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# Indonesian Stock Market's Dynamic Integration with Asian Stock Markets and World Stock Markets

*(Integrasi Dinamik Pasaran Modal Indonesia dengan Pasaran Modal di Asia dan Pasaran Modal di Dunia)*

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*ABSTRACT*

*The study examines the relationship and integration of stock markets by using a DCC-GARCH from the period of January 1999 to September 2015. The period of January 1999 to September 2015 is chosen because in this period there has been a revocation of foreign ownership restrictions on the Indonesia Stock Exchange. By using this dynamic approach, the relationship, even the integration, of the ever-changing stock markets need to be analyzed with an approach that can accommodate and capture the dynamism of emerging stock markets studied in more detail. Beside DCC-GARCH, several additional analysis were also conducted. The data used in this study are the stock price index data on the stock markets studied namely Nikkei 225 index, Dow Jones Industrial Average (DJIA), FTSE index, All Ordinaries index, Straits Times Index (STI), SET index, KOSPI index, Taipei WG index, KLSE Composite Index, Hang Seng Index (HSI), Manila Composite index (PSEi) and Jakarta Composite Index (JCI). This study found that after subprime mortgage crisis in 2008, the Indonesian stock market was more integrated with several stock markets in Asia and especially in the stock markets in the ASEAN region. By separating the study period into three periods of pre-crisis, during crisis and post-crisis, this study found that the level of stock market integration in Indonesia with stock markets in Asia and the world is increasing. This study shows the importance of dynamic approach's usage in stock market integration analysis.*

*Keywords: DCC-GARCH; stock market integration; stock market segmentation; emerging market; established market*

*ABSTRAK*

*Kajian ini mengkaji hubungan dan integrasi pasaran modal dengan menggunakan DCC-GARCH untuk tempoh Januari 1999 sehingga September 2015. Tempoh Januari 1999 sehingga September 2015 dipilih kerana pada tempoh ini berlakunya penarikan semula sekatan terhadap pemilikan asing di Bursa Saham Indonesia. Dengan menggunakan pendekatan dinamik ini, hubungan dan integrasi pasaran saham yang sentiasa berubah perlu dianalisis dengan pendekatan yang dapat menampung dan menangkap dinamisme pasaran saham baru muncul yang dikaji dengan lebih terperinci. Selain DCC-GARCH, beberapa analisis tambahan juga turut dijalankan. Data yang digunakan dalam kajian ini adalah data indeks harga saham di pasaran saham yang dikaji iaitu indeks Nikkei 225, Dow Jones Industrial Average (DJIA), Indeks FTSE, Indeks All Ordinaries, Indeks Straits Times (STI), indeks SET, indeks KOSPI, Indeks Taipei WG, Indeks Komposit KLSE, Indeks Hang Seng (HSI), Indeks Komposit Manila (PSEi) dan Indeks Komposit Jakarta (JCI). Kajian ini mendapati selepas krisis "gadai janji subprima" pada tahun 2008, pasaran saham Indonesia lebih terintegrasi dengan beberapa pasaran saham di Asia dan terutama di pasaran saham di rantau ASEAN. Dengan memisahkan tempoh kajian kepada tiga tempoh pra-krisis, semasa krisis dan pasca krisis, kajian ini mendapati bahawa tahap integrasi pasaran saham di Indonesia dengan pasaran saham di Asia dan dunia semakin meningkat. Kajian ini menunjukkan kepentingan penggunaan pendekatan dinamik dalam analisis integrasi pasaran saham.*

*Kata kunci: DCC-GARCH; integrasi pasaran saham; segmen pasaran saham; pasaran baru muncul, pasaran mantap*

## INTRODUCTION

The emergence of new technologies and the increasing integration of stock markets around the world lead to the allocation process of stock markets beyond national boundaries (Connoly & Wang 1998). In line with this, Bilson (2000) states that the movement of stock markets in the developing countries and the stock markets in developed countries become more closely related. The forces that drive globalization such as the increasingly rapid global communications, the infrastructure of transportations, and homogenization and the gathering of consumer demands are further enhanced by the reduction of barriers to capital investments in emerging markets.

Babecky et al. (2013) suggest that the process of financial integration occurred in the last decade is accelerated by the rapid development of the financial sectors, especially by the financial innovations. Meanwhile, Zaimovic and Arnaut-Berilo (2012) stated that the world stock market integration has been a very interesting topic today, especially after the subprime crisis in 2008. Unfortunately, the increasingly integrated stock markets

also raise new issues. Those stock markets tend to be more sensitive to global risk factors so that when there is an event in the financial markets that have a global impact, it will automatically give impact to the whole integrated stock markets. One of the phenomena in the financial area which becoms global fallout is the subprime mortgage crisis that occurred in the United States. This crisis has caused many stock markets to collapse. Most of the studies were conducted by focusing on stock markets that had been developed such as those in the United States, Western Europe, and Japan. In general, the findings show that the degree of co-movement between those stock markets become stronger after the subprime crisis.

Different from the case mentioned above, the studies of the integration of stock markets involving stock markets in Asia, especially those involving the Indonesia Stock Exchange are still being conducted which result to various conclusions. For example, a research conducted by Ibrahim (2005, 2006) concluded that the Indonesia Stock Exchange (formerly Jakarta Stock Exchange) is not integrated with the international stock markets. There are even empirical studies which found that the Indonesia Stock Exchange is not integrated with other ASEAN stock markets whereas the stock markets in other ASEAN regions are discovered to be integrated (Palac-McMiken 1997). This was confirmed by the results of research conducted by Roca, Selvanathan and Shepherd (1998) that found that all of the stock markets in the ASEAN region have a short-term relationship, except Indonesia. These findings are also confirmed by Suryanta (2011) who found that the Indonesian domestic factors have more influence on the Indonesia Stock Exchange compared with the external factors. A research by Suryanta (2011) also concluded that there is no co-movement between the Indonesia Stock Exchange and several stock exchanges in Asia.

