate that the volatility from world market would be sent under condition that the level of integration with its recipient stock market is higher.

For integrated domestic markets we interpret that the lower the returns volatility in world market, the lower the returns volatilities in domestic markets and vice versa. Higher integration of

a domestic stock market towards the world could accelerate the transmission of volatility. In segmented domestic markets, when returns volatility of world market changes, the returns volatilities of domestic markets would not be affected. Therefore, international investors should distribute their funds also on the stocks in segmented stock markets such as Pakistan that was not affected by the spillover volatility. This decision was taken to compensate for external risks originating from the world market to achieve minimum portfolio risk.

In addition, China stock market as a dominant market in its region does not send its volatility to Indonesia, Pakistan, and Philippines markets. Similar pattern suggests that China market also has a lower degree of integration with these three markets. This evidence indicates that volatility transmission from China would not happen by the condition of lower degree of integration. Exception in the Asian region appears in Malaysia stock market. The lower returns relationship between Malaysia and China market was not reflected in volatility on Malaysia which is significantly affected by the volatility of China market.

Furthermore, the returns volatility of Russia stock market as a dominant stock market in Eastern Europe affects the volatilities of Czech Republic, Romania, and Poland stock markets. In the same pattern, Russia stock market also has a higher degree of integration with these three stock markets. These two corresponding proofs indicate that volatility transmission from Russia would happen on condition that the level of integration with each of the three stock markets is higher. As an exception, Ukraine stock market is not in accordance with these general patterns. For the entire sample period, although Ukraine stock market has a higher level of integration with Russia market, this stock market was not affected by changes in returns volatility of the major market.

The general patterns of spillover volatility and degree of market integration as interpreted in the world level are not distantly different from general patterns in the regional level. However, it does not cover Malaysia and Ukraine stock markets against major stock market in their regions for all sample periods. The results from both regions indicate that change in the degree of integration with major stock market was not reflected in the spread of volatility in Ukraine and Malaysia stock markets, but it was more due to the degree of integration with world market.

According to the results of volatility spillover and market integration that have been examined, it can be argued that the volatility of stock market affected by the volatility of other stock market occurs when both stock markets have a higher degree of integration. In short, the recipient of volatility is integrated with the sender. In contrast, the volatility of a domestic stock market which is segmented toward world or regional market would not change. These empirical evidences corroborate the conseptual framework, for instance, from Rejeb and Arfaoui (2016) who argue that in the last decade, a number of studies have focused on analyzing the transmission of volatility among emerging markets with respect to the degree of financial integration after their liberalization process. Their statement confirms the opinion of Phylaktis and Ravazzolo (2002) that financial liberalization makes financial markets more integrated into global financial movements and thus more sensitive to external shocks. The propagation of volatility is the consequence of financial interdependence across markets.

All information and investor activity including returns volatility from world market would be delivered to integrated domestic markets. When the domestic markets have higher level of integration, the change in returns volatility on world market would be followed by change in returns

volatility on these markets. This evidence supports the theoretical framework of volatility spillover and contagion risk hypothesis. It states that volatility spillover and contagion risk could occur among stock markets which have interrelation each other. Alotaibi and Mishra (2015) confirm that as the progress of emerging markets to become increasingly integrated with global market, their response to the volatility spillovers of stock markets increases, their portfolio diversification ability decreases and they become more vulnerable to external shocks.

International investors who trade their stocks in several stock markets in the world would pay more attention on information and development of world market. When the volatility occurs on the world market, they would respond to this information reflected by change in volatility of domestic stock market. Jebran et al. (2017) state that the evidence of financial interdependence indicates that the financial shocks in one market will spill over to other market. Moreover, Gencer and Hurata (2017) find that volatilities among markets are significantly transmitted in varying magnitudes and signs. Observing the patterns of volatility spillover among different stock markets leads for policymakers to make accurate decision and effective intervention at times of instable market and financial system. In addition, investigating the integration among markets returns is of paramount importance in designing portfolio diversification and hedging decisions. Thus, analyzing in-depth the spillover and integration among different markets is eminent for all market participants.

5. CONCLUSION

We investigate volatility transmissions from world market to the ten stock markets in Asian and Eastern Europe regions, and from major stock market of both regions to the four rests stock markets. For overall sample period, the results suggest that volatility spillover from world market as a sender generally occurs on the whole stock markets, except to Pakistan; in Asian region, from China only to Malaysia stock market; and in Eastern Europe region, from Russia to Czech Republic, Poland, and Romania stock markets. These results differ from the findings during the global financial crisis which suggest that returns volatility from world market spreads on the seven stock markets, except to China, Pakistan, and Philippines; in Asian region, there is no volatility spillover from China; conversely, there is volatility spillover from Russia to the four rests markets in its region.

Stock markets that receive external volatility and were exposed against volatility transmissions from other stock markets reflect that investors in these stock markets face uncertainties in returns and higher risks in their securities. Such stock markets have stocks whose price movements are difficult for investors to predict so that they should redesign their portfolio formation with a larger number of stocks and longer analysis time and they could be inconvenient for this situation. In addition, such stocks could result in increased waiting time for transactions so that could reduce the trading liquidity.

Analysis of the volatility transmission was accompanied by observing its degree of integration. The findings on the degree of integrations among world market and ten selected stock markets show that world market has very low degree of integration only with Pakistan stock market; China has lower degree of integration with the four rests markets in Asian region; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. In addition, for the global

financial crisis period, world market has lower degree of integration with China, Pakistan, and Philippines stock markets; China has lower degree of integration with entire stock markets in Asian region; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. From this finding, including the stocks from Pakistan stock market is the better design in international portfolio diversification to minimize the portfolio risk.

When the existence of volatility spillover is involved to its degree of integration, the findings suggest that in general there is synchronous pattern on both aspects. We have notion that volatility spillovers are conditional on their degree of integrations. Specifically, domestic stock markets which have higher (lower) degree of integration would (not) receive volatility spillover from world market and major stock markets in their region. This phenomenon happened not only for overall period but also during financial crisis period. Stock market which is more integrated toward international financial movements would be more sensitive against external shock. As the consequence, the volatility from the international market will be easier to transmit to the integrated stock market.

