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The Impact of Subprime Crisis on Asia-Pacific Islamic Stock Markets

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The objective of this study is to examine the impact of the U.S. subprime crisis on the long-term and short-term dynamic relationships between selected Asia-Pacific Islamic stock markets and conventional stock markets in the region. The comovements among these stock markets are examined through cointegration tests, and vector error correction model–based Granger causality tests, for the period from February 2006 to December 2010. The study reveals that, after the debut of the U.S. subprime crisis, Asia-Pacific Islamic stock markets increasingly integrated among themselves and with their conventional counterparts. In addition, the conventional markets of the United States and Japan significantly influence the short-run fluctuations of Asia-Pacific Islamic and conventional markets.

KEYWORDS U.S. subprime crisis, Asia-Pacific Islamic stock markets, cointegration, VECM, Granger causality

INTRODUCTION

During the last three decades, the world economies have been increasingly globalized. As the world becomes integrated, economies tend to intensively liberalize their markets to compete for the foreign investments. Because the economic liberalization involves in the removal of capital barriers to investment, the liberalization process effectively enables one country's capital market to be more accessible to the foreign investors. Thus, economies around the world become integrated with one another.

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As the world economies become increasingly integrated, enormous researches have been devoted to examine whether the financial crisis in one country will be spilled over to other countries. For example, King and Wadhwani (1990) studied about the volatility transmission of the U.S. 1987 stock market crash on the global market, Masih and Masih (1999) and Yang, Kolari, and Min (2003) examined the intraregional contagious effect of Asian financial crisis, and so on. The emergence of the U.S. subprime crisis of 2007 has again spurred the research interest on the effect of the financial crisis to the new height. Being labeled as the worst financial crisis ever since the Great Depression, the U.S. subprime crisis has not only affected the U.S. economy, it has also spread to other countries as well, developed and developing nations alike. Nevertheless, as stated by Ibrahim (2005), studies pertaining to the impact of financial crisis on the financial markets integration may help investors to grasp the potential benefits of international portfolio diversification.

Although there are voluminous studies on stock market integration, most of the earlier researches have been focusing on the stock market integration among developed countries (see, e.g., Blackman, Holden, & Thomas, 1994; Eun & Resnick, 1994; Grubel, 1968; Hanna, McCormack, & Perdue, 1999; Lessard, 2008; Levy & Sarnat, 1970; Odier & Solnik, 1993; Solnik, 1974). Recently, the research focus has shifted to the stock markets of the developing countries (see, e.g., B. W.-S. Huang & Cheung, 1995; Majid, Meera, & Omar, 2008; Ratanapakorn & Sharma, 2002). Despite the rapid growth of Islamic banking and finance industry, especially in the Islamic equity markets, little attention has been given to the impact of financial crises on the integration of conventional and Islamic stock markets. In this regard, this study hopes to shed some light on the stock markets integration between conventional and Islamic stock markets, with a special focus on Asia-Pacific Islamic stock markets.

The aim of this study is twofold: first, it is to examine the impact of the U.S. subprime crisis on the integration of selected Asia-Pacific Islamic and conventional stock markets; second, it is to identify which stock market, either conventional or Islamic, that primarily drives the volatility of Asia-Pacific Islamic stock markets.

The rest of this study is organized as follows: the subsequent section discusses the background of the Islamic stock market index. The third section reviews past empirical literatures pertaining to the stock market integration. The fourth section describes the methodology and data used in this study. The fifth section illustrates the results of various empirical tests. Finally, major findings of this study are summarized, and some possible areas that warrant further research are provided in the Conclusion.

ISLAMIC STOCK MARKET INDICES

An Islamic stock market index can be simply defined as the index whose composition is made up with stocks that are Shariah compliant (International Shariah Research Academy for Islamic Finance [ISRA], 2012, p. 488). A stock is said to be Shariah compliant when it passes the Shariah stock screening process. This process normally comprises two phrases, namely, the qualitative and quantitative screening (Derigs & Marzban, 2008; see also Girard & Hassan, 2008; Hussin Muhammad, Abu, & Awang, 2012; Kassim, 2010; Rahman, Yahya, & Nasir, 2010; Sadeghi, 2008). For the qualitative screening, if the primary business activity of a company violates Shariah injunctions the stocks of the company will be marked as Shariah noncompliant securities. In general, business activities that are free from the exploitive elements or unfair gains, namely, usury (*riba*), excessive ambiguity (*gharar*), gambling (*maysir*), and prohibited goods (*haram*) are deemed to be Shariah compliant (Majid & Kassim, 2010). On the other hand, business activities that involve in interest-based finance (*riba*); conventional insurance (*gharar*); gaming (*maysir*); producing and selling pork, alcohol, and pornography (*haram*); manufacturing or selling tobacco, stockbroking, or selling non-Shariah-approved securities, entertainment, and weapons are Shariah noncompliant (ISRA, 2012, p. 482).

Once the stocks have passed the qualitative screening, they are then subjected to the second phrase of Shariah screening, namely, the quantitative screening. This phrase of screening is aimed to evaluate the extent of Shariah noncompliant activities in the total revenues and profits of a company (Sadeghi, 2008). Several financial benchmarks have been established by the Muslim scholars to set the level of tolerance for the extent of the Shariah noncompliant activities in the company. So long as the contributions of the Shariah noncompliant activities do not exceed the benchmark level, the company's securities can be marked as Shariah compliant. In general, three financial ratios have been mostly adopted to construct the quantitative criteria, namely, debt-to-equity ratio, interest income-to-total income ratio, and account receivables-to-total assets ratio (Rahman et al., 2010). However, the benchmark levels may vary from one index to another. For instance, Dow Jones Islamic Indices set 33% as the benchmark for activities that are interest based (*riba*). Thus, if a company's interest-based (*riba*) financing or income is less than 33% of its 24-month average market capitalization, the stocks of the company are considered as Shariah compliant. On the other hand, Financial Times Stock Exchange (FTSE) Islamic Indices stipulated the benchmark level for the proportion of interest-based income *i* at 5% (ISRA, 2012, p. 483). Upon the company passing both phrases of Shariah screening, its stocks will be stamped as Shariah compliant securities.