Click and Plummer (2005), Cheng et al. (2003), Karim and Ning (2013) discovered different conclusions that the stock markets of the five ASEAN countries including Indonesia are integrated. Even a study conducted by Majid, Meera and Omar (2008) concluded that the stock markets in the ASEAN (including Indonesia) were increasingly integrated with one another, where they are even integrated with the stock markets in the United States and Japan in the aftermath of the financial crisis in Asia in 1997. In a deeper study, Majid and Kassim (2009) found that the subprime crisis in the United States in 2008 caused the degree of integration between Indonesia and Malaysia stock markets increased. Results found by Karim and Karim (2012) also proved that the stock markets in the five countries of ASEAN are increasingly integrated before and after the financial crisis in Asia in 1997 and after the subprime mortgage crisis that occurred in the United States in 2008.

This suggests that a study on the integration of stock markets in the ASEAN region, especially involving the Indonesian stock market is still necessary given the differences in the results of research that have been done. The diversity of the results of such research can be due to the use of research periods and static analysis techniques as most of the previous studies did not use a dynamic approach in their technical analysis. In fact, the dynamic approach is very important to be applied as the condition of the stock markets is always changing over time. Based on these matters, this study examined the relationship and the integration of stock markets by using a Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroscedasticity (DCC-GARCH). The DCC-GARCH model introduced by Engle (2002) can be applied to a study of stock market integration dynamically although there is still limited research applying it (i.e., Zinecker et al. (2016) conducted integration studies on stock markets in Poland, Czechoslovakia, and Germany). According to Filis, Degiannakis and Floros (2011); Robiyanto, Wahyudi and Pangestuti (2017), the DCC-GARCH model also has successfully proven to estimate large matrices of time-varying covariances. In normal stock market circumstances, DCC-GARCH values tend to be stable at narrow range, but different things may occur if there is a turmoil in stock market and commodities, i.e. subprime mortgage crisis (Filis et al. 2011; Robiyanto 2018). By using this dynamic approach, the relationship, even the integration, of the ever-changing stock markets need to be analyzed with an approach that can accommodate and capture the dynamism of emerging stock markets studied in more detail.

The data used in this study are the stock price index data on the stock markets studied namely Nikkei 225 index, Dow Jones Industrial Average (DJIA), FTSE index, All Ordinaries index, Straits Times Index (STI), SET index, KOSPI index, Taipei WG index, KLSE Composite Index, Hang Seng Index (HSI), Manila Composite index (PSEi) and Jakarta Composite Index (JCI), monthly closing during the period of January 1999 to September 2015. This data are obtained from the Stock Market Statistics published by the Indonesia Financial Services Authority (FSA).

## LITERATURE REVIEW

### STOCK MARKET INTEGRATION IN ASEAN

In financial economics, it is common to assume that markets are integrated, either across market types or national border (Chen & Knez 1995). A commonly used definition of "financially integrated market" is that of Baele et al. (2004) and Weber (2006) who stated that the market for a given set of financial instruments and/or services are fully integrated if all potential market participants have the same relevant characteristics, in which they:

1. face a single set of rules when they decide to deal with those financial instruments and/or services;
2. have equal access to the set mentioned of financial instruments and/or services;
3. are treated equally when they are active in the market.

However, in the context of the integration of stock markets, this definition cannot be applied automatically as financially integrated markets may empirically not be integrated with stock markets. This occurs because the financially integrated markets are involving more macro factors and policies as in the financial intermediation sector, while the integration of stock markets is leading to yield and the risks tend to be the same. To obtain a better understanding of the concept, the following explanation will clarify the concepts of an integrated market and a fragmented market.

GIH (2008) defined integrated market as a market that has no barriers to financial flows and assets with the same risk should produce the same yield regardless of its location. Liberalization can bring emerging markets to be integrated with global stock markets. The liberal stock market is a market that permits foreign investors to buy and sell domestic securities without restriction. By assuming that integration, it implies that the risks involved in developing integrated stock markets can be more effectively defined as a map of the world stock markets. The stock market is considered to be integrated if there are similarities in returns to the risks associated with exposure to stock market risk while the segmented yield on the risk is not the same for different risk sources (Bekaert & Harvey 1995). In line with the statement, Hedi (2005) suggested that if stock markets are integrated, investors will face the risk of common and country-specific risks but the pricing is determined simply by considering the general risk for the specific country which has been diversified properly. In this case, similar asset pricing relationship can be applied to the integrated stock markets, and global risk factors only determine the expected yield.

As for the segmented stock markets, GIH (2008) defined it as a market that has limited the movement of capital flows freely, and the expected returns of the same assets in different countries do not have a significant correlation. Yields on local companies are more affected by domestic rather than global variables. On segmented stock markets, asset pricing relationship will vary from country to country and yields are expected to be determined by domestic risk factors. On segmented stock markets, investors will face two risks namely the general risk, and country-specific risks and they must use both in pricing. In this case, the expected yields must be determined by using both global and local communication sources of risks.

Bilson (2000) stated that the ongoing liberalization process which supports great changes also occurred in stock markets in Asia, such as in Indonesia, Malaysia, Philippines, South Korea, Taiwan, and Thailand. Many countries in Asia region change, especially regarding virtual technology which also expands to the stock markets and it also contributes to the economy. Further, a research conducted by Bilson (2000) also found that the integration of stock markets in Asia region under the study is increasing after the liberalization.

Furthermore, financial integration can benefit countries in the region and contribute to the financial development of ASEAN countries whose economics are still far from the developed ones. Investors in the ASEAN region can also predict the movement of assets in the ASEAN region in general (Suryanta 2011), even by using the movement of financial markets in the world because of investments from developed countries to developing countries. It cannot be denied, however, that there is a very substantial risk that accompanies the liberation of capital traffic and financial liberation. This risk can be the effect of transmission due to the stock market integration. Based on this background, a hypothesis is formulated as follows:

$H_1$ There is an integration between the Indonesian stock market with stock markets in the Asian region and stock markets in the world.

## PREVIOUS STUDIES

There have been a few studies that have specifically examined the relevance, relationship and the integration of stock markets that are potentially changing dynamically. Some of those studies are Lu and Mourdoukoutas (1997); Liu, Pan and Shieh (1998); Phylaktis (1999); Cha and Oh (2000); Phylaktis and Ravazzolo (2002); Lagoarde-Segot and Lucey (2007); Zinecker et al. (2016).

