Scientific Annals of Economics and Business
63 (2), 2016, 195-208
DOI: 10.1515/aicue-2016-0016

THE IMPACT OF THE 2008 GLOBAL FINANCIAL CRISIS ON THE STRUCTURE OF THE TRANSMISSION OF PRICE INNOVATIONS ACROSS FINANCIAL MARKETS: THE CASE OF SOUTHWEST ASIAN EQUITY MARKETS

Qunfeng LIAO[*], Seyed MEHDIAN[**], John STEPHENS[***]

Abstract

This study examines the reaction of Southeast Asian equity markets to the transmission of price innovations from major equity markets during the pre and post periods of the 2008 global financial crisis. In particular, we examine the reaction of returns indices in Malaysia, the Philippines, South Korea, Taiwan, and Thailand as endogenous variables, and compare them to the returns indices of the U.S., the Eurozone, Japan, and China as exogenous variables. The results of VAR models indicate the combined and individual impact of the price innovations from the major equity markets on the volatility of returns of selected countries is relatively trivial during either the pre- or post-financial crisis periods. However, the individual impact of the U.S. innovations is generally higher during the post-financial crisis. The ARCH and GARCH models indicate the stock markets of Southeast Asian countries are more responsive to their own price innovations during both the pre- and the post-crisis periods, although some response to U.S. and Eurozone shocks is also observed.

Keywords: global financial crisis; Southeast Asian equity markets; price innovations

JEL classification: G01, G15

1. INTRODUCTION

In mid-2008, the world witnessed a massive global financial crisis/meltdown that originated in the United Sates and quickly spread throughout most developed and emerging economies. While the 2008 crisis was not as destructive as the crash of 1929, the speed at which it spread was magnified because of today's wide-ranging use of advanced technology and telecommunications in global trade. As a result, the world observed a sharp drop in U.S. equity markets in mid-2008 continuing into 2009, as well as the collapse and insolvency of well-established financial institutions such as Lehman Brothers, Bear Stearns, and Merrill

[*] School of Management, University of Michigan-Flint, United States; e-mail: *qunliao@umflint.edu*.
[**] School of Management, University of Michigan-Flint, United States; e-mail: *seyed@umich.edu*.
[***] School of Management, University of Michigan-Flint, United States; e-mail: *johstep@umflint.edu*.

Lynch. All of this stemmed from real estate speculation on the part of individuals, banks, and other financial institutions. Accordingly, the 2008 crisis is regarded as the worst financial crisis since the stock market crash of 1929 and the Great Depression of the 1930s.

One concern arising from the 2008 crisis is the effect it has on the structure of the transmission of information and price innovations across financial markets as a whole. It may be possible the world economy is more intertwined from country to country than in previous eras, as can be seen with the number of ratified trade agreements including the North American Free Trade Agreement (NAFTA), the South Asian Free Trade Area (SAFTA), and the European Union Free Trade Agreements (EUFTA). Because of these trade agreements and widely used information technology, countries are more codependent financially and economically, and economic shocks are transmitted rapidly across borders. Therefore, it is essential to examine the behavior of equity markets regarding the transmission of price innovations during the pre- and the post-periods of the 2008 financial crisis so that new policies may help to prevent such crises in the future.

In finance, there is a body of literature on the integration of financial markets and the transmission of price innovations and volatilities across financial markets (e.g., Bailey and Stulz, 1990; Koch and Koch, 1991; Cheung and Ho, 1991; Ng, 2000; Longin and Solnik, 2001; Forbes and Rigobon, 2002; Shachmurove, 2005; Wongswan, 2006; Baltzer *et al.*, 2008; Aktan *et al.*, 2009; Yalama, 2009; Dimpfl and Jung, 2012; Peša and Festić, 2012 and Stoica *et al.*, 2015). There are also a few studies that focus on the examination of the impact of global financial crises on the structure of transmission of price information. As an example, Gębka and Serwa (2006) examine the Asian currency crisis and the pre- and the post-impact of the U.S. currency market variations on eight Southeast Asian capital markets. They find the transmission of price shocks is greater in the post-crisis period compared to the pre-crisis period. Similarly, Nam *et al.* (2008) study the Pacific basin financial markets and observe a general increase of U.S. price innovations in the region after the financial crisis.