Islamic stock market indices are still a relatively new phenomenon in comparison with its conventional counterpart. The first Islamic stock market

index, namely the Dow Jones Islamic Market (DJIM) World Index, was established by Dow Jones & Company in 1999. Since then, the DJIM family has expanded to include regional, sectorial, and market-capitalization indices. Until recently, the DJIM family has managed to develop 69 country-based indices (S&P Dow Jones Indices, 2012). The expansion pace was then followed by (FTSE, 2015), which launched its Shariah Global Equity Indices Series in 2006. In the same year, Standard & Poor's (S&P; 2011) managed to launch its first three members of Shariah indices family, namely the S&P 500 Shariah, S&P Europe 350 Shariah, and S&P Japan 500 Shariah. The year after, Morgan Stanley Capital International Inc. (MSCI; 2011) launched its MSCI Global Islamic Indices Series. Nowadays, almost all the major index companies around the global have launched their own Islamic indices.

LITERATURE REVIEW

Acknowledging the rapid growth of Asian economies and the Islamic financial industries during the last three decades, researchers have started shifting their focuses to the integration of Asian stock markets, Islamic and conventional ones. However, in comparison with the studies on the conventional stock markets, efforts devoted to the Islamic stock markets are still trivial.

In Janakiramanan and Lamba (1998), the authors applied vector autoregression model (VAR) to examine the integration of stock markets in Pacific-Basin region. They concluded that the U.S. stock market had significant influence on the Australasian stock markets during 1988 to 1996. They also attributed the level of integration between countries to four major factors, namely, geographical location, economic tie, numbers of cross-border listings, and precedence of market close.

In a similar study, A. M. M. Masih and Masih (1999) investigated the long-run and short-run dynamic linkages among emerging Asian stock markets and other leading stock markets internationally. Echoing with Janakiramanan and Lamba (1998), this article stated that the United States and the United Kingdom had significant influence, in long-run and short-run, over other stock markets globally. In addition, the authors also found that there were significant long-run and short-run relationships between Organisation for Economic Co-operation & Development (OECD) stock markets and Asian stock markets. On the other hand, the Hong Kong stock market had the leading role among Southeast Asia stock markets at the regional level. The article added that the volatility of Asian stock markets could be mostly attributed to the fluctuations in the regional markets, rather than the advanced markets.

Another early study on the long-run and short-run dynamic relationships among Asia emerging stock markets and the advanced stock markets (i.e., the United States and Japan) can be traced back to Yang et al. (2003). This study

gave special focus to the effects of Asia financial crisis on the stock market integration. By evaluating the stock market in the separated time intervals (i.e., precrisis, crisis, and postcrisis), the article concluded that the long-run cointegration and short-run causal linkages among these markets had been intensified during the crisis period. In addition, the level of integration among these stock markets was higher for the after-crisis period than the precrisis period. In a related study, Karim and Majid (2009) adopted a two-step estimation method, namely, the autoregressive distributed lag (ARDL) and generalized methods of moments (GMM), to examine the short-term and long-term dynamic causal relationships between Malaysia and its major trading partners. For the period from 1992 to 2008, the study revealed that the degree of stock markets comovements between these markets is significant and positively correlated with their trade ties. Besides, the study also found that the Japanese stock market plays a more important role than the U.S. counterpart over these countries.

Recently, Majid, Meera, Omar, and Aziz (2009) zoomed in to investigate the integration among selected Association of Southeast Asian Nations (ASEAN) markets and their interdependencies from the United States and Japan. By applying the two-step estimate, Johansen-Juselius (JJ) cointegration and GMM on the daily stock indices, ranging from January 1, 1988 to December 31, 2006, and the study revealed that in general, ASEAN stock markets were increasingly interrelated among themselves as well as with the U.S. and Japan markets after the 1997 Asian financial crisis. Thus, the benefits of diversifying the investments into ASEAN stock markets tend to disappear after the debut of the crisis. In a recent article, Sidek and Abdul-Rahman (2011) estimated the impact of the U.S. subprime crisis on the stock market returns of the five ASEAN countries. By applying the panel data techniques, the study found that the U.S. and ASEAN-5 stock markets are cointegrated. In accordance with Majid et al., Sidek and Abdul-Rahman also discouraged investors to diversify their portfolio into ASEAN-5 market during the financial crisis.

With regards to the integration of Islamic stock markets in the Asia region, Karim, Kassim, and Arip (2010), Rahim, Ahmad, and Ahmad (2009), Siskawati (2011), and Yusof and Majid (2007) could be considered as the pioneers in this subject. In the early study, Yusof and Majid employed the generalized autoregressive conditional heteroscedasticity (GARCH) model together with VAR model to estimate the responses of Malaysia conventional and Islamic stock markets to the conditional volatility of monetary policy variables. Confirming with the Islamic principles, the study found that, from January 1992 to December 2000, interest rate was significant for Malaysia conventional stock market but insignificant for its Islamic counterpart.

Meanwhile, Rahim et al. (2009) employed a bivariate VAR GJR-GARCH model to investigate the transmission of information and the correlation between the Kuala Lumpur Syariah and Jakarta Islamic Indices. For the

period from July 4, 2000 to December 29, 2006, the study indicated that there is only a low level of correlation between the two Islamic stock markets. The findings indicated that the return and volatility transmissions were unidirectional from the Kuala Lumpur Islamic stock market to the Jakarta Islamic stock market.