Lu and Mourdoukoutas (1997) in their qualitative study explained that psychological and natural factors can cause ties between the two stock markets. They also found that the correlation between the NYSE and the Tokyo Stock Exchange was 0.2 for the last five years and by 0.36 for the last ten years. This indicates that the stock market linkages can be varying over time. While, Liu et al. (1998) conducted a study on the relationship of stocks in the United States, Japan, Singapore, Taiwan, Thailand and Hong Kong. The data used is the data from January 2nd, 1985 to December 31st, 1990. The analysis was performed by using the Vector Autoregressive (VAR) and Granger Causality Test. In this study, it was found that the degree of dependency among stock markets increases after the crisis in 1987 and there is a stronger correlation between stock markets in Asia and the Pacific after the crisis.

Cha and Oh (2000) conducted a study on the relationship of stock markets in developed countries which was represented by the stock markets in the US and Japan with developing stock markets in Asia such as Hong Kong, Korea, Singapore and Taiwan by using the data from the period of January 4th, 1980 to September 1998, and are divided into three periods: from January 4th, 1980 to September 25th, 1987, from November 6th, 1987 to June 27th, 1997 and from July 4th, 1997 to September 18th, 1998. The analysis was performed by using VAR. The analysis showed that the relationship between the developed stock markets in the US and Japan and the developing stock markets in Asia begins to increase after the crisis in 1987 and this relationship becomes more intensive after the crisis in 1997.

Phylaktis and Ravazzolo (2002) suggested that some shocks to the economy of a country would have the same impact on economic growth of other countries because of the dependency. Co-movement in innovation expected returns in the future can be an indicator of financial integration since by assuming that the CAPM is valid, then returns and risks will move simultaneously to linear path. In order to prove this, a research was conducted with the object of stock markets in Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand and the United States. The data used are those from the period of January 1980 to December 1998, and the data were analyzed by using VAR. The results of the study showed that there are economic and financial integration of stock markets under the study, and it becomes stronger when the crisis of 1997 occurred. This supports the view that the integration and interdependency play an important role in the transmission of the Asian crisis.

Lagoarde-Segot and Lucey (2007) examined the integration of stock markets in the countries of the Middle East Africa and North Africa (MENA) such as stock markets in the countries of Morocco, Tunisia, Egypt, Lebanon, Jordan, Turkey and Israel with the European Union. The data used is on January 1st, 1998, to November 16th, 2004. By using the cointegration analysis techniques, the results obtained were used to reject the hypothesis of the existence of a stable relationship in the long term between MENA and EMU even with the United States. This indicates that there is a potential diversification.

Those previous studies on stock market integration still used a static approach, but the results of those studies indicated that stock market integration is dynamic and that follows the stock market conditions that are constantly changing. One of the studies that had used a dynamic approach is a research conducted by Zinecker et al. (2016) reviewing Polish, Czechoslovakia and German stock markets under the DCC-GARCH approach. In this study, Zinecker et al. (2016) found that the stock markets studied are strongly linked. DCC-GARCH is even able to show the interrelationships between stock markets over time. Therefore, DCC-GARCH application is seen to be able to provide a detailed picture of stock market integration.

## DYNAMIC CONDITIONAL CORRELATION GENERALIZED AUTOREGRESSIVE CONDITIONAL HETEROSCEDASTICITY (DCC-GARCH)

The DCC-GARCH model is introduced by Engle (2002). DCC model can be formulated with the following specifications:

$$r_t| =_{t\text{-}1} \sim N(0, D_t R_t D_t), \tag{1}$$

$$D_t^2 = \text{diag}\{\omega_i\} + \text{diag}\{\kappa_i\} \circ r_{t\text{-}1} r'_{t\text{-}1} + \text{diag}\{\lambda_i\} \circ D_{t\text{-}1}^2, \tag{2}$$

$$\varepsilon_t = D_{t\text{-}1}^2 r_t, \tag{3}$$

$$Q_t = \text{S} \circ (\iota \iota' - A - B) + A \circ \varepsilon_{t\text{-}1} \varepsilon_{t\text{-}1} + B \circ Q_{t\text{-}1}, \tag{4}$$

$$R_t = \text{diag}\{Q_i\}^{-1} Q_t \text{ diag } \{Q_i\}^{-1}. \tag{5}$$

Log likelihood for this estimator can be expressed as:

$$r_t | =_{t-1} \sim N(0, H_t), \tag{6}$$

$$L = -\frac{1}{2}\sum_{t=1}^{T} (n \log(2\pi) + \log|H_t| + r'_t H_t^{-1} r_t) \tag{7}$$

$$= -\frac{1}{2}\sum_{t=1}^{T} (n \log(2\pi) + \log|D_t R_t D_t| + r_t D_t^{-1} R_t^{-1} D_t^{-1} r_t) \tag{8}$$

$$= -\frac{1}{2}\sum_{t=1}^{T} (n \log(2\pi) + 2 \log|D_t| + \log|R_t| + \varepsilon'_t R_t^{-1} \varepsilon_t) \tag{9}$$

$$= -\frac{1}{2}\sum_{t=1}^{T} (n \log(2\pi) + 2 \log|D_t| + r'_t D_t^{-1} D_t^{-1} r_t - \varepsilon'_t \varepsilon_t + \log|R_t| + \varepsilon'_t R_t^{-1} \varepsilon_t), \tag{10}$$

which can be simply maximized to the parameter model. However, one of the purposes of the formulation of this model is that the model can be estimated easily despite of the covariance matrix that is very large. Adequate conditions for consistency and Asymptotic normality of these parameters follow the advice of Newey and McFadden (1994). If the parameter D is denoted by θ and additional parameters in the R denoted by φ. Log-likelihood can be written as the sum of the partial volatility and partial correlation as follows:

$$L(\theta, \phi) = L_V(\theta) + L_C(\theta, \phi) \tag{11}$$

Volatility *term* is

$$L_V(\theta) = -\frac{1}{2}\sum_t (n \log(2\pi) + \log|D_t|^2 + r'_t D_t^{-2} r_t) \tag{12}$$