The finding indicates that volatility of financial asset which is integrated across borders could potentially be a source of vulnerability for financial asset in national stock market. Analysis to generate this finding was very simple that only linking the patterns of volatility spillover to the patterns of dynamic degree of integration among markets. For future research, it would be better to expand this issue by utilizing the various causality methods that examine the effect of market integration on volatility spillover. To apply such methods, however, the research should to create a measure for volatility spillover which acts as a dependent variable. Moreover, the challenges for future research are to explore the other factors influencing potentially on volatility spillover and to investigate the consequence that could emerge from the volatility spillover among stock markets.

The implication for decision arising from the findings is that as emerging stock markets become more integrated with world market and major stock market regionally, the market participants should strengthen prudential regulations and actions to prevent harmful shock spillover and to limit the propagation of financial crises across borders. Moreover, according to the findings, risk managers, decision makers, and hedgers should redesign their optimal portfolios and rebuild their policies to prevent rising risks of financial transmission.

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Muharam, H., Wisnu, M., Arfinto, E. D., Najmudin. (2018). Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets. *Journal of International Studies, 11*(4), 277-293. doi:10.14254/2071-8330.2018……..

Journal of International Studies

Scientific Papers

Volatility spillovers under difference in the degree of market integration: evidence from selected Asian and Eastern European stock markets

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Abstract. This research aims to investigate volatility transmitted from world market to ten Asian and Eastern Europe stock markets and from major stock market in the region to the rest stock markets by considering their degree of integrations. To assess this purpose, we apply GARCH(p,q) model and involve the dynamic conditional correlation (DCC) model to generate the dynamic degree of integration. The monthly market indices data, over period from May 2002 to March 2018, are taken from eleven markets which consist of five Asian (China, Indonesia, Malaysia, Pakistan, and Philippines), five Eastern Europe (Czech Republic, Poland, Romania, Russia, and Ukraine), and world markets. Furthermore, the volatility spillover was analysed during the global financial crisis for period of May 1, 2008 to May 29, 2009. The finding shows that volatility spillovers from world and regional major markets to domestic stock markets are conditional on the degree of integrations. Specifically, there is no volatility spillover from world and regional major markets on segmented stock markets. In

Received:
September, 2018
1st Revision:
October, 2018
Accepted:
November, 2018

DOI:
10.14254/2071-8330.2018/……..

contrast, domestic stock markets which are integrated could experience in volatility spillover. Moreover, this finding exists in the crisis circumstance and overall period.

Keywords: volatility spillover, dynamic integration, GARCH model.

JEL Classification: F36, G15, C10

1. INTRODUCTION

Prior researches have investigated the integration among stock market classes or among stock market types, for instances between developed and developing stock markets or between conventional and Islamic stock markets (Al Nasser & Hajilee, 2016; Majdoub et al., 2016). Nevertheless, the integration of the stock markets toward international market has not been revealed yet. Similarly, volatility spillover as an effect of integration discussed on the prior researches was analyzed only among countries bilaterally, e.g. the volatility is transmitted from a particular developed country to an emerging country (Neaime, 2012). However, the susceptible strength to volatility spillover from international market has not been disclosed yet. This paper expands both issues focusing on the causality of volatilities from world market to domestic markets through the explanation involving the market integration aspect. It refers to the international portfolio diversification framework which states that the financial assets comovement among stock markets has an important part in volatility change.

Furthermore, the existing studies examining on the presence of volatility spillover have controversial findings. On the one side, some studies conclude that there are volatility spillovers on stock markets, among others Dungey et al. (2007); Rejeb and Boughrara (2015). On the other side, another study finds no evidence of volatility spillover (Majdoub & Mansour, 2014). In addition, Gebka and Serwa (2007) state that there is different evidence on volatility spillover among emerging stock markets in Latin America, East Asia and Eastern Europe. It is likely that the existing studies ignore the degree of integration among markets observed so that the findings of volatility spillover have dissimilar conclusion. This argument is supported by statement of Jebran et al. (2017). They acknowledge that the stock markets will be more vulnerable or contaminated by volatility from the other markets when they are integrated.

Although financial globalization and trade integration have enabled emerging countries to attain risk-sharing through better allocations of capital and thereby higher economic development, they also produced unwanted side-effects, including increased financial fragility and unstable long-term growth. As emerging markets develop further and exhibit higher comovement with the mature markets, they automatically become more responsive to the volatility of stock markets elsewhere in the world. The detailed assessments of the level and the nature of financial integration among stock markets are thus necessary. Such analysis can shed light on the source of shock spillover across markets (Balli et al., 2015). Accordingly, we expect that the event of volatility spillover may occur only for the stock markets which have higher integration with world market and the major stock market in the region such as China in Asian or Russia in Eastern Europe stock markets.

To solve the issue, this paper contributes in the four ways related to the expansion in subject of analysis and analytical procedure. The first is variation in the degree of integration that links the world market index movement to the returns of each stock market for different regional markets. The second is variation in the volatility spillover that connects world market volatility to the volatility of each stock market for different regional markets. The third, this paper provides explanation on dissimilar findings of existing studies which attempts to investigate dynamic volatilities for emerging markets by considering their integration level toward world market. Moreover, this paper contributes on the existing literature by employing the recent data and comparing to the crisis circumstance. The finding of this paper has valuable information for international investors and policy makers on consequence of integrated domestic market. It could make their decision more efficient and effective in anticipating the events among stock markets.

The higher integration of international stock markets and correlated stock prices volatility would weaken the international portfolio diversification (Bekaert et al., 2005). The integration of a stock market to the global market is urgent to be disclosed because otherwise it would limit the opportunities for investors to benefit from their portfolio diversification and reduce the chances for a number of firms to obtain a lower cost of capital. Moreover, side-effect of the higher integration could generate the financial disturbances and shocks in a stock market. For instance, the global financial crisis overspreads and suppresses emerging stock markets and makes a rapid decline in the prices (Neaime, 2012).

2. LITERATURE REVIEW

There is a wide variety of literature on stock market integration and volatilty across markets. Some studies have discussed only returns spillover, while some other studies have looked at both the first and the second moments of equity prices to discuss the cross-border spillover. We investigate, as the second category of the studies, the volatility spillover from international market and the major stock markets regionally to emerging stock markets by considering their dynamic integrations. The literature provides diverse definitions of financial integration. According to the law of one price, Chen and Knez (1995) define integrated markets as markets where investors can, in one country, buy and sell without restriction equities that are issued in another country and as a result, identical securities are issued and traded at the same price across markets after adjustment for foreign exchange rates.