Recently, Karim et al. (2010) examined the effects of the U.S. subprime crisis on the integration of selected Islamic stock markets (i.e. Malaysia, Indonesia, the United States, the United Kingdom, and Japan). By employing JJ cointegration technique, the study failed to prove the existence of cointegrated relationships among these Islamic stock markets for precrisis period (February 15, 2006–July 25, 2007) and during-crisis period (July 26, 2007–December 31, 2008). However, contradictory results were found by Siskawati (2011). In the later study, the cointegrated relationship was found among Jakarta Islamic Index, Kuala Lumpur Syariah Index, and Dow Jones Islamic Market Index.

METHOD

Data

The data used for this study were retrieved from Bloomberg Database and Google Finance, covering the period from February 1, 2006 to December 31, 2010. This study has chosen February 1, 2006 as the starting point of the analysis because of the availability of the Islamic stock market index of China from December 31, 2005,[1] and in the case of Japan and Malaysia where there were many public holidays in January 2006. To measure conventional stock markets of the United States, Japan, China, Malaysia and Indonesia, this study has used the end-of-day values of the Dow Jones U.S. Total Market Index (US), Nikkei 225 (JP), Dow Jones China 88 Index (CN), Kuala Lumpur Composite Index (MY), and Jakarta Composite Index (IN). In addition, we have also chosen the Dow Jones U.S. Islamic Market Index (IUS), Dow Jones Islamic Market Index Japan (IJP), Dow Jones Islamic Market Greater China Index (ICN), Kuala Lumpur Syariah Index (IMY), and Jakarta Islamic Index (IIN) to represent the Islamic stock markets of the five countries. For each stock market index, the logarithm forms of daily prices and returns are generated.

To comprehensively explore the impacts of the U.S. subprime crisis on the integration of the selected stock markets, the time interval has been divided into two subperiods, namely, the precrisis and during-crisis periods. Following Dungey, Fry, González-Hermosillo, Martin, and Tang (2010), Karim et al. (2010), and Majid and Kassim (2009), this study sets July 26, 2007 as the starting point of the U.S. subprime crisis. In the case of missing data, this study adopts a similar technique suggested by Hirayama and Tsutsui (1998) and Karim et al. (2010), whereby the slots of missing data were filled with the previous day's market index values.

Empirical Approach

To avoid spurious results, unit root tests have been first employed to ensure the stationarity of the time series data. Besides, unit root tests enable one to identify whether the external financial shocks have permanent or temporary impacts on the stock market. If time series data have a unit root (nonstationary), the impacts of a financial shock will never die out, and the market return will permanently deviate from its long-run equilibrium. However, if the unit root does not exist, the effects of an external shock will only be temporary. In other words, though in the short run there may be drift-away from the long-term equilibrium, the deviation will be reverted back to its long-run equilibrium level. To investigate the existence of the unit root, the Augmented Dickey Fuller (ADF) test is the common approach. However, since Gujarati (2003, p. 819) and Sidek and Abdul-Rahman (2011) have criticized the low testing power of the ADF test, the Phillips-Perron (PP) test has been included to complement the ADF test. As for the lag length of the unit root test, this study has employed the optimal lag length based on the Akaike Information Criterion (AIC).

Furthermore, this study has adopted the VAR based on JJ cointegration approach to investigate the long-run relationships between selected stock markets, for precrisis and during-crisis periods. Then, vector error correction model (VECM) based Granger causality tests are applied to explore the long-term and short-term dynamic relationships among these stock markets.

Since implementing the JJ cointegration technique on VAR model is believed to be a realistic representation of market linkages, this study has adopted this combination to investigate the long-run relationships among selected stock markets (Dekker, Sen, & Young, 2001; Sims, 1980). In addition, the JJ procedure is also believed to have relative superior performance over other methods for testing the orders of the cointegration rank. As for the advantage of the VAR model, one needs not to distinguish between exogenous and endogenous variables in the model. To put it simple, employing the VAR model will be less complicated (Gujarati, 2003, p. 853).

Given that the maximum likelihood of the JJ cointegration test is based on the VAR model, the VAR model can be specified as follows:

$$X_t = \alpha + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_k X_{t-k} + \upsilon_t \quad (1)$$

where,

X_t denotes the $n \times 1$vector of stock market indices
α is an $n \times 1$vector of constant terms
υ_t is a vector of white noise error terms
k is the lag length.

As this study investigates the Islamic stock market integration of five countries (United States, Japan, China, Malaysia, and Indonesia), n is equal to five.[2]

Because the levels form of the VAR model in Equation 1 does not contain the information of cointegration explicitly, it may be more advantageous to subtract X_{t-1} from both sides of the equation and rearrange the equation into Equation 2 as follows:

$$\Delta X_t = \delta + \sum_{k=1}^{k-1} \Gamma_k \Delta X_{t-k} + \Pi X_{t-k} + \varepsilon_t \tag{2}$$

where,

Δ = the first difference
X_t = a $n\times1$ vector of stock market indices
δ = a $n\times1$ vector of the constant terms
$\Gamma$and Π = the $n\times n$ matrix of coefficients
ε_t = a n×1 vector of white noise error terms
k = the lag length.

The value of k is determined by the optimal lag length based on the AIC. In addition, Γ represents the coefficients of the short-term dynamics (Karim, Jais, & Karim, 2011), which defines the short-run adjustments to changes in the variable (Bley & Chen, 2006). The number of cointegration vectors can be determined by the ranks of the matrix Π. Furthermore, Π can be decomposed into two matrices of α and β', such that $\Pi=\alpha\beta'$. Specifically, α is a $n\times1$ column vector contains the speed of short-run adjustment coefficients for the disequilibrium, whereas β' is a $1\times n$ cointegration row vector contains the coefficients such that X_t converges into its long-run equilibrium (Bley & Chen, 2006; Karim et al., 2011).

