THE ANALYSIS OF CAPITAL MARKET INTEGRATION IN ASEAN REGION BY USING THE OGARCH APPROACH

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ABSTRACT

Capital market integration is a topic that attracts a lot of research interests in regional and international capital markets. Unfortunately, the various studies that have been done tend to use analytical tools that have not been able to conclude the degree of capital market integration quantitatively, hence a study that is able to measure the degree of capital market integration quantitatively is required. This study investigated the capital markets integration in ASEAN by using the Orthogonal Generalized Autoregressive Conditional Heteroscedasticity (OGARCH) method which could provide the degree of integration quantitatively. Capital markets studied were Indonesia Stock Exchange, Kuala Lumpur Stock Exchange, Thailand Stock Exchange, Singapore Stock Exchange and Philippines Stock Exchange during period of January 2001 – December 2016. The result of this study was there was a co-movement among ASEAN capital markets studied, but not all these ASEAN capital markets were fully integrated. This study also found that Indonesia Stock Exchange, Kuala Lumpur Stock Exchange, Stock Exchange Thailand, and Singapore Stock Exchange were integrated but Philippines Stock Exchange was not. The Philippines Stock Exchange tended to be segmented rather than integrated.

Keywords: ASEAN, capital market integration, Orthogonal Generalized Autoregressive Conditional Heteroscedasticity (OGARCH), Principal Component Analysis (PCA)

JEL Classification: G11, G15

ABSTRAK

The integration of capital markets is an interesting topic for researchers in the stock market, so it is not surprising if there have been a lot of researches on the integration of capital markets that have been done either internationally (Mussa & Goldstein, 1993; Kearney & Lucey, 2004; Pukthuanthong & Roll, 2009; Mink, 2015) or regionally (Kim & McKenzie, 2008; Azad, 2009), that examine the integration of capital markets in Asia Pacific, Agyei-Ampomah (2011), that examine the integration of capital markets in Africa, Ameer (2006) and Arsyad (2015), that examine the capital markets in East Asia and South Asia. Meanwhile, for ASEAN region, there were many researchers who have conducted studies on the integration of financial markets and capital markets in this region such as Volz (2013) who finds that the integration of financial markets in ASEAN is still in the early stages, while Palac-McMiken (1997) finds that ASEAN capital markets in the period of 1987 to 1995 were integrated except for Indonesia.

The is also found by Roca et al. (1998), who state that all of the capital markets in the ASEAN region have interconnections except Indonesia. Meanwhile, Suryanta (2011) by using data from the post-crisis Asia (2004-2009) also found that capital markets in Indonesia do not have a comovement with the capital markets in ASEAN region, while the other capital markets have a comovement. On the contrary, some researchers such as Cheng et al. (2003), Click & Plummer (2005), and Karim & Ning (2013) who conducted a study on the ASEAN capital market integration by using the data after the occurrence of the crisis in Southeast Asia even found that the five capital markets in the ASEAN (including Indonesia) are integrated with each other.

Those findings also reinforced by Majid & Kassim (2009) and Suganda & Soetrisno (2016). Both researches using data after the subprime crisis in 2008. Majid & Kassim (2009) found that ASEAN capital market integration is even stronger following the 2008 subprime crisis. Karim & Karim (2012) and Suganda & Soetrisno (2016) even concluded that the integration of capital markets in ASEAN region even more integrated in the various crises occurred.

Various studies that have been conducted related to the integration of capital markets especially for capital markets in the ASEAN region still tend to produce inconsistent findings. Furthermore, these studies have not been able to conclude the integration degree of capital markets examined conclusively. Based on those facts, so this study aimed to review the integration of capital markets in ASEAN region using the Orthogonal Generalized Autoregressive Conditional Heteroscedasticity (OGARCH) method that were able to conclude the integration degree.

