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Interaction of Islamic and Conventional Stock Markets and the Economic Connectivity

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Abstract

This paper aims to analyze the dynamic interactions of the Islamic and conventional stock markets and the factors contributing to the interaction. Asymmetric dynamic conditional correlation (ADCC) model, as a recent technique, was applied to identify the interaction and it then acts as a consequence factor in panel data and GARCH(p,q) models regressions. The data were taken from four countries, which consist of developed and emerging markets and have Islamic stocks indices with sample period from January 2000 to December 2016. The results suggest that the stronger dynamic interaction level for all combination pairs was only found among developed markets and in each market. Moreover, the stronger (weaker) interaction level of developed (emerging) stock markets, for both the Islamic and conventional indices, reflects the smaller (greater) inflation rate differential, industrial production growth rate differential, interest rate differential, and exchange rate volatility. In addition, the widespread market crisis affects on interaction level of all stock market pairs.

Keywords: dynamic integration; Islamic equity; ADCC; panel data.

JEL Classification: F36; G15; C10; C23.

Introduction

Risk diversification and capital cost reduction are a set of benefits gained from strengthening financial integration, which is an implementation of financial liberalization process. Other financial integration benefits include reduced volatility and improved levels of informational efficiency in the stock market. These benefits would ultimately lead to strengthen the economic growth of a country (Akhmetova *et al*. 2017; Arouri *et al.* 2012; Diamandis 2008). In addition, most research on stock market integration focuses only on conventional equities and developed stock markets. The developing of research in the field of economic finance particularly focusing on the international stock markets integration is a necessity. The integration represents a widespread field of research in a financial economics that encompasses many aspects of various relationships among stock markets. Therefore, financial integration and the subsequent aspects become important information for market participants and policy makers, and interesting field for researchers.

Previous researches have explored the integration between developed and emerging stock markets or between conventional and Islamic stock markets. Nevertheless, the combination variation of the integration among stock market classes and types has not been revealed yet. If this is not disclosed, it will limit the opportunity for investors to benefit from their portfolio diversification, thereby reduce the chances for a number of firms to earn lower cost of capital. This research is difference as compared to the previous in the scope of discussion, which combines all possible pairs of integration among conventional and Islamic indices types as well as developed and emerging market classes.

In addition, a number of empirical approaches have been applied using increasingly sophisticated techniques to analyze the degree of integration of various international stock markets. Such approaches include asset pricing modeling, static and dynamic correlation techniques, and co-integration techniques frameworks (Abbes, Trichilli 2015; Arshad 2017). However, the development of research expansion involving determinants causality on the integration with new approaches has stagnated. It still can be calculated the studies examining on the determinants of market integration (Karim, Ning 2013; Mobarek, Mollah 2016; Pretorius 2002). It lies in the proxy or measure for the level of integration when it was applied as a consequence factor. From the analytical point of view, it is getting more sophisticated in reviewing this integration topic so that it can enrich the analysis expansion and reduce the weaknesses of previous analysis techniques worked among others by Karolyi and Stulz (1996); Karim and Ning (2013). The analysis expansion is indispensable because the financial integration changes over time and the economic and business factors develop dynamically (Bekaert, Harvey 1995; Guesmi, Teulon 2014; Kearney, Lucey 2004).

We propose two new ideas relating to the expansion of research object and the development of analytical methods. The first is related to a relatively more complete pairs of stock market integration, which combine conventional and Islamic indices types as well as developed and emerging market classes. Most previous researches paid more attention to the development of conventional stocks in developed markets. Subsequent researches expand their analysis by adding conventional equities of emerging markets. Due to the development of Islamic equity in a number of stock markets, research on the integration of Islamic equity among stock markets should to increase for both among the same market classes (among developed markets or among emerging markets) and among different market classes. Many literatures state that involving equities in emerging market into equities portfolios of developed market could improve the benefits of portfolio diversification. This is because of lower correlation between emerging market and developed markets equities. Therefore, it should be explored how the correlation between Islamic and conventional equities. Theoretically there are many fundamental differences between the two markets so it is stated that both have a lower connection. More interestingly, further analyses cover the correlation between Islamic equities of emerging market and conventional equities of developed market and, conversely, the correlation between Islamic equities of developed market and conventional equities of emerging market.

The second includes a measure of market integration level that plays as a dependent variable in causality analysis. The measure is derived from the latest econometric techniques adopted from Cappiello *et al.* (2006). They use the ADCC model to assess the degree of dynamic integration among financial markets that was assumed to change over time and was asymmetric. In this research, we use the measure of market integration level as dependent variable in the regression equation consisting of a number of economic variables, which are still relatively rare in previous researches. Hence, this research is the first, which attempts to explore variations in dynamic integration between the types of Islamic and conventional equities combined with developed and emerging market classes. In addition, it is also the first which applies the ADCC model that generates new measure for the dynamic integration level among stock markets which applicable as dependent variable in panel data regression technique and GARCH (p,q).