To determine the number of cointegration vectors, Johansen and Juselius (1990) and Johansen (1988) developed two test statistics, namely, the Trace and the Maximal Eigenvalue statistics:

$$\lambda_{trace} = -T \sum_{i=r+1}^{k} \ln (1 - \lambda_i) \tag{3}$$

$$\lambda_{max} = -T \ln (\mathrm{i} - \lambda_{\mathrm{r}+1}) \tag{4}$$

The Trace statistics test the null hypothesis that there are at most r cointegration vectors. On the other hand, the Maximal Eigenvalue statistics test the null hypothesis that the number of cointegration vectors is r against the alternative hypothesis that is $r+1$.

As indicated by Engle and Granger (1987), as long as the cointegrated relationship is present, there will always be a corresponding error correction representation. In other words, when the long-run equilibrium relationships exist, the short-run deviations will always be adjusted toward the long-run equilibrium. Thus, there must be dynamic relationships among these time series so that they can move together towards the long-run stable equilibrium.

Such belief can be evidenced from Granger (1988), where it concluded that if there is a cointegration vector among time series, there must be at least a unidirectional causality relationship among them. To explore the long-run and short-run dynamic relationships among these markets, this study has adopted the VECM model based on the Granger representation theorem. The matrix form of the five variables VECM model can be represented as follows:

$$\begin{bmatrix} \Delta US \\ \Delta JP \\ \Delta CN \\ \Delta MY \\ \Delta IN \end{bmatrix} = \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \\ \delta_5 \end{bmatrix} + \sum_{i=1}^{k} \Gamma_i \begin{bmatrix} \Delta US \\ \Delta JP \\ \Delta CN \\ \Delta MY \\ \Delta \mathrm{IN} \end{bmatrix}_{t-k} + \Pi \begin{bmatrix} US \\ JP \\ CN \\ MY \\ IN \end{bmatrix}_{t-1} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \end{bmatrix} \quad (3)$$

where *US, JP, CN, MY,* and *IN* represents the stock market indices of the United States, Japan, China, Malaysia, and Indonesia, respectively. The matrix with the summation notation represents the short-run terms, and the associated coefficient matrix Γ_i denotes the coefficients of short-run relationships between the short-run terms and the dependent variables. Whereas the matrix accompanied with the coefficient matrix Π represents the vector of lagged error correction terms (ECTs), and Π indicates the coefficients of the long-run relationships. In particular, the ECTs represent the deviations from the long-run equilibrium relationships at time t-1 and the coefficients represent the speed of adjustment for the dependent variable to return to its long-run equilibrium level at time t.

To determine the long-run causal relationships, the significance of the lagged ECTs is tested by the t statistics. On the other hand, the short-run causal relationships are determined through the F statistics, where the joint significance of the lagged short-run terms is tested. However, if neither t tests nor F tests are significant, it indicates the exogeneity of the dependent variables (Masih & Masih, 1999; Masih & Masih, 2001).

EMPIRICAL RESULTS

Descriptive Statistics

Table 1 presents the descriptive statistics of the data, which summarizes the basic statistical characteristics of the daily stock market indices returns

TABLE 1 Descriptive Statistics of the Stock Market Returns

	Conventional Stock Markets					Islamic Stock Markets				
	US	JP	CN	MY	IN	IUS	IJP	ICN	IMY	IIN
Precrisis										
Mean	0.0425	0.0209	0.3354	0.1110	0.1708	0.0478	0.0115	0.1149	0.1311	0.1544
Median	0.0729	0.0009	0.2774	0.1014	0.1805	0.0621	−0.0022	0.1591	0.1579	0.1541
Maximum	2.3181	3.3007	4.9372	3.0709	5.3223	2.4996	4.0962	2.6832	2.6546	6.9887
Minimum	−3.4694	−4.2304	−9.7834	−4.7465	−6.5152	−3.5928	−4.3420	−4.9159	−5.3193	−6.9188
SD	0.6841	1.0769	1.8456	0.7361	1.1983	0.7216	1.1196	0.9385	0.7580	1.3613
Skewness	−0.4167	−0.3032	−1.0363	−1.0686	−1.0210	−0.3324	−0.2422	−0.8420	−1.4729	−0.6689
Kurtosis	5.4842	4.0591	6.9715	10.4822	8.6145	5.1060	4.4950	5.8597	12.2003	8.0959
Jacque-Bera	110.14	23.89	321.93	971.33	572.57	78.24	39.62	176.68	1497.08	445.28
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	385	385	385	385	385	385	385	385	385	385
During Crisis										
Mean	−0.0141	−0.0613	−0.0481	0.0107	0.0501	−0.0029	−0.0220	0.0047	0.0042	0.0355
Median	0.0432	0.0000	0.0000	0.0497	0.0689	0.0641	0.0134	0.0733	0.0257	0.1202
Maximum	10.7740	13.2346	9.1091	4.2587	7.6231	11.7405	10.6591	10.8424	4.0747	8.7555
Minimum	−9.6348	−12.1110	−8.8334	−9.9785	−10.9540	−9.6970	−9.5475	−9.4763	−11.3205	−15.2439
SD	1.8231	1.9765	2.2150	0.9730	1.7932	1.6728	1.7180	1.8289	1.0216	2.0358
Skewness	−0.2333	−0.3506	−0.1604	−1.3242	−0.5197	−0.0222	−0.1675	−0.2312	−1.6746	−0.6576
Kurtosis	8.6914	9.8046	4.7849	17.1290	8.6567	10.6562	7.2859	6.9355	21.7082	9.2332
Jacque-Bera	1216.05	1745.04	122.65	7706.03	1233.56	2186.03	689.19	585.56	13470.19	1513.42
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	895	895	895	895	895	895	895	895	895	895