Bai (2011) states that the OGARCH method uses a Principal Component Analysis (PCA) to summarize the variation explanatory factors in the time series data and then used PCA covariance matrix to adjust the initial data of covariance matrix. The results of this OGARCH analysis will show the number of the total variation in the data that is able to be explained by each of the principle component (Alexander, 2001). In relation to the analysis of capital market integration, the greater the number of total variations that can be explained by the principle components will indicate the more integrated the capital markets are.

**METHOD**

The data used in this research were the monthly closing of composite stock price index in ASEAN region (Strait Times Index of the Singapore Stock Exchange, SET Index of the Stock Exchange Thailand, Kuala Lumpur Composite Index of the Kuala Lumpur Stock Exchange, PSEi from the Philippines Stock Exchange and Jakarta Composite Index of the Indonesia Stock Exchange) during period of January 2001 to December 2016.
The data were obtained from the Capital Market Statistics published by the Financial Services Authority/Otoritas Jasa Keuangan (OJK).

**Orthogonal Generalized Autoregressive Conditional Heteroscedasticity (OGARCH)**

This study used the OGARCH method to analyse capital market integration. In the OGARCH model, time series data studied were linearly transformed into time series data that were not tied one another by using PCA (Luo, 2015). PCA was defined as a procedure that used the orthogonal changes in summarizing an important information content of a series of variables bound to each other into unrelated variables. According to Bai (2011), those new orthogonal variables were then called as principal components (PC) and the number of PC to be less than the number of initial variables. Assume that K was the number of variables and M was the number of main components, M was expected to be less than K because it was expected that deviation from the data would be issued and could simplify the calculation.

Further, according to Alexander (2001), the number of major components used in the analysis would determine the accuracy of the calculations for PCA indicated the total number of variations in the initial data that could be explained by each of the main components. Thus in general, the principal component had to calculate the largest possible variance and any variance that followed it was likely to be the highest variance by considering the orthogonal of the preceding components.

**Estimation Model in OGARCH**

If Y becomes the matrix $T \times k$ of the monthly return $k$ of composite stock price index at $T$ month, the monthly return can be calculated by using the natural logarithm of the next monthly closing of composite stock price index divided by the monthly closing of composite stock price index. The formula is as follows:

$$y_i = log \frac{p_{i+1}}{p_i}$$

Where $p_i$ is the monthly closing of composite stock price index in period $i$.

The first step:

Standardizing the data into matrix $XTX_k$ with variance estimated and averaged for each $y_i$ and obtaining a correlation matrix $XX'$.

Step two:

Performing principal component analysis (PCA) on $XX'$ to obtain eigenvalue vector and eigenvalue. Eigenvector matrix is denoted by $L$ and its mth column with $l_{m} = (m_1, m, \ldots, l_{k,m})$, $1 \times K$ eigenvector associated eigenvalue $\lambda_m$. So that this column becomes $\lambda_1 > \lambda_2 > \ldots > \lambda_k$.

Third step:

Determining how many principal components should be used. If the first principal component is selected, then the mth principal component of the system is:

$$p_m = x_1 l_{1,m} + x_2 l_{2,m} + \ldots + x_k l_{k,m}$$

Where $x_i$ is the ith column of the column $X_{n'}$, $TXn$ matrix is then extracted from $X$. Thus, the principal component matrix of $P$ is represented by $TXn$ matrix and is obtained $P = X_n W_n$.

Fourth step:

Conditional variance of the principal components ith $p_i, i = 1, N$ is estimated by using GARCH $(1,1)$:
Fifth step:

Conditional covariance matrix of \( X_n \) is

\[ P_{i,t} = \varepsilon_{i,t} \]
\[ \sigma^2_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i \sigma^2_{i,t-1} \]
\[ \Sigma = \text{diag}(\sigma^2_{1,t}, ..., \sigma^2_{n,t}) \]

The accuracy of the conditional covariance matrix \( \Sigma \) from the original return is determined by how many components of \( n \) are selected to represent the existing system.

RESULTS

Bai (2011) stated that the OGARCH technique could work well in series of data that were correlated with one another. Thus, before making the OGARCH analysis, correlation analysis for the capital markets in the ASEAN region examined in this study was required. In Table 1 below, it can be seen results of correlation analysis of ASEAN capital market returns.