1. Literature Review

The integration has been defined based on two perspectives, namely asset pricing and statistical perspective. The first perspective shows that if the stock market is fully integrated, then identical securities should be priced identically also in those markets. Consequently, in the case of perfect financial integration, international investors could not acquire benefits from arbitrage opportunities. The second perspective shows that strongly integrated markets tend to move together and have long-term relationships. Understanding the nature of stock market integration is crucial for investors who are interested in diversifying their portfolios among international stock markets (Naranjo, Protopapadakis 1997).

Historically, the earlier studies about stock market interdependence and portfolio diversification are employed by utilizing simple correlation technique to test short term relationship. These studies are worked by

among others Grubel (1968) and Levy and Sarnat (1970). Most of these studies find that there is weak correlation among stock markets indicating that implementing the international portfolio diversification potentially could be relevant. Subsequent studies reported by Solnik (1974) and Lessard (1976) examine the benefits from international portfolio diversification (IPD). The theory from Solnik (1974) states that the benefit could be attained through IPD when the returns among different markets are not perfectly correlated. In addition, Lessard (1976) state that investing in equities of international market is dissimilar to investing in equities of domestic market.

The findings of prior researches examining stock market integration have highly varied in the conclusions. Karim *et al.* (2010) report that there is no evidence of integration among Islamic stock markets in the pre-crisis period and during the global crisis. Majdoub and Mansour (2014) conclude that there is a weak correlation over time between the Islamic equities of the US market and emerging markets, and among the Islamic stocks of emerging markets. Furthermore, Saiti *et al.* (2014) find that both the conventional and Islamic MSCI indices of Japan, GCC ex-Saudi, Indonesia, Malaysia and Taiwan stock markets provide better diversification benefits compared to Far Eastern countries.

Abbes and Trichilli (2015) suggest that there is a low level of short-term integration among the Islamic stocks of the European-Asian, MENA-Latin American, and European-Latin American emerging markets. In addition, Majdoub *et al.* (2016) have documented that firstly, there is a co-integration in the long run between conventional and Islamic stock markets in all countries, except the UK. Secondly, there is a weak relationship between the Indonesian market and developed markets in both conventional and Islamic stocks. Third, there is a high connection among developed markets for both among conventional stocks and among Islamic stocks. Fourth, in each country, the Islamic index is found to have a strong relationship with its conventional counterpart.

Al Nasser and Hajilee (2016) convey that there is short-term integration between developed and emerging stock markets, while the long-term integration is found only between Germany and emerging markets. The recent finding are provided by Arshad (2017) who concludes that only Malaysia, Indonesia, and Turkey markets show a high degree of integration. Meanwhile, the other OIC member countries appear to have a low degree of market integration. It signifies a lack of financial openness and a greater barrier to foreign investment. Najmudin, Syarif, *et al.* (2017) who apply International CAPM find that Indonesia, Japan, Malaysia, Singapore, Thailand, and the UK stock markets are integrated. Using DCC-GARCH model, Pietrzak *et al.* (2017) report that there are interdependences among European markets of Austria, Czech Republic, Germany, Hungary, and Poland.

Pretorius (2002) concludes that only the extent of bilateral trade and industrial production growth differentials are significant in explaining the pairwise correlation coefficients. In addition, a dummy variable to reflect the market crisis and regional dummy variable are significant. Johnson and Soenen (2002) find that a higher import share, a greater differential in inflation rates, real interest rates, and GDP growth rate have negative effect on stock market co-movement. In addition, increased export share by Asian economies to Japan and greater foreign direct investment from Japan to Asian economies contribute to greater co-movement. Moreover, research of Tavares (2009) documented that bilateral trade intensity increases the correlation of returns, while real exchange rate volatility, the asymmetry of output growth and export dissimilarity decrease it.

The important finding is delivered by Karim and Ning (2013) who apply the pooled OLS and panel data regressions. They report that trade and stock markets volatility significantly influence stock market integration in ASEAN-5 region. The proxy of market integration level is correlation of returns and the independent variables comprise trade, inflation differentials, industrial production growth, interest rate differentials, and stock markets volatility. In a similar way to Johnson and Soenen (2002) who apply geweke feedback measure as a proxy of markets co-movement, Mobarek and Mollah (2016) suggests that the statistically significant variables include on a global level, import dependence, stock markets' size differential and their relative size, difference in annual GDP growth rate, as well as the time trend.

2. Data Selection and Methodology

The research data are obtained from international financial statistics (IFS) International Monetary Fund (IMF), bloomberg.com, msci.com, yahoo.finance.com. The first data set covers stock market indices on monthly basis from the United States, the United Kingdom, Malaysia, and Indonesia stock markets for both conventional and Islamic indices. The data are provided by Morgan Stanley Capital International (MSCI) for all four stock markets. These four countries are chosen due to this research analyzes dynamic relationship between emerging markets (Indonesia and Malaysia) which have well built in Islamic financial industry and developed markets (the US and the UK) which have recently shown a prominent interest in the trading of Islamic securities. Indonesia was chosen because it is the largest Muslim country in the world and has the most advanced Islamic financial market

in Southeast Asia, followed by Malaysia (Majid 2016). The UK was chosen because it is the first European market to trade Islamic financial assets. While the US is a market that transmits virtually any shock to emerging Islamic stock markets. The second data set includes consumer prices index, industrial production index, interest rate (Treasury bill rate or central bank policy rate for Indonesia), and exchange rate among the countries. All data have the same time period from January 2000 to December 2016.