Stock market integration is the situation when the markets have higher and stable relationship due to their stocks prices move together in similar direction for similar period. It could be defined as a unification of a number of separate stock markets operationally in the mechanisms, activities, characteristics of the instruments and interactions of the participants. The markets in which the assets require the same expected returns regardless of the trading locations are said to be integrated. While the markets where the expected returns of an asset depends on its location are said to be segmented (Arouri et al., 2012; Bekaert & Harvey, 2003).

Attention to stock market integration arises mainly because the financial theory states that integrated stock markets will be more efficient than segmented stock markets. When the stock market was integrated, investors from all countries will be able to allocate their capital to the most productive locations. With more flow of cross-border funds, additional trade in any securities may

increase the liquidity of stock market. In addition, it could make the cost of capital to fall on companies that are looking for capital and make the transaction costs incurred by investors to be lower. It indicates a more efficient capital allocation (Click & Plummer, 2005).

Financial markets in most developed countries have grown rapidly over the past decade due to various factors such as deregulation, globalization and advances in information technology. There are no restrictions such as regulatory restrictions, transaction costs, taxes, and tariffs on foreign asset trading or portfolio equity flow mobility. The integration of financial markets around the world also appears to grow among them (Marashdeh dan Shrestha, 2010). In recent years, most of studies found that stock markets observed had higher integration level, for instance between Germany and emerging markets (Al Nasser & Hajilee, 2016) and among Malaysia, Indonesia, and Turkey stock markets (Arshad, 2017). Employing international CAPM method, Najmudin et al. (2017) find that there is higher integration on the UK, Japan, Malaysia, Thailand, Indonesia, and Singapore stock markets.

Returns volatility in economics and finance field reflects the degree of variation for the returns of a financial asset such as stock, market index, or exchange rate. The standard deviation and variance of returns are the most common measures of returns volatility. The standard deviation is used in studies which assume that volatility is constant time-series, whereas dynamic conditional variance or residual is used in studies which assume that volatility varies over time. Financial assets that have higher volatility indicate that the assets have higher risk (Kočenda, 2017). Economic and especially financial time series are prone to exhibit periods of high and low volatility. Therefore, it is often misleading to measure volatility by a static standard deviation or unconditional variance. However, exactly such pattern can be modelled using conditional heteroskedastic disturbances. The solution to this problem can be found in the conditional heteroskedasticity models.

The studies on volatility in many stock markets had grown by expanding the issue of how volatility of return in a stock market is contagious and affects the volatility of return in another stock market, also known as volatility spillover. In other words, volatility spillover is a change in volatility of returns in one market because of the transmission of market-specific information from other markets. Cross market linkages in the conditional second moments of stock return is another important topic of international financial relations. In addition to various domestic and global factors, returns volatility of major stock market is one of the important factors of stock returns volatility in a stock market (Mukherjee & Mishra, 2010).

Volatility spillover has been examined by Ng (2000) who investigates the magnitude and changing characteristics from the US and Japan. The evidence suggests that the significant factors of market volatility are regional and international variables. Similarly, Dungey et al. (2007) report developed market has important role in transmitting volatility to emerging market and there is volatility spillover among regions. Furthermore, Rejeb and Boughrara (2015) conclude that there is a volatility transmission across financial markets; geographical proximity is essential factor in enlarging volatility transmission; and the liberalization contributes significantly in enlarging international volatility transmission. Applying GARCH model on India, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, and Thailand stock markets, Mukherjee and Mishra (2010) suggest that return spillovers between India and its Asian counterparts are found to be positively significant and bidirectional.

Contemporaneous spillover of intraday volatility is stronger from other foreign markets to India. However, transmission of information lagged by one day is not found to be stronger.

3. METHODOLOGY

The data are obtained from the websites of stooq.com, msci.com, yahoo.finance.com, and the other relevant publications. The first data set covers stock market indices of China, Indonesia, Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, Ukraine, and world markets. MSCI ACWI is used as a proxy for world market index. All data have the same time period from May 2002 to March 2018 on monthly basis. The second data set covers on daily basis during the global financial crisis during period from May 1, 2008 to May 29, 2009.

The data which consist of five Asian, five Eastern Europe, and world market indices are used to calculate the returns on each market and then used to find the dynamic conditional correlation (DCC) of returns among world market and the ten stock markets, and among a dominant stock market and the four rests in the region. The return of time t for the sample of stock market index i ($R_{i,t}$) is the difference between the natural logarithm of the index price at the current time ($P_{i,t}$) and the natural logarithm of the index price at previous time ($\ln P_{i,t-1}$). The formula is expressed as follows $R_{i,t} = \ln P_{i,t} - \ln P_{i,t-1}$.

The objectives of this research are specifically as follows. The first objective is to analyze the strength of a stock market as recipient against the volatility spillover from international and regional markets as senders. The second is to analyze the dynamic integration of each stock market in both Asian and Eastern European markets toward international and regional markets. The third is to analyze the existence of volatility spillover involving its explanation with the dynamic degree of integration.

To achieve the first objective we adopt the framework of Balli et al. (2015) as well as Mukherjee and Mishra (2010); Ng (2000); Bekaert and Harvey (1997) in working the volatility spillover models for the equity returns from the originator world market to the ten recipient stock markets. The effects of volatility spillover from major stock markets regionally, China in Asian markets and Russia in Eastern Europe markets, to the rest four stock markets are also taken into consideration to formulate their respective univariate AR-GARCH-M(p,q) models.

The volatility of stock return series is time varying so that this paper examines the spillover of the conditional second moments across markets allowing for changing the variances. The generalized autoregressive conditional heteroscedasticity (GARCH) model proposed by Engle (1982) and developed by Bollerslev (1986) has been employed to account for the time-variant conditional variances (Mukherjee & Mishra, 2010). The mean and variance equations of ARCH(p) and GARCH(p,q) models respectively are generally expressed as follow:

Mean equation: $Y_t = c + \varepsilon_t, \varepsilon_t^2 \mid I_{t-1} \sim N(0, \sigma_t^2)$ (1)

Variance equations:

ARCH(p) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2$ (2)

GARCH(p,q) $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \ldots + \lambda_q \sigma_{t-q}^2$ (3)

Where Y_t is the individual returns at time t, c is a specific mean, ε_t is the error term, I_t denotes the information available at time t and σ_t^2 is the conditional variance of the error term at time t and a

function of both ε_{t-1}^2 (the squared error term in the previous time) and σ_{t-1}^2 (conditional variance in the previous time).