Components of correlation is

$$L_C(\theta, \phi) = -\frac{1}{2}\sum_t (\log|R_t| + \varepsilon'_t R_t^{-1} \varepsilon_t - \varepsilon'_t \varepsilon_t) \tag{13}$$

Partial volatility of likelihood is the number of GARCH likelihood counted individually

$$L_V(\theta) = -\frac{1}{2}\sum_t \sum_{i=1}^{n} \left( \log(2\pi) + \log(h_{i,t}) + \frac{r_{i,t}^2}{h_{i,t}} \right) \tag{14}$$

which in combination can be maximized by maximizing each term. The second part of the likelihood is used to estimate the correlative parameter. As the squared residuals are not dependent on these parameters, then it cannot enter into the condition of the first order and is ignored. The resulting estimator is called DCC LL INT because it uses the integrated model. The two-stage approach to maximize the likelihood is to find

$$\hat{\theta} = \arg\max(L_V(\theta))| \tag{15}$$

And then these values are entered into the second stage:

$$\max_{\phi} \{L_C(\hat{\theta}, \phi)\}. \quad (16)$$

Under the condition that has regularity, the consistency of the first phase will ensure the consistency of the second stage. The maximum of the second phase will be a function of the estimated parameter of the first stage so that if the first phase is consistent, then the second phase will also be consistent throughout a continuous function in proximity to the actual parameter.

## METHODOLOGY

This study used time series data, i.e., the stock price index data on the stock markets studied. Stock markets studied were Tokyo Stock Exchange with the Nikkei 225 index, the New York Stock Exchange with the Dow Jones Industrial Average (DJIA), the London Stock Exchange with the FTSE index, the Australian Stock Exchange with the ASX index, the Singapore Stock Exchange with the Straits Times Index (STI), Stock Exchange of Thailand with the SET index, Seoul Stock Exchange with the KOSPI index, Taiwan Stock Exchange with Taipei WG index, the Kuala Lumpur Stock Exchange with KLSE Composite index, Hong Kong Stock Exchange with the Hang Seng Index (HSI), Philippines Stock Exchange with Manila Composite index (PSEi) and Indonesian Stock Exchange with Jakarta Composite Index (JCI), monthly closing during the period of January 1999 to September 2015. The period of January 1999 to September 2015 is chosen because in this period there has been a revocation of foreign ownership restrictions on the Indonesia Stock Exchange.

To support the analysis results, this study divided the period of analysis into three periods, namely pre-crisis period (January 1999-June 2007), during crisis period (July 2007-December 2008) and post-crisis period (January 2009-September 2015). The division of pre-crisis period and during crisis period followed what had been done by Majid and Kassim (2009) and Karim et al. (2010).

This data were obtained from the Stock market Statistics published by the Indonesian Financial Services Authority (FSA). The stock market return studied ($R_{m,t}$) was calculated by the formula:

$$R_{m,t} = \left[ \frac{Composite_t - Composite_{t-1}}{Composite_{t-1}} \right] \quad (17)$$

Where:

$Composite_t$= The Closing of Stock Price Index in the Stock Exchange under study in month t

$Composite_{t-1}$= The Closing of Stock Price Index in the Stock Exchange under study in month t – 1

DCC-GARCH analysis was conducted by using EVIEWS software. In this study, the parameter D (in Equation 2 to Equation 11) which depicted the return of JCI is denoted by θ (in Equation 12 to Equation 17) and additional parameters in the R (in Equation 2 to Equation 11) which depicted the return of other stock markets were denoted by φ (in Equation 12 to Equation 17). Other analysis such as descriptive statistic analysis, correlation analysis, Granger Causality test and mean difference test were also held to support the DCC-GARCH analysis.

## RESULTS

### DESCRIPTIVE STATISTICS

The following Table 1. shows the descriptive statistics of the stock markets studied. Based on Table 1, it can be seen that the JCI's mean was the highest compared to other stock markets studied, meanwhile the FTSE' mean was the lowest. During the study period, Indonesia Stock Exchange was one of the best performing stock markets in the world from the perspective of the return. Meanwhile, from the perspective of the standard deviation, SET had the highest standard deviation value compared to other stock markets, while ASX had the smallest standard deviation value.

TABLE 1. Descriptive statistics

| | N | Maximum | Minimum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| JCI | 200 | 0.2581 | -0.3142 | 0.0142 | 0.0704 |
| STI | 200 | 0.2422 | -0.2394 | 0.0052 | 0.0600 |
| KLSE | 200 | 0.3423 | -0.1863 | 0.0066 | 0.0560 |
| SET | 200 | 0.3048 | -0.3018 | 0.0092 | 0.0723 |
| KOSPI | 200 | 0.2343 | -0.2313 | 0.0087 | 0.0716 |
| HSI | 200 | 0.2185 | -0.2247 | 0.0061 | 0.0653 |
| Nikkei225 | 200 | 0.1301 | -0.2383 | 0.0027 | 0.0588 |
| TaipeiWG | 200 | 0.2338 | -0.1935 | 0.0039 | 0.0682 |
| DowJones | 200 | 0.1060 | -0.1406 | 0.0037 | 0.0420 |
| FTSE | 200 | 0.0865 | -0.1302 | 0.0010 | 0.0408 |
| ASX | 200 | 0.0890 | -0.1400 | 0.0035 | 0.0379 |
| PSEi | 200 | 0.1999 | -0.2407 | 0.0082 | 0.0616 |

*Source*: Indonesia FSA, analyzed.