The analyses in this research are separated in two parts. The first part includes an estimate of the conditional correlations among the four stock markets. For this analysis, we adopt the multivariate approach proposed by Cappiello et al. (2006). The approach contains the asymmetric generalized dynamic conditional correlation (ADCC) model to estimate short-run conditional relationships among the US, the UK, Indonesia, and Malaysia stock markets. Specifically, to estimate the development of short-run dynamic interaction of conventional and Islamic stocks indices, and their variations with developed and emerging stock market classes.

ADCC model has been applied in the prior studies of Rajwani and Kumar (2016) and Majdoub *et al.* (2016). The principle advantage of this model is to use the main features of standard GARCH models and explicitly modeling the time variations in covariance and correlation matrices. The model is a simple generalization of the DCC-GARCH model proposed by Engle (2002) involving the asset specific correlation evolution coefficients and asymmetric dynamics in correlation. First, we employ the VAR(1)-GARCH(1,1) model as follows:

$$R_t = \omega + \psi R_{t-1} + v_t \quad (1)$$

$$v_t \,|F_{t-1} \approx N(0, H_t) \quad (2)$$

Where R_t is a k-vector of stock returns, ω is a k-vector of constant terms, ψ = diag(ψ1, ψ2, …, ψk) is a coefficient matrix of order k, v_t is a k-vector of innovation, F_{t-1} is an information set, and $H_t = D_t P_t D_t$ is the conditional variance-covariance matrix with $D_t = \text{diag}(h_{it}^{1/2})$ a diagonal matrix of conditional standard deviations of order k.

Equation of correlation evolution in ADCC-GARCH model is stated as follows:

$$Q_t = (\bar{Q} - A'\bar{Q}A - B'\bar{Q}B - G'\bar{M}G) + A'e_{t-1}e'_{t-1}A + B'Q_{t-1}B + G'm_{t-1}m_{t-1}G \quad (3)$$

Where $\bar{Q} = E[e_t e'_t]$; A, B and G are diagonal coefficient matrices of order k; $m_t = I[e_t < 0]$ o e_t (I\.] is a k-indicator function that takes 1 if the argument is true and 0 otherwise, and o is the Hadamard product, and $\bar{M} = E[m_t m'_t]$. The correlation matrix is given by $P_t = (\rho_{ij,t}) = Q_t^{*-1} Q^t$ where $Q_t^{*-1} = [(q_{ii,t})^{1/2}]$, and the correlation coefficient is $\rho_{ij,t} = q_{ij,t} / (q_{ii,t} q_{jj,t})^{1/2}$.

The second part of the analyses contains statistical testing of all observations by applying panel data regression technique. This stage is performed to prove the significance of each explanatory variable as a potential determinant to the dynamic interaction of stock market. Explanatory variables considered as the potential determinants of dynamic interaction are inflation rate differential, industrial production growth differential, interest rate differential, exchange rate volatility, and global financial market crisis. To obtain the proxy of the dynamic interaction as the dependent variable, we apply ADCC model resulting the level of dynamic correlation. While to obtain exchange rate volatility, we perform volatility modeling steps by following the GARCH(1,1) model procedure.

The model specification is stated as follows:

$$ADCC_{ij,t} = \alpha + \beta_1 ADIF_{ij,t} + \beta_2 ADIP_{ij,t} + \beta_3 ADIT_{ij,t} + \beta_4 VFRX_{ij,t} + \beta_5 DCR_{c,t} + \mu_t \quad (4)$$

Where $ADCC_{ij,t}$ is asymmetric dynamics conditional correlation of returns between stock market of country i and stock market of country j at period t; $ADIF_{ij,t}$ is absolute value of inflation rate differential between country i – j or $ADIF_{ij}$ = | inf i – inf j | at period t; $ADIP_{ij,t}$ is absolute value of industrial production growth differential between country i – j or $ADIP_{ij}$ = | ind i – ind j | at period t; $ADIT_{ij,t}$ is absolute value of interest rate differential between country i – j or $ADIT_{ij}$ = | int i – int j | at period t; $VFRX_{ij,t}$ is conditional variance of exchange rate between country i – j or $VFRX_{it} = \omega_i + \alpha_i \varepsilon^2_{it-1} + \beta_i h_{it-1}$ at period t; $DCR_{c,t}$ is dummy variable of market crisis period with 1 for crisis condition period and 0 otherwise; The global financial crisis period is identified as 03 May 2008–31 May 2009; μ_t is error term at period t.