Note: US = United States; JP = Japan; CN = China; MY = Malaysia; IN = Indonesia.
Precrisis period involves February 1, 2006 to July 25, 2007, whereas the during-crisis period covers from July 26, 2007 to December 31, 2010.

for the selected 10 stock markets, for the precrisis and during-crisis periods, respectively. In term of the market volatility, the Standard Deviations indicate that all the stock markets tend to be more volatile during the U.S. subprime crisis period, conventional and Islamic ones alike. As for the conventional markets, the volatility of stock market returns increased by about 166% for the United States, 83% for Japan, 20% for China, 32% for Malaysia, and 50% for Indonesia, whereas the Islamic stock market returns portrayed an increase of volatility with almost 132% for the United States, 53% for Japan, 95% for China, 35% for Malaysia, and 50% for Indonesia. Apparently, the U.S. stock markets were more volatile than the other stock markets after the debut of the 2007 subprime crisis. In fact, conventional and Islamic stock markets of the United States have more than doubled after the debut of the subprime crisis.

Because the skewness statistics are all negative, they indicate that all stock market indices return series are asymmetrical distributed. Instead, the distributions of these series are inclined to the left. In addition, since the kurtosis statistics for all the series are greater than 3, these series are leptokurtic. Lastly, the Jacque-Bera tests confirm the non-normal distribution features of all the series.

Unit Root Tests

For the stationary nature of the stock market indices (the natural logarithmic form) and indices returns (first difference of natural logarithmic indices multiplied by 100), Table 2 illustrates the unit root tests results for ADF and PP methods during the two subperiods. For the two subperiods, ADF and PP statistics indicate that at levels all the series are nonstationary, except for Japan's precrisis Islamic index. In general, this implies that when the market indices are at levels the null hypothesis of a unit root cannot be rejected at all levels of significance, regardless of the occurrence of the U.S. subprime crisis. On the other hand, when the series are at first difference, the null hypothesis of a unit root can be rejected at all levels of significance. Thus, we conclude that the series are stationary at their first difference. In other words, all the data series are said to be integrated at order one, or I (1).

Cointegration Analysis

Having noted that all stock market indices are integrated at order one, I (1), the study then proceeds to investigate the presence of long-run relationships among selected stock markets using JJ cointegration technique. The cointegration tests have been employed on two models, for precrisis and during-crisis periods. For the first model only the Islamic stock markets are included (i.e., IUS, IJP, ICN, IMY, and IIN). As for the second model, the

TABLE 2 Unit Root Tests

	Precrisis				During Crisis			
	Level		First Difference		Level		First Difference	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
Conventional Stock Markets								
US	−2.7818	−2.6784	−6.7361***	−20.1562***	−0.9871	−1.0750	−24.5056***	−34.1261***
JP	−2.6732	−2.6120	−21.2172***	−21.2098***	−1.6433	−1.7750	−15.4940***	−30.4371***
CN	−1.7174	−1.6876	−20.5324***	−20.5317***	−1.2563	−1.2653	−29.9022***	−29.9025***
MY	−2.2596	−1.8587	−5.7847***	−15.6621***	−0.9965	−1.0984	−27.3163***	−27.4026***
IN	−1.9888	−2.0440	−8.1657***	−18.7845***	−1.1137	−0.1000	−18.7358***	−25.9958***
Islamic Stock Markets								
IUS	−2.0485	−2.3232	−15.4707***	−19.9835***	−1.0810	−1.1840	−18.3083***	−34.6991***
IJP	−3.0908	−3.1523*	−20.2677***	−20.2708***	−1.0337	−1.4711	−16.3441***	−35.6036***
ICN	−1.5294	−1.6607	−19.2500***	−19.2550***	−1.0587	−1.0772	−27.8725***	−27.8495***
IMY	−2.0341	−1.5883	−5.6768***	−15.7716***	−0.9421	−1.0261	−26.9670***	−27.0284***
IIN	−1.9007	−2.5448	−8.6171***	−18.7191***	−1.1508	−1.0792	−19.1634***	−26.8617***

Note: ADF = Augmented Dickey Fuller; PP = Phillips-Perron; US = United States; JP = Japan; CN = China; MY = Malaysia; IN = Indonesia.
The above tests of ADF and PP are based on model with constant and trend.
*, ***denote significance at the 10%, and 1% level, respectively.

conventional and Islamic stock markets are included (i.e., US, JP, CN, MY, IN, IUS, IJP, ICN, IMY, and IIN). The appropriate lag lengths for the two models are determined by the AIC. For the first model, the lag structures are 2 and 4 for the precrisis and during-crisis periods, respectively. As for the second model, the lag structures are 2 and 3 for the precrisis and during-crisis periods, respectively. Subsequently, Trace and Maximal Eigenvalue statistics are applied to determine the number of the cointegration vectors at 5% significance level. Because the Trace statistics are more robust than the Maximal Eigenvalue statistics, if the two statistics give contradictory results the Trace statistics should prevail (Cheung & Lai, 1993; Johansen & Juselius, 1990).

The results of the cointegration tests are presented in Table 3. When only the Islamic stock markets are included in the model, the Trace and Maximal Eigenvalue statistics indicate the absence of cointegration relationships for the precrisis period. For the crisis period, the Trace statistics reveal that there are two cointegration relationships among the Islamic stock markets. However cointegrated relationships are not present based on Maximal Eigenvalue statistics. Because Trace statistics prevail over Maximal Eigenvalue statistics in the wake of conflicting results, it is safe to conclude the presence of the long-run equilibrium relationship among Asia-Pacific Islamic stock markets for the crisis-period. The results suggest that Asia-Pacific Islamic stock markets were relatively independent from each other prior to the U.S. subprime crisis but shifted together toward long-run stable relationship after the debut of the crisis. Thus, the potential benefits of diversifying portfolios across Asia-Pacific Islamic stock markets have diminished after the debut of the U.S. subprime crisis.