Given the scope and depth of the 2008 global financial crisis, there are a limited number of studies pertaining to the impact of the crisis on the structure of the transmission of price innovations. Chakrabarti (2011) investigates the effects of the crisis on Asia-Pacific equity markets without identifying the nations from which the crisis is originated. Yamamoto (2014) carries the analysis one step further by linking the U.S. crisis to the Asian economic downturn. On the contrary, other studies including Heymans and da Camara (2013), Kenani *et al.* (2013), Islam (2014) and Afnouch and Hammami (2014), attempt to identify the outsiders that influence the change in the structure of the transmission of price innovations.

The present paper compares the impact of the 2008 global financial crisis on the dynamics of the transmission of price innovations across Southeast Asian countries using GARCH and VAR models on a pre- and post-basis. Specifically, we study exogenous and endogenous price innovations that affect Southeast Asian equity markets during two time periods: (a) 2000 through 2008, the pre-financial crisis period, and (b) 2009 through 2015, the post-financial crisis period. We investigate whether any changes exist in the sensitivity of the Southeast Asian economies to exogenous and endogenous price innovations and shocks.

Our data set contains the daily returns indices of Malaysia, the Philippines, South Korea, Taiwan, and Thailand as endogenous variables, and the daily returns indices of the U.S., the Eurozone, Japan, and China as exogenous variables. The motivation for selection of these countries is twofold: (a) Southeast Asian financial markets have suffered a financial crisis twice in almost 10 years, i.e., the so-called 1997/1998 financial crisis and the 2008 global financial meltdown, and (b) the selected countries in this paper constitute 70.48% and

69.81% of the world gross domestic product in 2007 (pre-crisis) and in 2010 (post-crisis), respectively[1].In addition, these countries represent 64.48% and 56.32% of global foreign direct investment in 2007 and 2010, respectively[2].The selected countries also comprise 49.46% and 49.68% of the world market capitalization in 2007 and 2010, respectively[3].

The results of VAR models show that while a shift in exogenous countries does affect the stock market price innovations and volatilities of Southeast Asian countries, Southeast Asian equity markets are generally affected by their own price innovations during both the pre- and post-crisis periods. However, we also find these countries are less influenced by their own price shocks during the post-financial crisis compared to the pre-crisis period. These findings suggest the equity markets of Southeast Asian countries are only slightly more influenced by the exogenous price innovations following the global financial crisis, implying that the financial markets are still closely integrated even after the crisis. The ARCH and GARCH indicate Southeast Asian countries stock markets are more responsive to their own price innovations, although some response to the U.S. and the Eurozone shocks is also observed.

The rest of the paper is organized as follows: Section 2 explains the data and methodology. Section 3 describes the empirical results, and Section 4 presents a summary and conclusions.

2. DATA AND METHODOLOGY

2.1. Data

We compile the data for this study from Global Financial Data (GFD). It contains the daily closing stock indices of Malaysia, the Philippines, South Korea, Taiwan, and Thailand as endogenous stock indices, and the daily closing stock indices of the U.S., the Eurozone, Japan, and China as endogenous stock indices. Our sample covers a period from January 5, 2000 to June 24, 2015, which is used to generate two subsamples: the pre-crisis and the post-crisis periods. The pre-crisis period covers from January 5, 2000 to July 31, 2008, and the post-crisis period covers from May 2, 2009 to June 24, 2015. To avoid the effect of the crisis, we eliminate data from August 1, 2008 to May 1, 2009 from the entire data set. We choose to exclude this period because August 1, 2008 is the day that S&P 500 Index begins to plummet; however, it steadily recovers around May 1, 2009.

We use equation (1) in order to calculate daily return for each stock index:

$$Rit = \ln (Iit / Iit\text{-}1) * 100 \quad (1)$$

where:

Rit = the daily closing return of index i on day t;
ln = natural log;
Iit = the closing value of index i on day t;
Iit-1 = the closing value of index i on day t-1.

We perform the Augmented Dickey-Fuller test (ADF) for each series of index returns to test for stationarity of the series. The results of the ADF tests indicate all return series used are stationary in the first difference[4].

2.2. Methodology

We employ two time-series econometric models (Vector Autoregressive, VAR and Generalized Autoregressive Conditional Heteroscedasticity, GARCH) to study the reaction of the selected Southeast Asian returns to endogenous and exogenous price innovations and shocks. We believe VAR is appropriate model for our study since our objective is to examine the relationship between home country return series and its own lag returns and other countries' lag return series. Furthermore, GARCH (1,1) model is suitable for our analysis because, as is the characteristics of the time series return data, volatility of the returns is not constant and they are exposed to heteroskedasticity and time varying volatility.