Our empirical approach to achieve the first objective comprises the following steps. The first step, we estimate the volatility of world market and major stock markets in each region as the senders, namely China in Asian markets and Russia in Eastern Europe markets. To obtain the returns volatility for each world, China, and Russia market, respectively, as determinants of the rest eight stock markets volatilities, we perform volatility modeling steps by following the AR-GARCH(1,1) model. The mean equations of AR-GARCH(1,1) model for the three markets are expressed as follow:

$$R_{WI,t} = \alpha + \beta_1 R_{W,t-1} + \varepsilon_t \text{ World} \quad (4)$$

$$R_{CN,t} = \alpha + \beta_1 R_{CN,t-1} + \varepsilon_t \text{ China} \quad (5)$$

$$R_{RS,t} = \alpha + \beta_1 R_{RS,t-1} + \varepsilon_t \text{ Russia} \quad (6)$$

Where $R_{WI,t}$, $R_{CN,t}$, and $R_{RS,t}$ are market returns of world market, China, and Russia stock markets at time t, respectively; and ε_t is error term at time t.

The second step, we estimate how the returns volatilities of the three sender markets are contagious and affect the returns volatility in another stock market as recipient. In order to investigate this volatility spillovers, we apply AR-GARCH-M(p,q) model. Unlike in simple GARCH model, the GARCH-M or GARCH-in-Mean model includes the conditional variance or its square root in the conditional mean equation along with other explanatory variables. Conditional variances or GARCH variance series resulted from estimations of AR-GARCH(1,1) model, as in Eqs. (4) – (6), are then used to estimate volatility series as inputs for AR-GARCH-M(p,q) model. The model is estimated using the maximum likelihood procedure applying the Berndt–Hall–Hall–Hausman (BHHH) algorithm.

The first equation, called as mean equation, of AR-GARCH-M(p,q) model for the recipient domestic stock market i is expressed as follows:

$$R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t. \quad (7)$$

The second equation, called as variance equation, is expressed as follows:

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_p \varepsilon_{i,t-p}^2 + \lambda_q \sigma_{i,t-q}^2 + \Sigma\delta_n V_{j,t}. \quad (8)$$

Where $R_{i,t}$ is returns of recipient domestic stock market i at time t; $\sigma_{i,t}$ is the square root of conditional variance on stock market i at time t; ε_t is error term at time t; $\sigma_{i,t}^2$ is the conditional variance of the error term at time t; ε_{t-p}^2 is the squared error term at time t-p; σ_{t-q}^2 is conditional variance at time t-q; and $V_{j,t}$ is volatilities of sender market j at time t.

To achieve the second objective we apply the DCC (dynamic conditional correlation) approach as developed by Engle (2002) and worked by Majdoub and Mansour (2014). We estimate the conditional relationship of returns among world market and ten selected stock markets. The principal advantage of this model is that while it retains the main features of standard GARCH models, it allows us to model explicitly time variation in the conditional covariance and correlation matrix.

DCC model can be described briefly as follows. In the DCC-GARCH(1,1) model, the conditional variance–covariance matrix is defined by $H_t = D_t R_t D_t$, where H_t takes the following formulation:

$$H_t = \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \begin{bmatrix} 1 & \rho_{12,t} \\ \rho_{21,t} & 1 \end{bmatrix} \begin{bmatrix} \sqrt{h_{11,t}} & 0 \\ 0 & \sqrt{h_{22,t}} \end{bmatrix} \quad (9)$$

D_t is a (n x n) diagonal matrix of time-varying standard deviations from univariate GARCH models with $(h_{ii,t})^{1/2}$ on the *i*th diagonal, i = 1, 2, …, n; R_t is the (n x n) time-varying correlation matrix and R_t is conditional correlation matrix:

$$R_t = (\text{diag}(Q_t)^{-1/2}\, Q_t\, (\text{diag}(Q_t))^{-1/2} \quad (10)$$

The evolution of the correlation in DCC model is given by:

$$Q_t = \bar{Q}(1 - \alpha - \beta) + \alpha\, \varepsilon_{t-1}\, \varepsilon'_{t-1} + \beta Q_{t-1} \quad (11)$$

Where $\bar{Q}$ is the unconditional correlation matrix of the epsilons; $Q_t = (q_{ii,t})$ is the (n x n) time-varying covariance matrix of ε_t; α and β are non-negative scalar parameters satisfying $(\alpha + \beta) < 1$.

In the empirical methodology, Arouri and Nguyen (2010) convey that conditional correlation coefficient ρ_{ij} between two markets i and j at time t is then expressed by the following equation:

$$\rho_{ijt} = \frac{(1-\alpha-\beta)\bar{q}_{ij} + \alpha\mu_{i,t-1}\mu_{j,t-1} + \beta q_{i,t-1}}{\left((1-\alpha-\beta)\bar{q}_{ii} + \alpha\mu^2_{i,t-1} + \beta q_{ii,t-1}\right)^{1/2}\left((1-\alpha-\beta)\bar{q}_{jj} + \alpha\mu^2_{j,t-1} + \beta q_{jj,t-1}\right)^{1/2}} \quad (12)$$

Where q_{ij} refers to the element located in the *i*th row and *j*th column of the matrix Q_t.

DCC-GARCH model as described above is estimated using a two-stage procedure. In the first stage, a univariate GARCH(1,1) model is estimated for each return series included in the multivariate system. During the second stage, the transformed residuals from the first stage, namely the estimated residuals standardized by their conditional standard deviations, are used to infer the conditional correlation estimators.

The Log likelihood for this estimator can be expressed as:

$$L = -\frac{1}{2}\sum(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon_t) \quad (13)$$

To achieve the third objective we relate the patterns of volatility spillover across markets to the patterns of the degree of integration among those markets. This analysis could confirm the statement that a stock market which has higher comovement with the other stock markets would automatically become more responsive to the volatility of those stock markets. Therefore, in order to understand the patterns of volatility spillover across markets, it is necessary to assess the level and the nature of integration among those markets (Balli et al., 2015).