### RESULTS OF DATA STATIONARITY TEST

In the following Table 2, we can see the test results of the stationarity data. Based on Table 2, it can be seen that all the data used in this study had significant values of ADF level at a significance level of 1%. On this basis, it can be concluded that all data used in this study were stationary data, and they were not indicated to have a unit root. Therefore, it was not necessary to conduct further treatment for these specific data and these data could be directly analyzed by using analytical technique GARCH

TABLE 2. Stationarity test result of data

| No. | Description | Level |
|---|---|---|
| 1. | ASX | -12.796* |
| 2. | Dow Jones | -15.561* |
| 3. | FTSE | -14.398* |
| 4. | HSI | -12.542* |
| 5. | JCI | -11.146* |
| 6. | KLSE | -13.632* |
| 7. | KOSPI | -13.059* |
| 8. | Nikkei 225 | -12.795* |
| 9. | PSEI | -18.025* |
| 10. | SET | -13.590* |
| 11. | STI | -12.553* |

*Source*: Indonesia FSA, analyzed.
*Note*: * significant at the 0.01 level

to obtain DCC. Analysis of GARCH (1,1) is the appropriate analysis used for a data that can be analysed directly without any further treatment (Posedel 2005).

### RESULTS OF CORRELATION ANALYSIS

Based on the results of correlation analysis as shown in Table 3, all stock markets reviewed had a significant positive correlation. This showed that from the value correlation perspective, it was as if all the stock markets studied were interconnected and mutually integrated.

### RESULTS OF GRANGER CAUSALITY TEST

Based on the Granger Causality Test results as shown in Table 4, it can be seen that JCI and ASX did not affect

TABLE 3. Correlation analysis results

| | JCI | STI | KLSE | SET | KOSPI | HSI | Nikkei225 | TaipeiWG | DowJones | FTSE | ASX | PSEi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JCI | 1 | 0.656** | 0.531** | 0.642** | 0.529** | 0.513** | 0.430** | 0.426** | 0.460** | 0.433** | 0.503** | 0.634** |
| STI | 0.656** | 1 | 0.529** | 0.685** | 0.672** | 0.757** | 0.531** | 0.595** | 0.658** | 0.643** | 0.675** | 0.602** |
| KLSE | 0.531** | 0.529** | 1 | 0.459** | 0.386** | 0.438** | 0.276** | 0.478** | 0.393** | 0.314** | 0.342** | 0.386** |
| SET | 0.642** | 0.685** | 0.459** | 1 | 0.629** | 0.571** | 0.456** | 0.568** | 0.548** | 0.504** | 0.523** | 0.616** |
| KOSPI | 0.529** | 0.672** | 0.386** | 0.629** | 1 | 0.659** | 0.535** | 0.624** | 0.607** | 0.563** | 0.589** | 0.485** |
| HSI | 0.513** | 0.757** | 0.438** | 0.571** | 0.659** | 1 | 0.531** | 0.600** | 0.661** | 0.686** | 0.670** | 0.461** |
| Nikkei225 | 0.430** | 0.531** | 0.276** | 0.456** | 0.535** | 0.531** | 1 | 0.468** | 0.520** | 0.521** | 0.592** | 0.377** |
| TaipeiWG | 0.426** | 0.595** | 0.478** | 0.568** | 0.624** | 0.600** | 0.468** | 1 | 0.532** | 0.497** | 0.490** | 0.433** |
| DowJones | 0.460** | 0.658** | 0.393** | 0.548** | 0.607** | 0.661** | 0.520** | 0.532** | 1 | 0.833** | 0.678** | 0.484** |
| FTSE | 0.433** | 0.643** | 0.314** | 0.504** | 0.563** | 0.686** | 0.521** | 0.497** | 0.833** | 1 | 0.743** | 0.417** |
| ASX | 0.503** | 0.675** | 0.342** | 0.523** | 0.589** | 0.670** | 0.592** | 0.490** | 0.678** | 0.743** | 1 | 0.461** |
| PSEi | 0.634** | 0.602** | 0.386** | 0.616** | 0.485** | 0.461** | 0.377** | 0.433** | 0.484** | 0.417** | 0.461** | 1 |

*Note* : **. Correlation is significant at the 0.01 level (2-tailed).

each other, and so did JCI with DJIA. However, JCI with Nikkei225 turned out to be mutually influential, while FTSE, HSI, KOSPI, STI and Taipei WG influenced JCI. It was further discovered that JCI was able to influence KLSE, PSEi, and SET.

## DISCUSSIONS

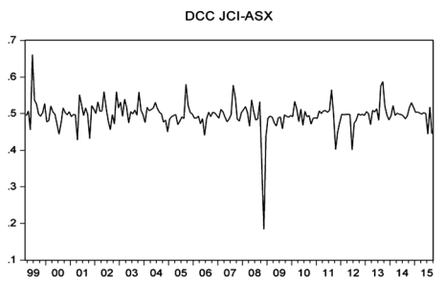
Based on the analysis performed by DCC-GARCH as shown in Figure 1, it can be seen that by using DCC-GARCH, the correlation between JCI with several stock markets studied were seen to be dynamically changing along the time. This was similar to the results of a research done by Zinecker et al. (2016), who also conducted a study on stock market integration with DCC-GARCH, which concluded that DCC-GARCH is even able to show the interrelationships between stock markets over time. The results of this study also supported the results of a research conducted by Lagoarde-Segot and Lucey (2007) which concluded that long-term stock market integration is not stable. Furthermore, this study also found that based on the division of research period which were divided into the pre-crisis period, during the crisis period and post-crisis period, it was known that the average value of DCC-GARCH for each period was different. In Table 5, we can see the DCC-GARCH summary for each period.

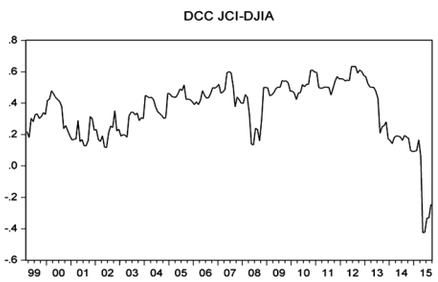
The findings as shown in Table 5 also show that the average DCC-GARCH value between JCI and other stock markets studied in this study tended to increase from the pre-crisis period (with an average value of DCC-GARCH of 0.4506), during crisis period (with average value of DCC-GARCH of 0.4956) to post-crisis period (with average value of DCC-GARCH of 0.5249). These findings suggest that the integration between JCI and other stock markets has increased over time and after the crisis. This supported a research by Lu and Mourdoukoutas (1997) which found that there was a stronger relationship between stock markets in Asia and the Pacific after the crisis, despite the study period studied by Lu and Mourdoukoutas (1997) which only involved the 1997 Asian crisis. This research