The VAR model is specified as follows:

$$R_{it} = B_1 + \sum_{j=1}^{j=p} C_j R_{i,j-1} + \sum_{j=1}^{j=p} D_j R_{US,j-1} + \sum_{j=1}^{j=p} F_j R_{Eurozone,j-1} + \sum_{j=1}^{j=p} G_j R_{Japan,j-1} + \sum_{j=1}^{j=p} H_j R_{China,j-1} + \varepsilon_{it} \quad (2)$$

where:

R_{it} is the daily return of endogenous stock returns (Malaysia, the Philippines, South Korea, Taiwan, and Thailand) and

R_{US}, $R_{Eurozone,}$ R_{Japan} and R_{China} are daily stock returns of the U.S., the Eurozone, Japan, and China, respectively.

As can be seen in model (2), the daily return of each country is a function of the lag value of all returns in the system. VAR specification provides the possibility to examine the degree of responsiveness of each endogenous stock market to its own price innovations and price shocks from exogenous stock markets. We estimate an unrestricted version of VAR because the Johansen test indicates the returns included in the system are not co-integrated. We use model (2) to run impulse response function to investigate the dynamic responses of the returns of each country to home country price innovations, as well as the price innovations from the endogenous countries. To test whether the global financial meltdown has changed the structure of the responses to price innovations, we estimate model (2) using the pre-crisis and the post-crisis data sets, respectively.

Additionally, we use the GARCH (1,1) model to investigate the degree of exogenous dependency between the returns of Malaysia, the Philippines, South Korea, Taiwan, and Thailand and the stock markets of the U.S., the Eurozone, Japan, and China. One advantage of GARCH model is that it shows whether the return volatility of each endogenous stock market is affected by its own price innovations, return volatility or the price innovations from the exogenous stock markets. Therefore, the results may reveal which advanced country contributes to the volatility of returns in Southeast Asian countries during the pre- versus the post-global financial meltdown periods. GARCH (1,1) model is specified as follows:

$$R_{it} = \gamma_0 + \sum_{j=1}^{n} \gamma_i L_i R_{it} + e_t; \quad (3)$$

$$e_t | \Phi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1} + \delta_{US} R_{US} \quad (4)$$

$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1} + \delta_{Euro} R_{Euro} \quad (5)$$

$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1} + \delta_{Japan} R_{Japan} \quad (6)$$

$$h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1} + \delta_{China} R_{China} \quad (7)$$

where,

R_{it} is the daily return for the equity market index in each South East Asian country (Malaysia, the Philippines, South Korea, Taiwan, and Thailand),

L is the lag operator,

h_t is the conditional variance of South East Asian series,

R_{US}, $R_{Eurozone,}$ R_{Japan} and R_{China} are daily stock returns of the U.S., the Eurozone, Japan, and China, respectively,

γ, α, β and δ vectors of parameters to be estimated, and

e_t is a random error term.

R_{US}, $R_{Eurozone,}$ R_{Japan} and R_{China} are included in the models to capture the impacts of the advanced markets on Southeast Asia stock market volatility during the pre- and the post-global financial meltdown periods.

A stable conditional variance process requires that $\alpha_0 > 0$, $\alpha_1 \geq 0$, and $\beta_1 \geq 0$. The speed of volatility in response to the price innovations and persistence of the model is evaluated by the sum of α_1 (ARCH coefficient) and β_1 (GARCH coefficient). If $\alpha_1 + \beta_1 < 1$, then the impact of price innovations on market volatility has a persistent effect on the conditional variance, and if $\alpha_1 + \beta_1 = 1$, the price innovations have a permanent impact on the conditional variance. The persistence of price innovation to volatility increases as $\alpha_1 + \beta_1$ converges to 1. In the occurrence of price innovations from the U.S., the Eurozone, Japan, or China, the persistence of variance, as measured by the sum of ARCH and GARCH coefficients, should fall following a price innovation.