When conventional and Islamic stock markets are included in the model, the Trace and Maximal Eigenvalue statistics have rejected the existence of the cointegration relationships prior to the U.S. subprime crisis. However, for the crisis-period both statistics have indicated the presence of a long-run equilibrium relationship among these markets. This suggests that the Asia-Pacific Islamic and conventional stock markets are relatively independent from each other before the crisis but arbitrarily moving together toward the long-run equilibrium after the crisis. This implies that there are only marginal benefits for the international investors to diversify portfolios across Asia-Pacific conventional and Islamic stock markets.

The results of the cointegration tests for the two models indicate that the U.S. subprime crisis has a significant impact on the integration of Asia-Pacific Islamic stock markets. In particular, after the debut of the U.S. subprime crisis the Asia-Pacific Islamic stock markets tend to increasingly integrated among themselves and with their conventional counterparts. These findings are found to be in support of the past researches that the extent of the stock market integration tends to increase extensively after the debut of the crisis (Majid, Meera, & Omar, 2008; Majid et al., 2009; Ratanapakorn & Sharma, 2002). However, the integration nature of stock markets in this study tend

TABLE 3 Cointegration Tests

		Before Crisis				During Crisis			
Model	H_0	Trace Statistic	Trace 0.95	Maximal Eigenvalue	Trace 0.95	Trace Statistic	Trace 0.95	Maximal Eigenvalue	Max. 0.95
IUS, IJP, ICN, IMY, IIN	$r = 0$	46.6662	69.8189	15.7392	33.8769	87.9402**	69.819	30.8338	33.8769
	$r \leq 1$	30.927	47.8561	14.3051	27.5843	57.1065**	47.8561	30.0334**	27.5843
US, IUS, JP, IJP, CN, ICN, MY, IMY, IN, IIN	$r = 0$	222.647	239.2354	56.7507	64.5047	258.0536**	239.235	68.1183**	64.5047
	$r \leq 1$	165.8963	197.3709	44.6164	58.4335	189.9353	197.371	50.6043	58.4335

Note: IUS, IJP, ICN, IMY, and IIN represents the Islamic stock market in the US, Japan, China, Malaysia, and Indonesia, respectively, while US, JP, CN, MY, and IIN refers to the conventional stock market for the same five countries.

**denotes statistical significance at the 5% level.

to contrast with the findings of Karim et al. (2010), which concluded that the Islamic stock markets of United States, United Kingdom, Japan, Malaysia, and Indonesia were not cointegrated prior and after the 2007 U.S. subprime crisis. However, it is believed that the contrary results from the two studies may be because of the differences embedded in the research models of the two studies, particularly the time interval and the stock markets included in the models.

Vector Error Correction Model–Based Causality Tests

To explore the long-term and short-term dynamic relationships among Asia-Pacific Islamic and conventional stock markets, the VECM-based causality tests are applied in the analysis. Because the existence of cointegration relationships is the prerequisite condition for the application of the VECM model, and the cointegration relationships for both models are only present during the crisis period, hence the VECM model is only used for this crisis period.

Tables 4 and 5 summarize information on the long-run and short-run causal relationships among the Asia-Pacific stock markets. In particular, Table 4 provides findings for the Islamic stock markets only, whereas Table 5 covers information on Islamic and conventional stock markets. To investigate the dynamic causal relationships among these markets, the significance of the *t* statistics for ECTs indicates the presence of long-run causal relationships among the stock markets, whereas the significance of the *F* statistics through

TABLE 4 Vector Error Correction Model Multivariate Causality Analysis

During-Crisis Lag Length = 4						
Dependent Variable	*F* statistics of the short-run lagged differences [*p* Value]					*t* Statistic. (*t* Value)
	ΔIUS	ΔIJP	ΔICN	ΔIMY	ΔIIN	ECT_{t-1}
ΔIUS	–	3.8988*** [0.0038]	1.7485 [0.1373]	3.4079*** [0.0089]	0.948 [0.4355]	−0.0767*** (0.0000)
ΔIJP	88.8655*** [0.0000]	–	1.54 [0.1886]	3.2668** [0.0114]	4.4185*** [0.0015]	−0.0324*** (0.0047)
ΔICN	55.3467*** [0.0000]	7.6734*** [0.0000]	–	3.8624*** [0.0041]	2.5701** [0.0367]	−0.0205 (0.1879)
ΔIMY	25.4011*** [0.0000]	5.2058*** [0.0004]	0.6117 [0.6543]	–	7.3278*** [0.0000]	−0.0221** (0.0145)
ΔIIN	26.0184*** [0.0000]	2.3194* [0.0554]	3.5304*** [0.0072]	1.8438 [0.1184]	–	−0.0425*** (0.0004)

Note: Figures in the brackets and parentheses represent the probabilities for *F* statistics and *t* value for *t* statistics, respectively. ΔIUS, ΔIJP, ΔICN, ΔIMY, ΔIIN refers to the one-period lagged-difference term for the Islamic stock market of the US, Japan, China, Malaysia, and Indonesia, respectively.
*, **, ***denote statistical significance at 10%, 5%, and 1% level, respectively