Additional analysis is performed to compare the different result possibilities between developed and emerging stock markets for each conventional and Islamic index. We apply GARCH(p,q) models for the

specifically causality analysis. Engle (1982) proposed autoregressive conditional heteroscedasticity (ARCH) methodology for assessing volatility of stock returns. He assumed that the conditional variance depends on squared residual in the previous periods or ARCH. Bollerslev (1986) extended ARCH into GARCH (generalized autoregressive conditional heteroscedasticity) methodology. GARCH is the evaluation methodology to measure volatility of asset price movements such as indexes, stocks, and bonds. GARCH model consists of conditional variance equation, which is a function of lagged σ^2_t and lagged ε^2_t.

3. Empirical Results and Discussion

We observed monthly sample period from January 2000 to December 2016, totaling 204 monthly observations for each conventional indices series. Whereas the sample period observed for each Islamic indices series was only from June 2002 to December 2016, totaling 175 monthly observations. It is because the data at the source we browse were incomplete. Both indices were collected from the US, the UK, Malaysia, and Indonesia stock markets. The indices were provided by Morgan Stanley Capital International (MSCI) and expressed in US dollar so as to get a homogenous data and to take into account the currency risk. MSCI indices are widely employed in the integration analysis on the basis of degree of comparability and avoidance of dual listing at different stock exchange (Al Nasser, Hajilee 2016).