4. EMPIRICAL RESULTS AND DISCUSSION

We examine volatility spillover accros stock markets and the degree of markets integration by employing the data of market indices during period from May 2002 to March 2018 monthly totaling 191 observations and during sub-period from May 1, 2008 to May 29, 2009 on daily basis. Table 1 exhibits descriptive statistics for ten observed market returns, namely China (CN), Indonesia (ID), Malaysia (MY), Pakistan (PK), Philippines (PH), Czech Republic (CZ), Poland (PL), Romania (RM), Russia (RS), and Ukraine (UR). It consists of mean, deviation standard, maximum, and minimum values for overall and global financial crisis (GFC) sample periods.

Table 1
Descriptive statistics of market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
Mean	0.39	1.29	0.48	1.58	0.95	0.48	0.69	1.02	0.61	1.26
St. Dev	8.08	6.13	3.58	7.15	5.32	5.97	5.91	8.34	9.56	11.63
Max.	24.25	18.34	12.70	20.23	13.95	17.11	18.84	25.72	26.68	44.51
Min.	–28.28	–37.72	–16.51	–44.88	–27.54	–31.65	–27.45	–41.42	–44.91	–35.26
Panel B. Global Financial Crisis Period (Daily)										
Mean	–0.10	–0.06	–0.09	–0.30	0.04	–0.25	–0.17	–0.28	–0.18	–0.22
St. Dev	2.50	2.33	1.12	2.01	1.86	3.17	2.13	3.24	4.43	3.61
Max.	9.03	7.36	4.06	8.25	7.06	12.36	6.08	12.85	20.20	11.67
Min.	–8.04	–10.95	–3.68	–5.13	–5.32	–16.19	–8.29	–11.82	–21.20	–13.21

This table reports the mean, standard deviation, and the minimum and maximum values of market indices returns for overall sample period (monthly) and global financial crisis period (daily) for China (CN), Indonesia (ID), Malaysia (MY), Pakistan (PK), Philippines (PH), Czech Republic (CZ), Poland (PL), Romania (RM), Russia (RS), and Ukraine (UR) stock markets.

For all sample period, Pakistan is the stock market which provides the highest average returns amount to 1.58 percent. This interesting value, however, was accompanied by the higher risk measured by the standard deviation of returns (7.15) and the spread of returns (65.11 percent) ranging from maximum value (20.23 percent) to minimum value (–44.88 percent). In contrast, China has the lowest average returns (0.39 percent) followed by Malaysia stock market (0.48 percent) and yet investors in China stock market bear the highest risk in Asian region with standard deviation amount of 8.08.

The lowest risk in Asian region appears in Malaysia stock market with standard deviation and spread of returns are 3.58 and 29.21 percent, respectively. Similar position is found on Poland stock market in Eastern European region with standard deviation and spread of returns are 5.91 and 46.29 percent, respectively. Moreover, Malaysia stock market is the only one stock market that has the lower risk than the world market returns. Standard deviation and spread of returns for world market are 4.50 and 33.07 percent, respectively.

In Eastern European region, Czech Republic stock market has the lowest average returns (0.48 percent) and has lower risk indicated by the standard deviation and spread of returns in this market amount of 5.97 and 48.75 percent, respectively. Conversely, Ukraine stock market has the highest average returns in the region followed by the highest risk. This information was presented by the average returns, standard deviation, and spread of returns for this market which are 1.26 percent, 11.63, and 79.77 percent, respectively.

For the GFC period, the highest standard deviation and spread values in Eastern Europe region are found in Ukraine stock market amount of 4.43 and 41.40 percent, respectively. This

phenomenon on Ukraine stock market for the GFC period is similar with condition for all sample period. In Asian region, such phenomenon on Ukraine stock market is found in China stock market that has the highest standard deviation for the GFC period (2.50) and for all sample period (8.08) in the region. In general, the data of all stock markets inform that each stock market has a difference characteristic or heterogeneous in rate of returns and its risk.

We consider the stationarity pattern of data to analyze furthermore all variables and to draw an inference from statistical ways. To test the stationarity, we apply one of unit root methods, namely ADF (Augmented Dickey-Fuller) Test. According to unit root test, the result shows that stationer patterns in the level form appear on all observed market returns data. This conclusion prevails on the data for overall sample period (monthly) and for sub-sampel period of global financial crisis (daily). Therefore, it is not necessary to transform or differentiate the data of those eleven markets returns.

The variance equation of the AR-GARCH-M(p,q) model for this research is written in general as follows:

$\sigma_{i,t}^2 = \alpha_0 + \alpha_p\, \varepsilon_{i,t-p}^2 + \lambda_q\, \sigma_{i,t-q}^2 + \Sigma\delta_n\, V_{j,t}$.

The variance equation above becomes operational guidelines to interpret generally the volatililty transmission from one market to the volatility of another market. Table 2 contains the results of ten estimate models for each recipient stock market. These ten estimate models are the best fit regression models which are selected through iteration process from various models, such as ARCH(p,q), GARCH(p,q), ARCH-M(p,q), and GARCH-M(p,q).

The model specifications in variance equation using overall sample period for each ten recipient stock market are expressed as follow:

$\sigma_{CN,t}^2$ = ***28.129 + ***0.341 $\varepsilon_{CN,t-1}^2$ + **0.999 V_WI$_t$	China
$\sigma_{ID,t}^2$ = 7.132 + **0.278 $\varepsilon_{ID,t-1}^2$ – 0.174 $\sigma_{ID,t-1}^2$ + 0.132 V_CN$_t$ + *0.791 V_WI$_t$	Indonesia
$\sigma_{MY,t}^2$ = ***3.821 + 0.053 $\varepsilon_{MY,t-1}^2$ + **0.052 V_CN$_t$ + ***0.216 V_WI$_t$	Malaysia
$\sigma_{PK,t}^2$ = ***43.073 – 0.006 $\varepsilon_{PK,t-1}^2$ – ***0.698 $\sigma_{PK,t-1}^2$ + 0.271 V_CN$_t$ + 0.680 V_WI$_t$	Pakistan
$\sigma_{PH,t}^2$ = ***13.817 – ***0.156 $\varepsilon_{PH,t-1}^2$ + 0.095 V_CN$_t$ + ***0.417 V_WI$_t$	Philippines
$\sigma_{CZ,t}^2$ = ***10.975 – 0.079 $\varepsilon_{CZ,t-1}^2$ + ***0.345 V_RS$_t$ + ***1.176 V_WI$_t$	Czech R.
$\sigma_{PL,t}^2$ = ***16.684 + 0.096 $\varepsilon_{PL,t-1}^2$ + ***0.281 V_RS$_t$ + ***0.622 V_WI$_t$	Poland
$\sigma_{RM,t}^2$ = ***41.223 – 0.177 $\sigma_{RM,t-1}^2$ + ***0.755 V_RS$_t$ + ***1.815 V_WI$_t$	Romania
$\sigma_{RS,t}^2$ = **72.584 – 0.563 $\sigma_{RS,t-1}^2$ + **2.838 V_WI$_t$	Russia
$\sigma_{UR,t}^2$ = ***71.994 – 0.031 $\varepsilon_{UR,t-1}^2$ + 0.829 V_RS$_t$ + **2.642 V_WI$_t$	Ukraine

Table 2

Estimates of GARCH-M(p,q) model for overall period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.659	*-0.444	**-0.684	-0.597	-0.588		
C	-0.250	***1.360	**0.536	5.997	***3.089	***4.084	**4.060	**5.449	0.535	1.207
$R_{i,t-1}$	**0.184	0.095	0.051	0.093	0.009	0.079	0.028	0.127	**0.174	***0.297
Conditional Variance ($\sigma^2_{i,t}$)										
C	***28.129	7.132	***3.821	***43.073	***13.817	***10.975	***16.684	***41.223	**72.584	***71.994
$\varepsilon^2_{i,t-1}$	***0.341	**0.278	0.053	-0.006	***-0.156	-0.079	0.096			-0.031
$\sigma^2_{i,t-1}$		-0.174		***-0.698				-0.177	-0.563	
V_CN		0.132	**0.052	0.271	0.095					
D(V_RS)						***0.345	***0.281	***0.755		0.829
V_WI	**0.999	*0.791	***0.216	0.680	***0.417	***1.176	***0.622	***1.815	**2.838	**2.642
R^2	0.005	0.034	0.007	0.064	0.016	0.035	0.014	0.034	0.058	0.082
N	189	189	189	182	189	188	188	188	189	188

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for overall period. The first equation, called as mean equation, is $R_{i,t} = \alpha + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t$. The second equation, called as variance equation, is $\sigma^2_{i,t} = \alpha_0 + \alpha_p \varepsilon^2_{i,t-p} + \lambda_q \sigma^2_{i,t-q} + \Sigma\delta_n V_{i,t}$. In addition, V_CN, D(V_RS), and V_WI in variance equation stand for returns volatility of China, Russia, and world markets, respectively. The volatility of Russia stock market partially was performed in transformation form, i.e., in first difference form D(V_RS), due to multicollinearity problem with volatility of the world market index (V_WI). The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

Table 3

Estimates of GARCH-M(p,q) model for global financial crisis period

	Asian markets					Eastern Europe markets				
	CN	ID	MY	PK	PH	CZ	PL	RM	RS	UR
Dependent Variable ($R_{i,t}$)										
$\sigma_{i,t}$				-0.091				-0.209		
C	-0.122	-0.083	**-0.145	0.007	0.050	**-0.268	-0.135	0.376	-0.213	**-0.402
$R_{i,t-1}$	-0.052	***0.181	***0.130	***0.241	*0.162	0.106	**0.142	0.079	**0.146	***0.224
Conditional Variance ($\sigma_{i,t}^2$)										
C	***5.384	0.228	***0.211	***2.527	0.183	0.223	***0.051	***8.886	0.279	***0.377
$\varepsilon_{i,t-1}^2$	0.069	0.039	***-0.101	***0.186	*0.127		***-0.066		-0.049	
$\sigma_{i,t-1}^2$			***0.779	***0.446	**0.597	***0.661	***1.025	***-0.968		***0.951
V_CN		0.081	0.005	-0.144	0.037					
D(V_RS)						***0.840	***0.139	**0.292		***0.909
V_WI	0.071	***0.975	***0.029	-0.155	0.104	***0.556	**0.027	**1.051	***4.349	***0.068
R^2	0.002	0.050	0.029	0.069	0.029	0.001	0.020	0.013	0.018	0.019
N	247	247	247	246	247	256	256	257	258	257

This table contains the results of estimate regressions using AR-GARCH-M(p,q) model for each stock market for global financial crisis period.

The model specifications in variance equation above, as presented in Table 2, inform that conditional variance of world market (V_WI) has positive effect on conditional variances of China, Indonesia, Malaysia, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine stock markets. It is indicated by the significant coefficients of V_WI statistically amount of 0.999, 0.791, 0.216, 0.417, 1.176, 0.622, 1.815, 2.838, and 2.642, respectively. Conversely, conditional variance of world market has no effect on conditional variance of Pakistan stock market which is indicated by the insignificant coefficient of V_WI statistically amount of 0.680. These results suggest that there are volatility spillovers for all sample period from world market to nine observed stock markets and there is no volatility spillover on Pakistan stock market.

Regionally, the results of estimate on Asian stock markets inform that conditional variance of China stock market (V_CN) has positive effect on conditional variance of Malaysia stock market. It is indicated by the significant coefficient of V_CN amount of 0.052 at the 5% level. In contrast, conditional variance of China has no effect on conditional variances of Indonesia, Malaysia, and Philippines stock markets. It is indicated by the insignificant coefficients of V_CN amount of 0.132, 0.271, and 0.095, respectively. These evidences suggest that the volatility spillover in Asian region from China stock market only occurs on Malaysia stock market.

In Eastern Europe, conditional variance, in first difference form, of Russia stock market D(V_RS) has significantly positive effect on conditional variances of Czech Republic, Poland, and Romania stock markets. It is indicated by the significant coefficients of D(V_RS) amount of 0.345, 0.281, and 0.755 at the 1% level, respectively. Conversely, conditional variance of Russia stock market has no effect on conditional variance of Ukraine stock market which is indicated by the insignificant coefficient of D(V_RS) amount of 0.829. These results inform that there are volatility spillovers from Russia as a major stock market to all stock markets observed in Eastern Europe region, except to Ukraine stock market.