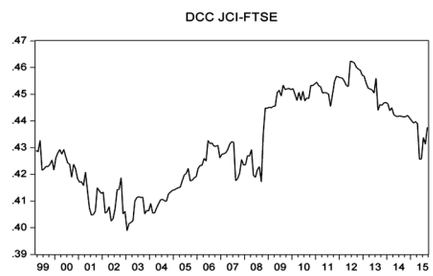
TABLE 4. Granger Causality test results

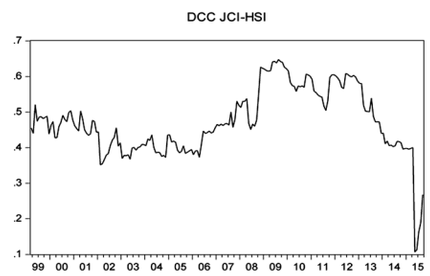
| Null Hypothesis: | F-Statistic | Prob. |
|---|---|---|
| JCI does not Granger Cause ASX | 0.39113 | 0.6768 |
| ASX does not Granger Cause JCI | 2.21653 | 0.1118 |
| JCI does not Granger Cause DOW_JONES | 0.05256 | 0.9488 |
| DOW_JONES does not Granger Cause JCI | 0.90084 | 0.4079 |
| JCI does not Granger Cause FTSE | 1.02522 | 0.3607 |
| FTSE does not Granger Cause JCI | 4.65073** | 0.0107 |
| JCI does not Granger Cause HSI | 1.96481 | 0.143 |
| HSI does not Granger Cause JCI | 6.24114*** | 0.0024 |
| KLSE does not Granger Cause JCI | 0.51373 | 0.5991 |
| JCI does not Granger Cause KLSE | 10.417*** | 5.00E-05 |
| KOSPI does not Granger Cause JCI | 3.8604** | 0.0227 |
| JCI does not Granger Cause KOSPI | 2.12581 | 0.1221 |
| NIKKEI_225 does not Granger Cause JCI | 3.3403** | 0.0375 |
| JCI does not Granger Cause NIKKEI_225 | 2.80995* | 0.0627 |
| PSEI does not Granger Cause JCI | 0.35034 | 0.7049 |
| JCI does not Granger Cause PSEI | 3.64502** | 0.0279 |
| SET does not Granger Cause JCI | 0.98297 | 0.3761 |
| JCI does not Granger Cause SET | 3.87073** | 0.0225 |
| STI does not Granger Cause JCI | 4.70063** | 0.0102 |
| JCI does not Granger Cause STI | 0.63552 | 0.5308 |
| TAIPEI_WG does not Granger Cause JCI | 3.30637** | 0.0387 |
| JCI does not Granger Cause TAIPEI_WG | 1.15625 | 0.3168 |

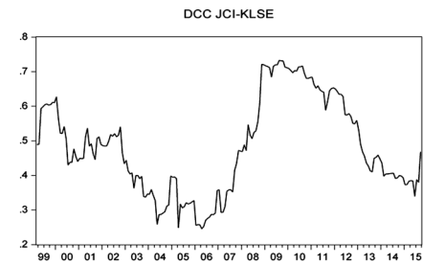
*Note*: *** Significant at the 0.01 level
** Significant at the 0.05 level
* Significant at the 0.10 level