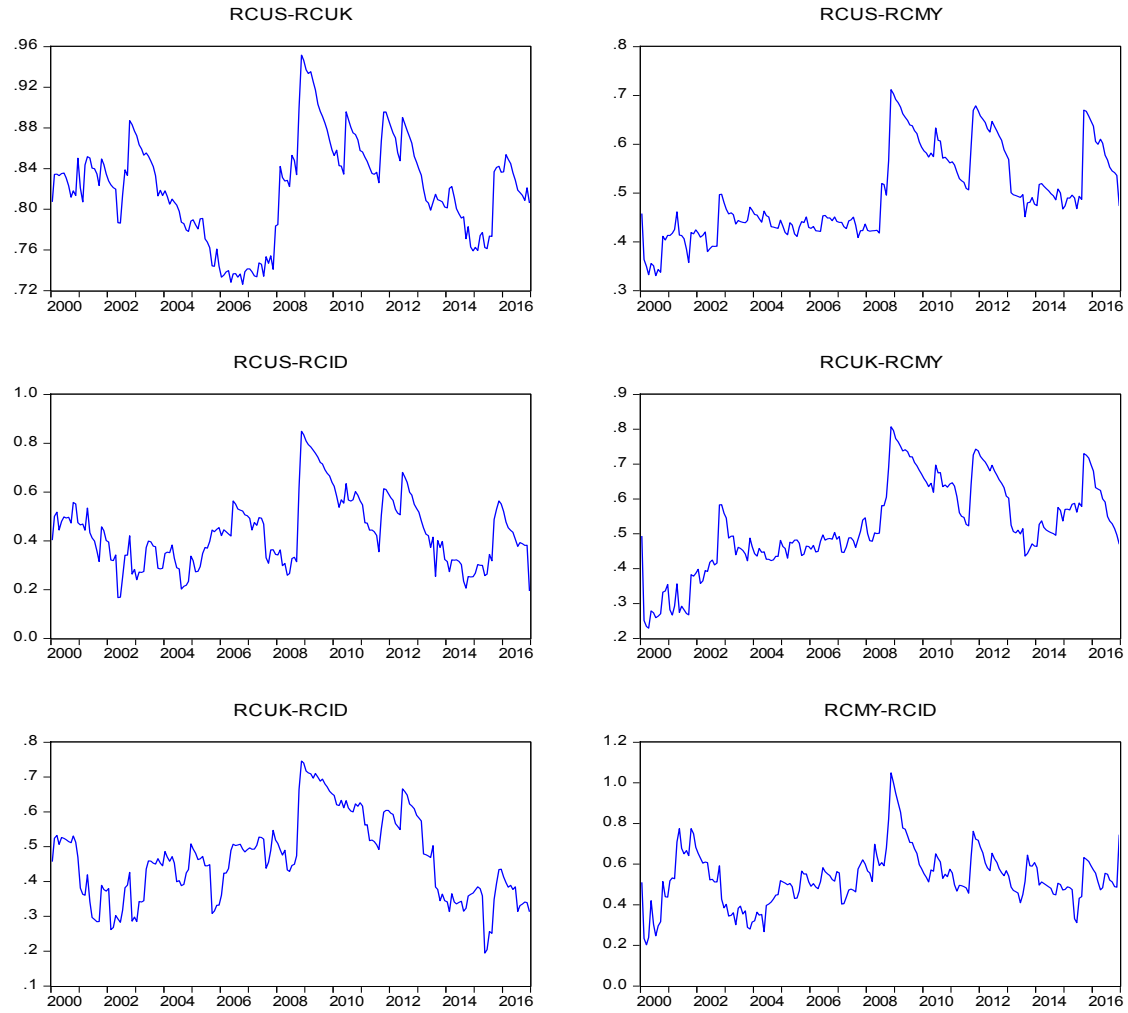

Figure 1. Multiple graphs: ADCC of conventional indices returns

Figure 1 shows six plots series of country pair's monthly ADCC among the US, the UK, Malaysia, and Indonesia *conventional* indices returns during the sample period spanning over January 2000–December 2016. Table 1 provides average ADCC to quantify the multiple graphs of Figure 1. As presented in Table 1, the RCUS-RCUK pair exhibits the highest average dynamic correlation amount to 0.82. It was followed by the RCMY-RCID pair amount to 0.53. It indicates that there is stronger degree of integration only between conventional stock

markets for the same class of developed markets. In other word, the pair of developed stock markets has a higher degree of integration than the pair of emerging stock markets (Najmudin, Shaferi *et al.* 2017). This evidence is partly dissimilar to conclusion from Lean and Smyth (2014) who review that relationship among the major markets and between major market and emerging market have increased over time. Another conclusion supported by this evidence is from Naranjo and Porter (2007). They report that stocks returns in emerging markets appear very low correlation with stocks returns in developed markets.

Similar with conventional indices, the strongest degree of integration for Islamic indices only was found among developed markets. Both developed markets, however, have weakly interactions with Islamic indices of emerging markets. These findings support the conclusions stated by Majdoub and Mansour (2014). Due to this, including Islamic stocks of emerging markets in an international portfolio could create greater diversification benefits than adding only Islamic stocks of the developed markets. Table 1 also presents ADCC of indices returns pairs *cross conventional and Islamic* indices of the four markets that have twelve pairs of graphs. It shows that both of RCUS-RIUK pair amount to 0.75 and RIUS-RCUK pair amount to 0.80 have higher dynamic correlations over sample period. With the exception of both pairs, the remaining ten pairs appear lower correlations which are below 0.58. This evidence is similar with the previous analysis indicating that the stronger degree of integration was only found across conventional and Islamic indices of the same class of developed markets.

Table 1. Average ADCC among conventional and Islamic indices returns

	Conventional stock indices				Islamic stock indices		
	RCUS	RCUK	RCMY	RCID	RIUS	RIUK	RIMY
RCUK	0.82						
RCMY	0.50	0.52					
RCID	0.43	0.47	0.53				
RIUS	0.97	0.84	0.57	0.47			
RIUK	0.75	0.96	0.55	0.53	0.80		
RIMY	0.57	0.58	0.95	0.47	0.57	0.55	
RIID	0.41	0.48	0.49	0.94	0.44	0.48	0.45

Note: RCUS, RCUK, RCMY, and RCID stand for conventional indices returns of the US, the UK Malaysia, and Indonesia stock markets, respectively. RIUS, RIUK, RIMY, and RIID stand for Islamic indices returns of the US, the UK, Malaysia, and Indonesia stock markets, respectively.

According to all analyses above, we could state that the interaction levels among develop markets for both conventional and Islamic indices are very strong. In others word, conventional stocks in a developed market have stronger correlation with conventional and Islamic stocks in another developed market. Similarly, there are stronger interaction levels between conventional and Islamic indices within a stock market for both developed and emerging markets. In contrast, conventional stocks in a developed market have weaker correlation with conventional and Islamic stocks in emerging market. In addition, all average ADCC among observed markets indicate that the Indonesia stock market index has the weakest degree of integration for both conventional and Islamic indices. The results are similar with findings of Majdoub *et al.* (2016) who examined market integration between conventional and Islamic stock prices. They concluded that there is high correlation between the developed markets for both conventional and Islamic indexes, the Islamic index is found to be strongly linked with its conventional counterpart for each stock market, and there is evidence of weak linkages between the Indonesian market and the developed markets for both conventional and Islamic stock prices.

These evidences are important in the policy implications for international investors and market participants. They would have the motivation to restructure their portfolio perspectives by utilizing risk diversification in international financial markets. It could be achieved by looking at the lower correlation and the absence of shock transmission. This research explains these issues by contributing to empirical evidence on potential diversification of Islamic equities. Particularly, portfolio diversification could be utilized when they invest on different class of stock market by including conventional and/or Islamic stocks of emerging markets.

Table 2 presents the result of panel data regression of five predictors and asymmetric dynamic conditional correlation (ADCC) of returns as dependent variable. The five predictors are inflation rate (ADIF), industrial production growth (ADIP), interest rate (ADIT), exchange rate volatility (VFRX), and dummy variable of market crisis (DCR). All these variables are analyzed by using three alternative models of panel data regression method, namely pooled ordinary least squares (PLS) model, fixed effect model (FEM), and random effects model (REM). From this estimation, it could be decided which the appropriate model is, and hence it used as a basis to interpret the causality of variables.