The model specifications in variance equation using the GFC sample period for each ten recipient stock market, as presented in Table 3, are expressed as follow:

$\sigma^2_{CN,t}$ = ***5.384 + 0.069 $\varepsilon^2_{CN,t-1}$ + 0.071 V_WI_t — China

$\sigma^2_{ID,t}$ = 0.228 + 0.039 $\varepsilon^2_{ID,t-1}$ + 0.081 V_CN_t + ***0.975 V_WI_t — Indonesia

$\sigma^2_{MY,t}$ = ***0.21 – ***0.10 $\varepsilon^2_{MY,t-1}$ + ***0.779 $\sigma^2_{MY,t-1}$ + 0.005 V_CN_t + ***0.03 V_WI_t — Malaysia

$\sigma^2_{PK,t}$ = ***2.527 + ***0.186 $\varepsilon^2_{PK,t-1}$ + ***0.446 $\sigma^2_{PK,t-1}$ – 0.144 V_CN_t – 0.155 V_WI_t — Pakistan

$\sigma^2_{PH,t}$ = 0.183 + *0.127 $\varepsilon^2_{PH,t-1}$ + **0.597 $\sigma^2_{PH,t-1}$ + 0.037 V_CN_t + 0.104 V_WI_t — Philippines

$\sigma^2_{CZ,t}$ = 0.223 + ***0.661 $\sigma^2_{CZ,t-1}$ + ***0.840 V_RS_t + ***0.556 V_WI_t — Czech R.

$\sigma^2_{PL,t}$ = ***0.05 – ***0.07 $\varepsilon^2_{PL,t-1}$ + ***1.025 $\sigma^2_{PL,t-1}$ + ***0.14 V_RS_t + **0.03 V_WI_t — Poland

$\sigma^2_{RM,t}$ = ***8.886 – ***0.968 $\sigma^2_{RM,t-1}$ + **0.292 V_RS_t + **1.051 V_WI_t — Romania

$\sigma^2_{RS,t}$ = 0.279 – 0.049 $\varepsilon^2_{RS,t-1}$ + ***4.349 V_WI_t — Russia

$\sigma^2_{UR,t}$ = ***0.377 + ***0.951 $\sigma^2_{UR,t-1}$ + ***0.909 V_RS_t + ***0.068 V_WI_t — Ukraine

Volatility spillover is the causality in variance among markets (BenSaïda et al., 2018). The results from causality analyses of volatilities using overall sample period are not distantly different with the results using the GFC sample period. The differences are as follow: volatility of world market has no effect on volatilities of China and Philippines stock markets; volatility of China stock market has no effect on volatility of Malaysia stock market; and volatility of Russia stock market has positive effect

on volatility of Ukraine stock market. The findings of this paper on the existence of volatility spillover are consistent with studies of Abbas et al. (2013); Balli et al. (2015); Rejeb and Boughrara (2015).

This empirical study on volatility spillover from the global market to a stock market has an important role from the particular perspective of portfolio diversification and hedging strategies (Majdoub & Mansour, 2014). Moreover, studying spillover volatility has direct implication in designing optimal portfolios and building policies to prevent harmful shock transmission and to limit the propagation of financial crises across borders (BenSaïda et al., 2018). Therefore, understanding the volatility across markets is crucial for risk managers, hedgers, and policy makers, especially volatility spillover due to the financial crisis.

Table 4 presents pairwaise dynamic conditional correlation (DCC) among market indices returns in average values. More specific, it was divided into two part sub-sample periods: overall sample period in Panel A and global financial crisis sample period in Panel B. Furthermore, Table 4 Panel A exhibits eighteen average series of stock market pairs monthly among the world market and ten stock markets in Asian and Eastern Europe regions, namely China, Indonesia, Malaysia, Pakistan, Philippines, Czech Republic, Poland, Romania, Russia, and Ukraine.

The pairs of R_CN vs R_PK and R_WI vs R_PK, as presented in Panel A, appear the lowest average dynamic correlation amount to -0.02 and 0.02, respectively. They are followed by the pairs of R_CN-R_ID and R_CN-R_PH amount to 0.22 and 0.23, respectively. This information suggests that Pakistan stock market has lowest degree of integration in observed markets pairs with world market and major markets in its region. In additon, the pairs of world market with all markets in Eastern Europe have strong average dynamic correlation from 0.43 with Ukraine to 0.65 with Czech Republic and Poland stock markets, respectively. This evidence indicates that the degree of integrations among world market and five stock markets in Eastern Europe region in a whole are higher.

In Asian region, only the pair of China and Malaysia stock markets which has strong average dynamic correlation amount to 0.31. In Eastern Europe region, the pairs of Russia with the four rests markets have strong average dynamic correlations from 0.46 with Ukraine to 0.54 with Poland stock market. This fact informs that China has higher degree of integration only with Malaysia stock market in Asian region and Russia has higher degree of integration with entire stock markets in Eastern Europe region. The results generally do not support the conclusion of Naranjo and Porter (2007) which state that returns in emerging markets appear very low correlation with returns in developed markets. Moreover, it was partly similar to conclusion of Lean and Smyth (2014) which report that relationship among the major markets and between major market and emerging market have increased over time.

Table 4 Panel B, which contains observations during GFC period, provides confirmation against previous information interpreted from Panel A. It differs to observations for overall sample period in average dynamic correlations only for pairs of R_WI vs R_CN and R_WI vs R_PH. The values of average dynamic correlations between world market and China market returns and between world market and Philippines market returns in the later sample observations are 0.19 and 0.23, respectively. These values are lower than the values of average dynamic correlations for overall sample period observations amount to 0.37 and 0.50, respectively. Therefore, the interpretation of the data at Panel B has much similarity with the interpretation from Panel A. The result informs that in general there is

opportunity for international investors to diversify internationally their fund by involving the stocks from China and Pakistan stock markets into their portfolio formation.