TABLE 5 Vector Error Correction Model Multivariate Causality Analysis

During Crisis Lag Length = 3											
Dependent Variable	*F* Statistics of Short-Run Lagged Differences [*p* Value]										*t-stat. (t-value)*
	ΔUS	ΔIUS	ΔJP	ΔIJP	ΔCN	ΔICN	ΔMY	ΔIMY	ΔIN	ΔIIN	ECT_{t-1}
ΔUS	–	4.6255***	5.1843***	2.2621*	0.6248	2.3452*	1.3724	0.3887	4.5823***	2.5588*	−0.0262
		[0.0032]	[0.0015]	[0.0798]	[0.5991]	[0.0715]	[0.2499]	[0.7612]	[0.0034]	[0.0539]	(0.2397)
ΔIUS	2.7175*	–	4.1086***	1.7325	0.7657	2.1784*	1.4086	0.4250	6.1095***	3.6811**	0.0068
	[0.0436]		[0.0066]	[0.1588]	[0.5134]	[0.0891]	[0.2389]	[0.7351]	[0.0004]	[0.0118]	(0.2988)
ΔJP	3.8417***	1.7045	–	16.3757***	3.1672**	0.3312	0.3627	0.8207	0.8513	0.5563	−0.0079
	[0.0095]	[0.1645]		[0.0000]	[0.0238]	[0.8028]	[0.7800]	[0.4826]	[0.4661]	[0.6440]	(0.2516)
ΔIJP	2.2722*	3.1923**	2.9226**	–	1.6803	0.9364	0.6262	0.5397	0.4928	0.0797	−0.0011
	[0.0788]	[0.0230]	[0.0331]		[0.1697]	[0.4225]	[0.5982]	[0.6552]	[0.6873]	[0.9710]	(0.3323)
ΔCN	3.1965**	1.1082	0.6190	2.0139	–	0.4541	0.7531	1.0186	0.7159	0.5017	−0.0184***
	[0.0229]	[0.3449]	[0.6028]	[0.1104]		[0.7145]	[0.5207]	[0.3836]	[0.5426]	[0.6812]	(0.0043)
ΔICN	3.6293**	0.0302	0.7899	2.6658**	3.3855**	–	2.7272**	2.7387**	1.5374	0.3565	−0.0079
	[0.0127]	[0.9930]	[0.4997]	[0.0467]	[0.0177]		[0.0431]	[0.0424]	[0.2033]	[0.7845]	(0.2665)
ΔMY	1.9169	0.2121	1.7473	0.5090	0.6374	0.7979	–	1.1502	2.0690	1.8929	−0.0315***
	[0.1252]	[0.8881]	[0.1558]	[0.6762]	[0.5910]	[0.4952]		[0.3279]	[0.1028]	[0.1292]	(0.0003)
ΔIMY	0.7208	0.9306	2.3905*	0.6053	0.4673	0.9193	0.7755	–	1.4083	1.2843	−0.0109***
	[0.5397]	[0.4253]	[0.0674]	[0.6117]	[0.7052]	[0.4309]	[0.5078]		[0.2390]	[0.2785]	(0.0072)
ΔIN	3.1478**	0.1969	1.8944	0.3496	0.3157	4.0347***	1.9211	1.9143	–	2.0711	−0.0134**
	[0.0244]	[0.8985]	[0.1289]	[0.7894]	[0.8140]	[0.0073]	[0.1246]	[0.1257]		[0.1025]	(0.0357)
ΔIIN	2.1929*	0.6379	2.4497*	0.4541	0.2452	3.3908**	2.1927*	2.3676*	2.3329*	–	−0.0166**
	[0.0874]	[0.5907]	[0.0623]	[0.7145]	[0.8648]	[0.0176]	[0.0875]	[0.0695]	[0.0727]		(0.0187)

Note: Figures in the brackets and parentheses represent the probabilities for *F* statistics and *t* value for *t* statistics, respectively.
*, **, ***denote statistical significance at 10%, 5%, and 1% level, respectively.

joint tests of the lagged differences of each variable determines the presence of short-run causal relationships.

The results shown in Table 4 unveil four noteworthy observations for the Asia-Pacific Islamic markets during the U.S. subprime crisis. First, during the crisis-period, all the Islamic stock markets are statistically endogenous. In other words, either the short-run or/and long-run causal relationships are significant for the five Asia-Pacific Islamic stock markets.

Second, the ECTs are significant for all the Islamic stock markets except China. In other words, there are significant long-run causal relationships from ECTs to the Islamic stock markets of the United States, Japan, Malaysia, and Indonesia. This implies that when there are deviations from the long-run equilibrium in the system/model of Islamic stock markets, these four Islamic markets will adjust to clear the disequilibrium (Masih & Masih, 1999; Masih & Masih, 2001). The long-run interrelationships between the Islamic stock markets of the United States, United Kingdom, Malaysia, and Indonesia are found to be consistent with Majid and Kassim (2010). As for the Islamic stock market of China, the insignificance of its ECT term indicates the isolate nature of the stock market in the Asia-Pacific region. The segmentation of this stock market can also be evidenced from Karim and Majid (2009) and Huyghebaert and Wang (2010). It is believed that the key factor behind the isolation of the stock market of China regionally and globally is rooted at the strict capital control of its financial system (Fahami, 2011; Luo & Tang, 2007). More specifically, foreign investors are constrained severely to access the domestic stock markets of China. Similarly, the Chinese domestic investors are also restricted severely to diversify portfolios internationally (Huyghebaert & Wang, 2010).

Third, the lagged-differences terms of the U.S. and Japan Islamic stock markets are found to have significant short-run causal relationships with all the Asia-Pacific Islamic stock markets. In other words, the Islamic stock markets of the United States and Japan play significant roles in the short-run fluctuations of the Asia-Pacific Islamic stock markets. Our findings in the importance of U.S. and Japan markets are in line with Huang, Yang, and Hu (2000), Kim (2005), Masih and Masih (1999), and Masih and Masih (2001). The global leadership of the U.S. and Japan stock markets could be explained by four factors suggested by Masih and Masih (1999), namely, the liquidity of the market, the share of market capitalization in the global equity market, the cost of transection, and the openness and deregulations of the economy. In principle, if a stock market is more liquid, having a larger share of global market captialization, lower costs of transaction, and more open and deregulated, the market is expected to be more leading in the information context. In particular, the leadership of the U.S. market may be because of its dominance in the market place, and its role as the most influential news producer globally (Masih & Masih, 1999). The importance of Japanese stock market in the region is believed to be rooted at its large volume of financial flows to the region via bank lending (Kim, 2005).