Table 2. Estimates of panel data regression on ADCC of returns

Indices	Conventional			Islamic		
Model Variables	PLS	FEM	REM	PLS	FEM	REM
C	***0.6413	***0.5889	***0.5927	***0.6879	***0.5979	***0.5989
ADIF	-0.0155	***-0.0185	***-0.0184	**-0.0242	**-0.0184	**-0.0184
ADIP	-0.0011	***-0.0024	***-0.0024	***-0.0027	***-0.0036	***-0.0036
ADIT	***-0.0202	***-0.0062	***-0.0071	***-0.0335	***-0.0089	***-0.0092
VFRX	***-0.0427	***-0.0345	***-0.0354	-0.0078	**-0.0121	**-0.0122
DCR	***0.1573	***0.1576	***0.1576	***0.1685	***0.1585	***0.1586
Adj. R^2	0.2675	0.6311	0.1766	0.3738	0.6177	0.1718
F *p-value*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	1224	1224	1224	1050	1050	1050

Note: The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

The estimation result of PLS model for conventional market indices as presented in Table 2 suggests that the influences of interest rate, exchange rate volatility, and market crisis variables are significant on dynamic correlation of returns. In particular, inflation rate and industrial production growth variables are insignificant. Using the Chow test to select the appropriate model between PLS and FEM, it suggests that FEM estimation is more appropriate and the specification of fixed effect is better. This decision is supported by the values of F-test and chi-square, which are significant with p-value of 0.000 and 0.000, respectively.

The coefficients of each variable on FEM and REM appear relatively similar. However, result from the Hausman test, to select one type of panel data estimator techniques between FEM and REM, suggests that panel estimation of REM is inappropriate. In other word, the specification of fixed effect is better which has probability value of Hausman test of 0.000. Subsequently, result of panel estimator based on FEM shows that all of five independent variables in the equation are significant in affecting dynamic correlation of returns. This result can be written in equation as follows:

$$ADCC_{ij,t} = ***0.5889 - ***0.0185\ ADIF_{ij,t} - ***0.0024\ ADIP_{ij,t} - ***0.0062\ ADIT_{ij,t} - ***0.0345\ VFRX_{ij,t} + ***0.1576\ DCR_{c,t}$$

Applying the same process as employed on the conventional indices sample, the results from Chow test dan Hausman test on regression of Islamic indices sample conclude that specification of fixed effect is better model to be utilized as source of interpretation. Panel estimator based on FEM for Islamic indices sample shows that all of five independent variables in the equation are significant in affecting dynamic correlation of returns. This result is similar with estimation for sample of conventional indices counterpart. The specification of estimate for Islamic indices is expressed as follows:

$ADCC_{ij,t}$ = ***0.5979 – **0.0184 $ADIF_{ij,t}$ – ***0.0036 $ADIP_{ij,t}$ – ***0.0089 $ADIT_{ij,t}$ – **0.0121 $VFRX_{ij,t}$ + ***0.1585 $DCR_{c,t}$

Statistical tests for both conventional and Islamic market indices show that inflation rate empirically has a negative effect on dynamic correlation of returns. It is indicated by the p-value, which is less than 1% level. Similarly, industrial production growth, interest rate, and exchange rate volatility have significantly negative effect on dynamic correlation of returns. In addition, the global financial crisis circumstance positively influences dynamic correlation of returns for both conventional and Islamic market indices at the level of significance below 1%. Furthermore, all independent variables in the estimation have highly contribution in explaining the variation of dynamic correlation of returns. It appears from the estimations generating highly adjusted R squared amount to 63.11% and 61.77% for conventional and Islamic market indices, respectively.

The coefficients of inflation rate in both estimate equations above for each conventional and Islamic index samples have negative values. These signify that when differential in inflation rate (ADIF) among two economies is greater, interaction rate of their stock markets is weaker. This evidence corroborates Johnson and Soenen (2002) who report that differential in inflation rates has a negative effect on stock market co-movement. In this context, decreased inflation rate in emerging economies against developing economies counterpart contributes to greater co-movement. Similarly, Guesmi and Teulon (2014) state that inflation rate is a key market integration.

The negative direction appears on the coefficients of industrial production growth for each conventional and Islamic index samples. It indicates that the greater the differential in industrial production growth (ADIP) among two economies, the weaker the interaction rate of their stock markets. Similar finding has been reported by Pretorius (2002) who suggests that industrial production growth differential is significant in explaining the pairwise correlation coefficient. In addition, a dummy variable to reflect the market crisis and regional dummy variable were significant.

Both estimate equations above also exhibit the negative value for interest rate (ADIT) coefficients. These results are in accordance with the theory that the smaller the difference in interest rates among two economies, the stronger the degree of their stock markets interaction. Johnson and Soenen (2002) have concluded that real interest rates has a negative effect on stock market co-movement. Such conclusion has been reported by Guesmi and Teulon (2014) who suggest that variations in interest rate spread is one variables of intra-regional integration. Earlier study by Bracker *et al.* (1999) find also that degree of international integration is influenced by real interest rate differential.