The volatility transmission from one stock market to other stock markets found in the investigation of this research has a pattern that is almost similar to the pattern occurring at the level of integration among those stock markets. The returns volatility of world market affects returns volatilities of all observed stock markets, except for the volatility of Pakistan stock market. Similarly, world market also has a higher degree of integration with all observed stock markets, except with Pakistan stock market. These patterns indicate that the volatility from world market would be sent under condition that the level of integration with its recipient stock market is higher.

Table 4

Average dynamic correlations among market indices returns

	Asian markets					Eastern Europe markets				
	R_CN	R_ID	R_MY	R_PK	R_PH	R_CZ	R_PL	R_RM	R_RS	R_UR
Panel A. Overall Sample Period (Monthly)										
R_CN		0.22	0.31	-0.02	0.23					
R_RS						0.53	0.54	0.52		0.46
R_WI	0.37	0.54	0.58	0.02	0.50	0.65	0.65	0.49	0.61	0.43
Panel B. Global Financial Crisis Period (Daily)										
R_CN		0.30	0.33	0.08	0.28					
R_RS						0.61	0.57	0.44		0.51
R_WI	0.19	0.39	0.38	0.04	0.23	0.62	0.59	0.44	0.52	0.40

This table reports pairwaise cross-market returns correlation. R_CN, R_ID, R_MY, R_PK, and R_PH stand for indices returns of China, Indonesia, Malaysia, Pakistan, and Philippines stock markets, respectively. R_CZ, R_PL, R_RM, R_RS, and R_UR stand for indices returns of Czech Republic, Poland, Romania, Russia, and Ukraine stock markets, respectively. R_WI is world market returns of MSCI AC World Index.

In addition, China stock market as a dominant stock market in the Asian region only sends its returns volatility to Malaysia stock market. Similar pattern suggests that China stock market also has a higher degree of integration only with Malaysia stock market. This evidence indicates that volatilty transmission from China would happen by the condition of higher degree of integration with Malaysia stock market. Furthermore, the returns volatility of Russia stock market as a dominant stock market in Eastern Europe only affects the volatilities of Czech Republic, Romania, and Poland stock markets. On the other hand, the Russia stock market also has a higher degree of integration with these three stock markets. These two corresponding proofs indicate that volatilty delivery from Russia would happen on condition that the level of integration with each of the three stock markets is higher.

According to the results of volatility spillover and market integration that have been examined, it can be argued that the volatility of stock market affected by the volatility of other stock market occurs when both stock markets have a higher degree of integration. In short, the recipient of volatilty is integrated with the sender. In contrast, the volatilty of a domestic stock market which is segmented toward world or regional market would not change. These empirical evidences corroborate the conseptual framework, for instance, from Rejeb and Arfaoui (2016) who argue that in the last decade,

a number of studies have focused on analyzing the transmission of volatility among emerging markets with respect to the degree of financial integration after their liberalization process. Their statement confirms the opinion of Phylaktis and Ravazzolo (2002) that financial liberalization makes financial markets more integrated into global financial movements and thus more sensitive to external shocks. The propagation of volatility is the consequence of financial interdependence across markets.

5. CONCLUSION

We investigate volatility transmissions from world market to the ten stock markets in Asian and Eastern Europe regions, and from major stock market in the region to the four rests stock markets. For overall sample period, the results suggest that spreading of volatility from world market as a sender generally occurs on the whole stock markets, except to Pakistan; spreading of volatility in Asian region from China only occurs on Malaysia stock market; and spreading of volatility in Eastern Europe region from Russia occurs on Czech Republic, Poland, and Romania stock markets. These results differ from the findings during the global financial crisis which suggest that spreading of volatility from world market does not occur on China, Pakistan, and Philippines stock markets; spreading of volatility from China does not occur on the whole stock markets in Asian region; conversely, spreading of volatility from Russia occurs on the whole stock markets in Eastern Europe region.

Stock markets that receive external volatility and were exposed against volatility transmissions from other stock markets reflect that investors in these stock markets face uncertainties in returns and higher risks in their securities. Such stock markets have stocks whose price movements are difficult for investors to predict so that they should redesign their portfolio formation with a larger number of stocks and longer analysis time and they could be inconvenient for this situation. In addition, such stocks could result in increased waiting time for transactions so that could reduce the trading liquidity.

Analysis of the volatility transmission was accompanied by observing its degree of integration. The findings on the degree of integrations among world market and ten selected stock markets show that world market has very low degree of integration only with Pakistan stock market; China has higher degree of integration only with Malaysia stock market; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. In addition, for the global financial crisis period, world market has lower degree of integration with China, Pakistan, and Philippines stock markets; China has higher degree of integration with Indonesia and Malaysia stock markets; and Russia has higher degree of integration with entire stock markets in Eastern Europe region. From this finding, including the stocks from Pakistan stock market is the better design in international portfolio diversification to minimize the portfolio risk.

When the existence of volatility spillover is involved to its degree of integration, the findings appear that in general there is synchronous pattern on both aspects. We have notion that volatility spillovers are conditional on their degree of integrations. Specifically, domestic stock markets which have higher (lower) degree of integration would (not) receive volatility spillover from world market and major stock markets in their region. This phenomenon happened not only for overall period but also during financial crisis period. Stock market which is more integrated toward international financial movements would be more sensitive against external shock. As the consequence, the volatility from the international market will be easier to transmit to the integrated stock market.

The finding indicates that volatility of financial asset which is integrated across borders could potentially be a source of vulnerability for financial asset in national stock market. Analysis to generate this finding was very simple that only linking the patterns of volatility spillover to the patterns of dynamic degree of integration among markets. For future research, it would be better to expand this issue by utilizing the various causality methods that examine the effect of market integration on volatility spillover. To apply such methods, however, the research should to create a measure for volatility spillover which acts as a dependent variable. Moreover, the challenges for future research are to explore the other factors influencing potentially on volatility spillover and to investigate the consequence that could emerge from the volatility spillover among stock markets.

The implication for decision arising from the findings is that as emerging stock markets become more integrated with world market and major stock market regionally, the market participants should strengthen prudential regulations and actions to prevent harmful shock spillover and to limit the propagation of financial crises across borders. Moreover, according to the findings, risk managers, decision makers, and hedgers should redesign their optimal portfolios and rebuild their policies to prevent rising risks of financial transmission.

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