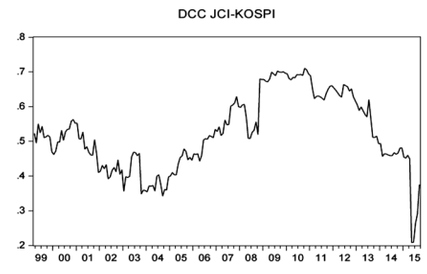


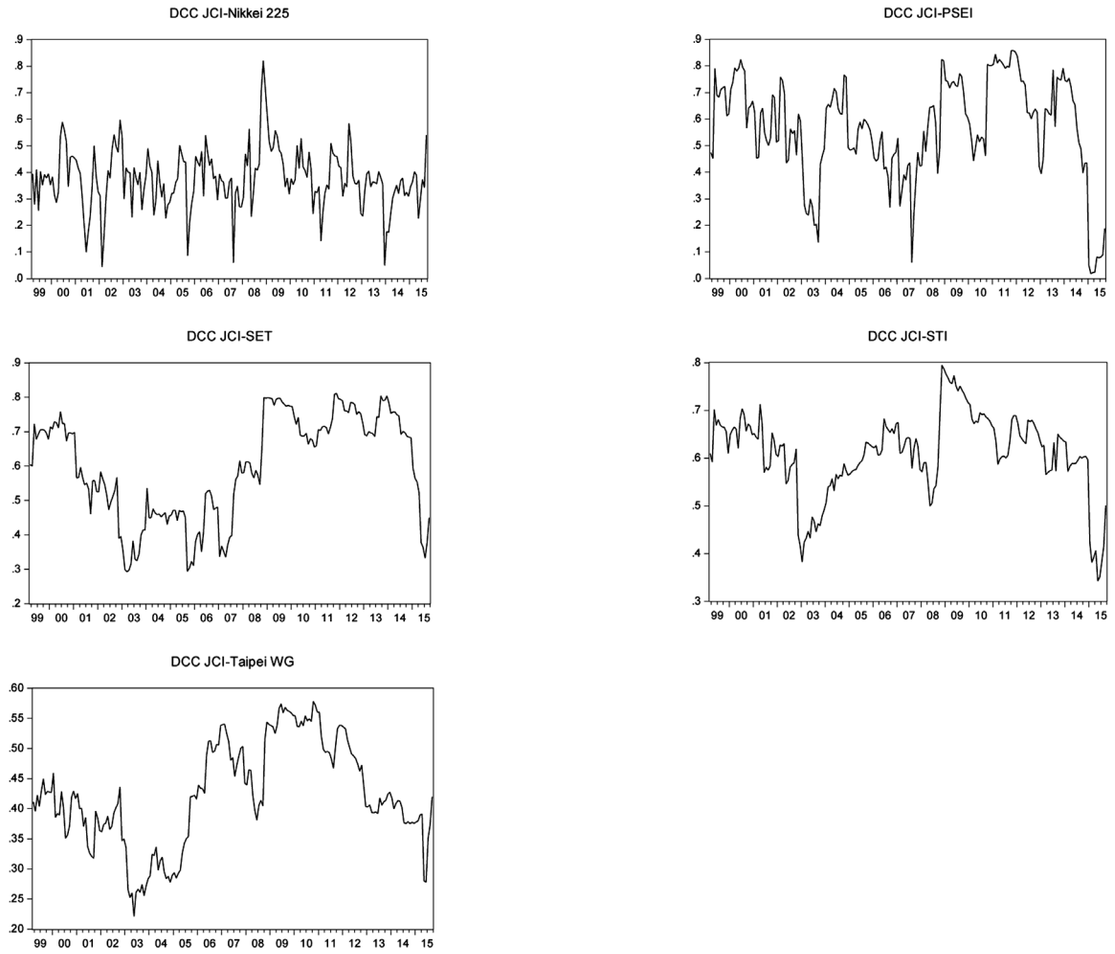



FIGURE 1. DCC Jakarta Composite Index (JCI of IDX) – Several Stock Markets January 1999 – September 2015

finding also supported Cha and Oh (2000); Phylaktis and Ravazzolo (2002) who found that stock market integration in developed stock markets in Asia was intensified after the crisis in 1997.

The average value of DCC-GARCH JCI-ASX tends to decrease from 0.5009 in the pre-crisis period to 0.4782 during the crisis period, but increase to 0.4953 in the post-crisis period. The same finding is also found in JCI-PSEi. The average value of DCC-GARCH JCI-PSEi tends to decrease from 0.5464 in the pre-crisis period to 0.5038 during the crisis period, but increase to 0.6045 in the post-crisis period. On the contrary, the average value of DCC-GARCH JCI-Nikkei 225 tends to increase from 0.3709 in the pre-crisis period to 0.4145 during the crisis period but decrease to 0.3744 in the post-crisis period. Meanwhile, the average value of DCC-GARCH JCI-DJIA, JCI-FTSE, JCI-HSI, JCI-KLSE, JCI-KOSPI, JCI-SET, JCI-STI and JCI-Taipei WG are increasing from the pre-crisis period, during the crisis period and post-crisis period. These findings support the research that has been done by Majid et al. (2008); Majid and Kassim (2009); Karim, Kassim and Arip (2010); Suganda and Soetrisno (2016); Robiyanto (2017); Guesmi et al. (2013) who have found that stock markets in Asia were increasingly integrated following the 2008 sub-prime mortgage crisis. Based on all findings, the hypothesis which states there is an integration between the Indonesian stock market with stock markets in ASEAN region and stock markets in the world, is supported. This finding was also consistent with Karim and Ning (2013), who found that the degree of co-movements of ASEAN stock markets become higher in post-crisis period. The reasons were that the bilateral trade ties among the ASEAN countries become stronger after post-crisis period (Karim & Ning 2013), and the regulators of ASEAN stock markets also have tried to focus on mutual recognition and harmonization as mechanisms to foster regional stock market integration (Singh 2009).

To strengthen the result of this research as shown in Table 5, the DCC-GARCH difference test was analyzed for the pre-crisis period, during the crisis period and post-crisis period. The results of this test are shown in Table 6. The average value of DCC-GARCH in pre-crisis period and during crisis period were significantly different; it also applied to the average value of DCC-GARCH during

TABLE 5. DCC-GARCH summary

| Pre-Crisis Period | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JCI-ASX | JCI-DJIA | JCI-FTSE | JCI-HSI | JCI-KLSE | JCI-KOSPI | JCI-Nikkei 225 | JCI-PSEi | JCI-SET | JCI-STI | JCI-Taipei WG | Average |
| Max | 0.6611 | 0.6009 | 0.4327 | 0.5206 | 0.6268 | 0.5627 | 0.5970 | 0.8238 | 0.7577 | 0.7125 | 0.5402 | |
| Min | 0.4282 | 0.1170 | 0.3989 | 0.3514 | 0.2460 | 0.3425 | 0.0437 | 0.1360 | 0.2931 | 0.3824 | 0.2211 | |
| Average | 0.5009 | 0.3405 | 0.4172 | 0.4286 | 0.4126 | 0.4599 | 0.3709 | 0.5464 | 0.5045 | 0.5960 | 0.3795 | 0.4506 |
| During Crisis Period | | | | | | | | | | | | |
| | JCI-ASX | JCI-DJIA | JCI-FTSE | JCI-HSI | JCI-KLSE | JCI-KOSPI | JCI-Nikkei 225 | JCI-PSEi | JCI-SET | JCI-STI | JCI-Taipei WG | Average |
| Max | 0.5774 | 0.5944 | 0.4448 | 0.6260 | 0.7213 | 0.6794 | 0.8204 | 0.8238 | 0.7989 | 0.7942 | 0.5438 | |
| Min | 0.4796 | 0.3776 | 0.4176 | 0.4567 | 0.3526 | 0.5485 | 0.0591 | 0.0605 | 0.3984 | 0.5713 | 0.4393 | |
| Average | 0.4782 | 0.3647 | 0.4261 | 0.5099 | 0.5091 | 0.5821 | 0.4145 | 0.5038 | 0.5976 | 0.6068 | 0.4583 | 0.4956 |
| Post-Crisis Period | | | | | | | | | | | | |
| | JCI-ASX | JCI-DJIA | JCI-FTSE | JCI-HSI | JCI-KLSE | JCI-KOSPI | JCI-Nikkei 225 | JCI-PSEi | JCI-SET | JCI-STI | JCI-Taipei WG | Average |
| Max | 0.5874 | 0.6339 | 0.4624 | 0.6473 | 0.7326 | 0.7103 | 0.6155 | 0.8577 | 0.8114 | 0.7761 | 0.5779 | |
| Min | 0.4011 | -0.4256 | 0.4257 | 0.1071 | 0.3398 | 0.2085 | 0.0484 | 0.0179 | 0.3328 | 0.3424 | 0.2779 | |
| Average | 0.4953 | 0.3789 | 0.4487 | 0.5162 | 0.5635 | 0.5867 | 0.3744 | 0.6045 | 0.7097 | 0.6263 | 0.4693 | 0.5249 |
| All Period | | | | | | | | | | | | |
| | JCI-ASX | JCI-DJIA | JCI-FTSE | JCI-HSI | JCI-KLSE | JCI-KOSPI | JCI-Nikkei 225 | JCI-PSEi | JCI-SET | JCI-STI | JCI-Taipei WG | Average |
| Max | 0.6611 | 0.6339 | 0.4624 | 0.6473 | 0.7326 | 0.7103 | 0.8204 | 0.8577 | 0.8114 | 0.7942 | 0.5779 | |
| Min | 0.1841 | -0.4256 | 0.3989 | 0.1071 | 0.2460 | 0.2085 | 0.0437 | 0.0179 | 0.2931 | 0.3424 | 0.2211 | |
| Average | 0.4957 | 0.3560 | 0.4314 | 0.4703 | 0.4772 | 0.5227 | 0.3745 | 0.5476 | 0.5845 | 0.6033 | 0.4250 | 0.4807 |