Other finding was also contained in both similar estimations substantially that there is a negative causality from exchange rate volatility (VFRX) against the degree of stock markets interaction in the context of among conventional stock markets and among Islamic stock markets. It signifies that the higher the exchange rate volatility among two economies, the weaker the interaction rate of their stock markets. Some studies showed similar findings, such as Tavares (2009) and Guesmi and Teulon (2014). They, respectively, show that real exchange rate volatility decreases the correlation of returns and exchange rate volatility is one key of integration variables. These findings clarify the conclusion of Bracker *et al.* (1999).

The last independent variable covered in both estimate equations above is dummy variable of market crisis (DCR). Global financial crisis identified as 03 May 2008–31 May 2009 is taken as a proxy of sample periods for this variable. It is found that when a market experiences in crisis, the interaction rate could be higher. It can be known from the estimation that market crisis has a positive effect on the interaction rate among stock markets for both conventional and Islamic indices. This evidence supports most previous studies, such as Pretorius (2002), Majid and Kassim (2009). For examples, Pretorius (2002) state that a dummy variable of market crisis is significant in explaining the pairwise correlation coefficients; and Majid and Kassim (2009) report that due to the US subprime crisis, the stock markets appear more integrated.

Overall analyses using panel data regression above lead us to state that the connectivity of macroeconomics factors among economies and financial market crisis play important roles to drive interaction rate among stock markets. This evidence prevails for both conventional and Islamic markets. The similar results of estimation between conventional and Islamic markets are due to interaction rate among conventional indices has similar characteristic with interaction rate among Islamic indices. This reason can be explained by comparing the average ADCC for both indices. For examples, for conventional indices, the average dynamic correlations of RCUS-RCUK and RCMY-RCID pairs are 0.82 and 0.53, respectively. While for Islamic indices, the average dynamic correlations of the RIUS-RIUK and RIMY-RIID pairs are 0.80 and 0.45, respectively.

Subsequent section contains the analyses using various GARCH(p,q) models to generate interpretation about variables causality that are more specifically rather than analyses in previous panel data technique. The

GARCH(p,q) model analyses are utilized to predict and to know further important roles of variables on each developed and emerging market for each conventional and Islamic market index. It possible that the results could be different because, as known from previous correlation analyses, the interaction rate patterns between developed market pairs and emerging market pairs are dissimilar. For example, ADCC of returns among developed stock markets, mainly RCUS-RCUK and RIUS-RIUK pairs, are very strong and ADCC of returns among emerging stock markets, mainly RCMY-RCID and RIMY-RIID pairs, are weak for both conventional and Islamic market indices.

Table 3 presents the results of four estimate models chosen for each pair of the same stock market type, mainly among conventional indices for developed stock markets (RCUS-RCUK), among conventional indices for emerging stock markets (RCMY-RCID), among Islamic indices for developed stock markets (RIUS-RIUK), and among Islamic indices for emerging stock markets (RIMY-RIID). These four models are the best fit regression models which are selected through iteration process from various models, such as OLS, ARCH(p,q), GARCH(p,q), ARCH-M(p,q), and GARCH-M(p,q). The models chosen have the smallest Akaike Info Criterion and Schwarz Criterion and considered have significant values of all independent variables and have higher adjusted R^2 values.

Table 3. Estimates of GARCH(p,q) models on ADCC of returns

Indices	Conventional		Islamic	
Markets Variables	Developed	Emerging	Developed	Emerging
Dependent Variable (Y_t)				
C	***0.8561	***0.6022	***0.8359	***0.7524
ADIF	**–0.0252	*–0.0162	**–0.0258	*–0.0308
ADIP	***–0.0021	***–0.0027	**–0.0016	***–0.0079
ADIT	*–0.0048	*–0.0027	***–0.0106	***–0.0363
VFRX	***–35870494	***–1.5075	***–30382975	***–3.4249
DCR	***0.0969	***0.2988	***0.0691	***0.2849
Conditional Variance (σ^2_t)				
C	***0.0007	***0.0016	**0.0002	***0.0171
ARCH(1)				***0.2271
GARCH(1)	***0.5749	**0.4945	***0.5601	
GARCH(2)		*–0.2094	***–0.3929	
ADIF			***0.0023	***–0.0064
DCR	***–0.0007	0.0059		
Adjusted R^2	0.3387	0.3479	0.4134	0.4760
Prob. J-Berra	0.3793	0.1125	0.6690	0.0748
N	204	204	175	175

This table contains results of estimate regressions using GARCH(p,q) model for each pair of stock market. The first equation, called as mean equation, is $ADCC_{ij,t} = \alpha + \beta_1 ADIF_{ij,t} + \beta_2 ADIP_{ij,t} + \beta_3 ADIT_{ij,t} + \beta_4 VFRX_{ij,t} + \beta_5 DCR_{c,t} + \mu_t$. The second equation, called as variance equation, is $\sigma^2_t = \alpha_0 + \alpha_p \varepsilon^2_{t-p} + \lambda_q \sigma^2_{t-q} + \delta X_{it}$. The asterisks (***, **, *) indicate that *p-value* is significant respectively at the 1%, 5%, 10% level.