Based on Table 1, it can be seen that in general, the correlations of capital market returns in the ASEAN region studied in this research was significant therefore the OGARCH analysis was suitable for being applied on a series of data used in this study. Meanwhile, based on the OGARCH analysis result (which is combining GARCH and PCA) which had been done, it showed that the conditional variance of each capital market return in ASEAN region formed two main components. In detail, it can be seen in Table 2 and Table 3, whereas in Figure 1 it can be seen Ordered Eigenvalue and Eigenvalue Cumulative Proportion.

### Table 1. Correlation of Capital Market Returns in the ASEAN Region

<table>
<thead>
<tr>
<th></th>
<th>IDX</th>
<th>KLCl</th>
<th>STI</th>
<th>PSE</th>
<th>SET</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDX</td>
<td>Correlation Coefficient 1.000</td>
<td>0.578</td>
<td>0.637</td>
<td>0.159</td>
<td>0.594</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>KLCl</td>
<td>Correlation Coefficient 0.578</td>
<td>1.000</td>
<td>0.657</td>
<td>0.181</td>
<td>0.485</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>STI</td>
<td>Correlation Coefficient 0.637</td>
<td>0.657</td>
<td>1.000</td>
<td>0.157</td>
<td>0.641</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>PSE</td>
<td>Correlation Coefficient 0.159</td>
<td>0.181</td>
<td>0.157</td>
<td>1.000</td>
<td>0.142</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>SET</td>
<td>Correlation Coefficient 0.594</td>
<td>0.485</td>
<td>0.641</td>
<td>0.142</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: Capital Market Statistics, processed.

### Table 2. Results of PCA analysis

<table>
<thead>
<tr>
<th>Principal Component</th>
<th>Eigenvalue</th>
<th>Cumulative Value</th>
<th>Proportion</th>
<th>Cumulative Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.854341</td>
<td>2.854341</td>
<td>0.5709</td>
<td>0.5709</td>
</tr>
<tr>
<td>2</td>
<td>0.947009</td>
<td>3.801350</td>
<td>0.1894</td>
<td>0.7603</td>
</tr>
</tbody>
</table>

Source: Capital Market Statistics, processed.
Principal component (PC) 1 had an eigenvalue with value of 2.854. The proportion of PC 1 was 0.5709 which indicated that the five capital markets in ASEAN region had the same principal return variance explanatory. This PC 1 was even able to explain the 57.09% magnitude of variance in ASEAN capital market returns. It showed that the five capital markets in ASEAN region had a same main risk factor and accounted for 57.09% to conditional variance of each capital market return.

Meanwhile, the principal component (PC) 2 had eigenvalue of 0.9470 with a proportion of 0.1894. The second factor was able to explain 18.94% of the variance in the capital markets studied. It indicated that there were other factors that had the same role in determining the number of variances on ASEAN capital markets studied. The risk factors of the second principal component accounted for 18.94% of conditional variance of each capital market return.

These two principal components were able to contribute as much as 76.03% in explaining the conditional variance of the capital market returns in ASEAN region. In the context of capital market integration, this finding also implied that there were 76.03% of the same factors that could affect the capital markets in ASEAN region. Furthermore, there were 23.97% variance that could not be explained by the two principal components and these factors were random and not able to affect the capital markets in ASEAN region simultaneously.

DISCUSSION

Based on PCA analysis results shown in Table 2., it was seen that the capital market in ASEAN region had 57.09% of the principal factors causing the same movement, so that there were comovements in those capital markets. This result supported the research results done by Click & Plummer (2005); Cheng et al. (2003) (2003); Karim & Ning (2013) who found that there were comovements in the capital markets in ASEAN region. The results also showed that despite the capital markets had comovement but the capital markets were not fully integrated. It could be seen from the communalities degree (cumulative proportion), which only reached 57.09%.