the crisis period and post-crisis period; and also pre-crisis period and post-crisis period. The average value of DCC-GARCH JCI-ASX, JCI-DJIA, and JCI-Nikkei 225 were not significantly different, while for others, almost all were significantly different.

## MANAGERIAL IMPLICATION

Based on the findings, investors and fund managers who invest in Indonesia Stock Exchange (IDX) should consider the stock markets which are more integrated with Indonesia Stock Exchange especially after crisis periods such as US, UK and other Asian stock markets (except Philipines Stock Exchange and Tokyo Stock Exchange). Investors and fund manager in IDX should consider the condition of the TSE, HSI, KOSPI, STI and Taipei WG since they influence JCI. It is further discovered that IDX's condition is able to influence KLSE, PSEi, and SET. Therefore, investors and fund managers in this stock exchanges should also consider the IDX conditions before making the decision to invest there. Besides, international investors (from US, UK, and other Asian stock markets except Philipines and Japan) may find limited opportunity from international diversification in Indonesia because the Indonesian stock market is interdependent with those stock markets mentioned.

## CONCLUSION

By using DCC-GARCH, the study found that the dynamic relationship between the Indonesian stock market with stock markets in Asia and the world was always changing over time. The DCC-GARCH value between JCI and the stock market indexes studied tended to vary. It was found that the value of DCC-GARCH between JCI and the stock market indexes studied (except Australia Stock Market, Philipines Stock Exchange, and Tokyo Stock Exchange) tended to increase from the pre-crisis period, during the crisis period and post-crisis period. Consistent with previous research, this study found that the degree of stock market integration tended to increase after the big financial crisis such as 2008 Sub-prime Mortgage Crisis.

TABLE 6. DCC-GARCH differences across periods

| | | Mean Difference | t | Sig. |
|---|---|---|---|---|
| JCI-ASX | Pre-During | 0.2271 | 1.092 | 0.29 |
| | During-Post | -0.01714 | -0.824 | 0.421 |
| | Pre-Post | 0.00557 | 1.301 | 0.195 |
| JCI-DJIA | Pre-During | -0.02426 | -0.702 | 0.49 |
| | During-Post | -0.01418 | -0.332 | 0.741 |
| | Pre-Post | -0.03844 | -1.27 | 0.207 |
| JCI-FTSE | Pre-During | -0.00997 | -4.058*** | 0 |
| | During-Post | -0.02262 | -10.51*** | 0 |
| | Pre-Post | -0.0315 | -25.732*** | 0 |
| JCI-HSI | Pre-During | -0.08136 | -6.269*** | 0 |
| | During-Post | -0.0063 | -0.346 | 0.73 |
| | Pre-Post | -0.08766 | -6.278*** | 0 |
| JCI-KLSE | Pre-During | -0.09652 | -3.716*** | 0.001 |
| | During-Post | -0.0544 | -1.954* | 0.06 |
| | Pre-Post | -0.15092 | -8.349*** | 0 |
| JCI-KOSPI | Pre-During | -0.1224 | -8.9*** | 0 |
| | During-Post | -0.99454 | -0.251 | 0.803 |
| | Pre-Post | -0.12678 | -8.719*** | 0 |
| JCI-Nikkei225 | Pre-During | -0.04363 | -0.955 | 0.351 |
| | During-Post | 0.04011 | 0.876 | 0.392 |
| | Pre-Post | -0.00352 | -0.232 | 0.817 |
| JCI-PSEi | Pre-During | 0.04257 | 0.912 | 0.372 |
| | During-Post | -0.10063 | -1.981* | 0.057 |
| | Pre-Post | -0.05805 | -1.959* | 0.052 |
| JCI-SET | Pre-During | -0.09316 | -3.746*** | 0.001 |
| | During-Post | -0.11207 | -4.645*** | 0 |
| | Pre-Post | -0.20523 | -11.817*** | 0 |
| JCI-STI | Pre-During | -0.01081 | -0.519 | 0.609 |
| | During-Post | -0.01958 | -0.878 | 0.387 |
| | Pre-Post | -0.03039 | -2.303** | 0.023 |
| JCI-Taipei WG | Pre-During | -0.07884 | -5.647*** | 0 |
| | During-Post | -0.01097 | -0.762 | 0.451 |
| | Pre-Post | -0.0898 | -7.837*** | 0 |
| Average | Pre-During | -0.04495 | -3.139*** | 0.005 |
| | During-Post | -0.0293 | -1.708* | 0.095 |
| | Pre-Post | -0.07425 | -6.488*** | 0 |

*Note*: *** Significant at the 0.01 level
** Significant at the 0.05 level
* Significant at the 0.10 level

For future research, this study shows the importance of dynamic approach's usage in stock market integration analysis. Since this study becomes a pioneer in this approach and there are only few stock markets studied, the future study can expand the scope of stock market analyzed. The study which includes longer period is also recommended (i.e., before the 1997 Asian Crisis) to explore the potentially increase of integration in the long run.

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