Although the results of estimated explanatory variables appear similar, GARCH(p,q) models applied on each pair of stock market are different, especially in the probability value and the variance equation parts. For example, the suitable model for conventional-developed markets is GARCH(0,1) with dummy variable of market crisis in variance equation, while the suitable model for conventional-emerging markets is GARCH(0,2) with dummy variable of market crisis in variance equation. According to four models above, all explanatory variables tested on mean equation (ADIF, ADIP, ADIT, VFRX, DCR) have significant effect on the dynamic conditional correlation of returns for all four pairs of stock markets with various levels of significance. The adjusted R^2 values for each model serially are 0.3387; 0.3479; 0.4134; 0.4760. These indicate that the explanatory variables have contributions in explaining the variation of dynamic correlation of returns amount of 33.87%, 34.79%, 41.34%, and 47.60%, respectively.

Analysis results on causality of all explanatory variables using GARCH(p,q) models are not distantly different with the results using panel data technique. Statistical tests for four pairs of stock markets suggest that inflation rate, industrial production growth, and interest rate connectivity respectively has a negative effect on dynamic interaction of stock markets. Furthermore, the exchange rate volatility has a negative effect and the market crisis circumstance has a positive effect. In other word, the higher interaction rate of stock markets reflects the lower inflation rate differential, industrial production growth rate differential, interest rate differential, and exchange rate volatility, and the widespread market crisis. These results contradict Karim and Ning (2013) who report that inflation rate, industrial production growth, and interest rate are insignificant in influencing the degree of stock market integration. From five factors they examine, stock market volatility and bilateral trade are only significant.

The findings indicate that macroeconomic factors and crisis period affect on interaction level for all stock market pairs without distinction between developed and emerging markets. The estimate results of each explanatory variable appear similar for both developed and emerging markets pairs. But actually, the characteristic of interaction level for developed markets is different as compared to emerging markets. The interaction level of developed markets pairs, as analyzed in ADCC section, is stronger than the interaction level of emerging markets pairs for both conventional and Islamic indices. The similar estimate result is likely because the values on each explanatory variable for both markets have dissimilar variations. For example, although the interaction level among developed markets is stronger, the inflation rate differential among these markets is lower. In contrast, although the interaction level among emerging markets is weaker, the inflation rate differential among these markets is higher.

Conclusions

According to the asymmetric dynamic conditional correlation analysis, we report that there are strongly dynamic interactions among conventional stock markets and among Islamic stock markets for the same class of developed markets. These results are affirmed by stronger dynamic interactions across conventional and Islamic of developed markets. In addition, for each stock market, the conventional index has strongly interaction with its Islamic index counterpart. In contrast, the pairs of indices returns among emerging markets and among different class of markets have weakly interactions for both conventional and Islamic indices. In other word, the interaction level of developed markets pairs is stronger than the interaction level of emerging markets pairs for both conventional and Islamic indices.

The results of causality analyses, by employing panel data regression on overall sample observations, indicate that the connectivity of macroeconomic factors among economies and financial market crisis have important roles in changing the dynamic interaction for both conventional and Islamic stock markets. The causality analyses for both stock markets exhibit similar results. It is likely that dynamic interactions of conventional stock markets pairs have strong resemblances to dynamic interactions of Islamic stock markets pairs.

To obtain more specifically clarity, the subsequent analysis divides each conventional and Islamic stock market on their development basis, mainly developed and emerging markets, and hence they become four pairs of stock markets. The analyses applying various GARCH(p,q) models substantially generate identical results to the panel data regression analyses. Statistical tests for these pairs of stock markets suggest that inflation rate, industrial production growth, and interest rate connectivity respectively has a negative effect on dynamic interaction of stock markets. Furthermore, the exchange rate volatility has a negative effect and the market crisis circumstance has a positive effect.

To minimize risk, therefore, these facts provide opportunity for market participants to diversify their securities by adding Islamic stocks of emerging markets in their portfolio investment. In addition, for investors

who implement the international portfolio diversification should to understand the patterns of inflation rate, industrial production growth, interest rate, exchange rate volatility, and stock market circumstance within all economies where they would invest. It was because all those factors have important roles as determinants of integration level among stock markets. In particular, the level of market integration is a benchmark to determine portfolio combinations, which consist of weaker correlated individual stocks or market indices returns.

Due to the limitation of this research, further researchers should to examine specifically the causality of explanatory variables on dynamic correlation of returns among different class of stock markets for each conventional and Islamic indices. Moreover, to expand this field, they could investigate the volatility spillover of Islamic and conventional equities for emerging and developed stock markets and their determinants. Furthermore, investigating the dynamic international portfolio diversification of Islamic and conventional equities for emerging and developed stock markets and its effect on cost of capital could be interesting further research.

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