Lastly, significant short-run causal relationships can be found between Islamic stock markets of the developing Asia-Pacific economies. In particular, the Islamic stock market of China is significantly influenced by the other four Islamic stock markets in the region, whereas it is shown to be significant only to the Indonesia Islamic stock market. As for the Islamic stock market of Malaysia, there are significant bidirectional short-run causalities between Islamic stock markets of the United States and Malaysia, and between Japan and Malaysia. However, only unidirectional short-run causalities are found to be significant from the Islamic stock market of Malaysia to China and from Indonesia to Malaysia. As for the Islamic stock market of Indonesia, the short-run bidirectional causality is found to be significant only between Indonesia and Japan. The unidirectional short-run causalities can be found from the Islamic stock market of the United States to that of Indonesia, and from Indonesia to that of China and Malaysia. The significant short-run interdependences between Asia-Pacific Islamic stock markets signify the nonexistence of diversification benefits in the short-run.

The results shown in Table 5 reveal the short-run and long-run causal relationships between conventional and Islamic stock market in the Asia-Pacific region. Similar to the findings from Table 4, four interesting observations can be found from Table 5. First, during the crisis-period all the Asia-Pacific stock markets, Islamic and conventional, are statistically endogenous. This suggests that at least one channel of the causal relationships is active: either the short-run channel when lagged-differences are jointly significant, or the long-run channel with a significant ECT.

Second, the ECTs are significant for Islamic and conventional markets of Malaysia and Indonesia, but only for the conventional market of China. This suggests that when there is disequilibrium in the system, it is mainly these five markets that adjust to reverse the system back to its long-run equilibrium (Masih & Masih, 1999; Masih & Masih, 2001).

Third, the U.S. conventional market is found to be the most significant factor for the short-run fluctuations of the Asia-Pacific stock markets, conventional and Islamic ones alike. The lagged difference of U.S. conventional market is found to be of importance for all the markets, except for the conventional and Islamic markets of Malaysia. This implies the regional leadership of the U.S. conventional stock market in the short run. Having noted the statistical insignificance of the ECT in the equation of the U.S. conventional stock market, the significance of the U.S. conventional stock market in the short run signifies its role of being the initial receptor of the shocks to the long-term equilibrium in the system. In other words, the external shock will affect the performance of the U.S. conventional market before passing over to the other markets in the region (Masih & Masih, 1999; Masih & Masih, 2001).

Lastly, in comparison with other markets in the region the stock markets of Malaysia, Islamic and conventional ones alike, are found to be relatively

exogenous in the short run. In particular, only unidirectional causal relationships can be found from both markets of Malaysia to the Islamic markets of China and Indonesia. This finding suggests the existence of short-run diversification benefits for the Asia-Pacific portfolio investors to venture into the Islamic and conventional stock markets of Malaysia.

CONCLUSION

The objective of this study is to examine the impact of the U.S. subprime crisis on the long-run and short-term dynamic relationships between selected Asia-Pacific Islamic and conventional stock markets, namely the United States, Japan, China, Malaysia and Indonesia. It is observed that as Asia countries increasingly liberalize their financial markets to attract more foreign investments, the vulnerability of their stock markets to the external financial shocks has also increased.

Due to the far-reaching influences of the U.S. subprime crisis on the global economy, the study aims to investigate whether it is beneficial for investors to diversify their portfolios into Asia-Pacific Islamic stock markets in the event of financial crisis. As it is revealed by the study, Asia-Pacific Islamic stock markets have been significantly integrated among themselves and with their conventional counterparts after the debut of the U.S. subprime crisis. This implies that the potential benefit of diversifying across Asia-Pacific Islamic and conventional stock markets have diminished during the crisis.

In addition, as the VECM-based dynamic Granger causality analysis reveals, among the five Islamic stock markets, only China seems to be isolated from other Islamic markets in the long-run. On the other hand, the significant ECTs for the four other Islamic markets suggest that in wake of the U.S. subprime crisis the disequilibrium will be adjusted by these four Islamic markets. In the short run, this study finds the U.S. Islamic market leads the short-run fluctuations of the other Asia-Pacific Islamic markets during the crisis period. In addition, the significant short-run dependency among Asia-Pacific Islamic markets signifies the absence of short-run diversification benefits across these markets.

When conventional and Islamic markets are included in the model, in the long-run the significant ECTs for Malaysia (Islamic and conventional), Indonesia (Islamic and conventional), and China (conventional only) stock markets imply that when there is any deviation from long-run equilibrium, these five markets will bear the brunt of short-run adjustments toward the equilibrium relationship. As for the short-run dynamic relationship, this study finds that the conventional markets of the United States and Japan are the two significant forces for the fluctuations of the other Islamic and conventional markets in the region. Besides, the short-run exogeneity of Malaysia stock

markets (Islamic and conventional) in the region indicates the existence of potential short-run diversification benefits in the two markets.

The results of this study have opened a wide variety of possible areas that warrant further researches. Among the possible areas include investigating if there are diversification benefits to be gained by buying different sectorial stocks during specified periods, by investigating multiple sources of risks (such as foreign exchange risks), and by assessing the effects of regulatory changes of the stock markets.

NOTES

1. The Dow Jones Islamic Market Greater China Index was launched on August 28, 2009, but the daily data were available since December 31, 2005 through estimated back-testing method.

2. This study has designed two models to investigate the integration of stock markets in United States, Japan, China, Malaysia, and Indonesia. The first model only comprises five Islamic stock market indices (i.e., IUS, IJP, ICN, IMY, & IIN), whereas the second model covers Islamic and conventional stock markets (i.e. US, JP, CN, MY, IN, IUS, IJP, ICN, IMY, & IIN).

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