Table 3. Eigenvector (Loadings)

<table>
<thead>
<tr>
<th>Variable</th>
<th>PC 1</th>
<th>PC 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESID_1_01</td>
<td>0.494893</td>
<td>-0.089596</td>
</tr>
<tr>
<td>RESID_2_01</td>
<td>0.479424</td>
<td>-0.027178</td>
</tr>
<tr>
<td>RESID_3_01</td>
<td>0.169801</td>
<td>0.983278</td>
</tr>
<tr>
<td>RESID_4_01</td>
<td>0.476519</td>
<td>-0.115696</td>
</tr>
<tr>
<td>RESID_5_01</td>
<td>0.518971</td>
<td>-0.104937</td>
</tr>
</tbody>
</table>

Source: Capital Market Statistics, processed.
If it was analysed further by using Eigen-
vector Loadings as shown in Table 3., it could be
seen that there were four capital markets in ASEAN
region which formed same principal major com-
ponents (PC 1), namely Indonesia Stock Exchange
(represented by JCI), Kuala Lumpur Stock Ex-
change (represented by KLCI), Stock Exchange
Thailand (represented by SET) and Singapore Stock
Exchange (represented by STI), while Philippines
Stock Exchange (represented by PSEi) formed a
separate principal component (PC 2). This finding
sharpens the analysis result and showed that the
four capital markets in ASEAN (Indonesia Stock
Exchange, Kuala Lumpur Stock Exchange, Stock
Exchange Thailand and Singapore Stock Exchange
were integrated while the Philippines Stock Ex-
change tended to be segmented). This condition
might occur due to factors that affected the stocks
movement in Philippines Stock Exchange during
the period of observation tended to be dominated
by internal factors than external factors, compared
to the external factors especially regionally. The
research results showed that in fact the capital
market in Indonesia was integrated with Kuala
Lumpur Stock Exchange, Stock Exchange Thailand
and Singapore Stock Exchange. These research
findings led to the policy that portfolio formation
among integrated capital markets would not pro-
vide an optimal diversification, but portfolio for-
mation by engaging Philippines Stock Exchange
was able to provide diversification benefits.

CONCLUSION AND SUGGESTION

Conclusion

This study aimed to review the integration
of ASEAN capital markets by using the Orthogo-
nal Generalized Autoregressive Conditional
Heteroscedasticity (OGARCH) method which was
able to conclude the degree of integration. In gen-
eral it can be concluded there is co-movement
in the five capital markets in ASEAN region exam-
ined in this study. However, from the five capital
markets studied there are two principal com-
ponents factors that influence the conditional vari-
ance. The four capital markets in ASEAN form a
principal component with the biggest weight (In-
donesia Stock Exchange, Kuala Lumpur Stock Ex-
change, Stock Exchange Thailand and Singapore
Stock Exchange) while Philippines Stock Exchange
forms a separate principal component. It indicates
that Philippines Stock Exchange tends to be seg-
mented from the capital markets in ASEAN re-

genion, while Indonesia Stock Exchange, Kuala
Lumpur Stock Exchange, Stock Exchange Thailand
and Singapore Stock Exchange are integrated.
Based on this finding, it can be stated that the capi-
tal markets in ASEAN region are not fully inte-

gated.

Suggestion

Portfolio manager that forms the portfolio
across countries in ASEAN region does not need
to diversify internationally (or regionally) if in-
vesting in Indonesian Stock Exchange, Kuala
Lumpur Stock Exchange, Stock Exchange Thailand
and Singapore Stock Exchange because they tend
to be integrated. Diversification can be done by
including Philippines Stock Exchange into portfo-
lio because this capital market is segmented from
other capital markets in ASEAN region, so includ-
ing Philippines Stock Exchange into portfolio can
provide diversification benefits.

Researchers who are interested in develop-
ing the same research can use longer daily data
and involve other international capital markets in
order to explore in more detail. Furthermore, fu-
ture researches need to conduct a study on capital
market integration in ASEAN region after ASEAN
Economic Community (AEC) has implemented
because the implementation of the AEC is likely
to increase the integration degree of capital mar-
ket in ASEAN region.
REFERENCES