3. EMPIRICAL RESULTS

As mentioned earlier, we use the daily index returns from Malaysia, the Philippines, South Korea, Taiwan, and Thailand as endogenous variables, and the daily index returns of the U.S., the Eurozone, Japan, and China as endogenous variables. Table no. 1 reports the list of the selected countries, the stock indices, and the descriptive statistics of the returns for each country before and after the global financial meltdown. As can be seen, in all counties selected, daily mean returns in the post-global financial meltdown period are higher compared to those in the pre-global financial meltdown period. In addition, the volatilities of the stock returns, measured by standard deviations, are lower during the post-global financial meltdown compared to the pre-global crisis.

Table no. 1 – Descriptive Statistics of daily returns of indices

Country	Stock Index	Pre-crash: 1/5/2000-7/31/2008 (Obs.=1,199)				Post-cash: 5/2/2009-6/24/2015 (Obs.=867)			
		Mean (%)	Std Dev.	Min.	Max.	Mean (%)	Std Dev.	Min.	Max.
China	SSE Comp.	-0.0150	1.5888	-9.2562	8.8874	-0.0052	1.3138	-6.7260	4.6789
EuroZone	STOXX50	-0.0751	1.4396	-5.7458	7.0783	0.0232	1.3600	-6.3182	5.8978
Japan	Nikkei 225	-0.0515	1.3214	-5.5695	4.3012	0.0080	1.4028	-11.1534	5.5223
Malaysia	KLSE	0.0026	0.9160	-9.9785	4.1395	0.0095	0.5715	-2.4644	1.8629
Philippines	PSE	-0.0248	1.1845	-4.1659	4.7765	0.0654	1.0620	-4.1053	5.5419
S. Korea	SK11	-0.0030	1.6493	-7.4414	6.4179	0.0037	1.0615	-6.4202	3.7844
Taiwan	TWII	-0.0558	1.4889	-6.9123	6.1721	-0.0215	1.0173	-5.7422	4.4594
Thailand	SET	0.0131	1.4288	-16.0633	10.5770	0.0369	1.1556	-5.4430	5.2919
USA	SP500	-0.0505	1.1267	-4.4141	5.2667	0.0412	1.0286	-6.8958	4.6317

Table no. 2 and Table no. 3 display the correlation matrices of returns among selected countries before and after the global finance meltdown. It is interesting to discover that in all cases, the correlation of returns is higher during the post-global financial crisis than during the pre-global financial crisis. Furthermore, we note that the correlations between the U.S. stock returns and other selected countries have increased following the financial crisis. This increase in correlation suggests the U.S. equity market and other selected equity markets have become even more integrated following the crisis.

Table no. 2 – Correlation Matrix of returns, pre-global financial

	China	Eurozone	Japan	Malaysia	Philippines	S. Korea	Taiwan	Thailand
China								
Eurozone	0.0872							
Japan	0.1230	0.3393						
Malaysia	0.1397	0.2343	0.3166					
Philippines	0.0707	0.2742	0.2694	0.2789				
S. Korea	0.0899	0.2750	0.5813	0.3152	0.2666			
Taiwan	0.0878	0.1934	0.4233	0.2653	0.2409	0.4982		
Thailand	0.0583	0.1339	0.2943	0.3252	0.1726	0.3370	0.2681	
USA	0.0826	0.5641	0.4289	0.3111	0.3488	0.3710	0.3046	0.2239

Table no. 3 – Correlation Matrix of returns, post-global financial

	China	Eurozone	Japan	Malaysia	Philippines	S. Korea	Taiwan	Thailand
China								
Eurozone	0.1609							
Japan	0.2970	0.4407						
Malaysia	0.2540	0.3377	0.4328					
Philippines	0.1855	0.3644	0.3907	0.4706				
S. Korea	0.3523	0.4147	0.5819	0.4954	0.4341			
Taiwan	0.3193	0.3816	0.5380	0.4805	0.4389	0.7268		
Thailand	0.2653	0.1603	0.3138	0.4149	0.3353	0.4025	0.3796	
USA	0.2041	0.6944	0.5052	0.4442	0.4769	0.5038	0.4752	0.3006

We estimate VAR models using each country's past returns in addition to the returns from the U.S., the Eurozone, Japan, and China as exogenous variables. Following the estimation of the VAR models, we obtain the forecast error variance decomposition, which shows to what extent the forecast error variance of each return series (of selected countries) can be explained by price innovations and shocks from the U.S., the Eurozone, Japan, and China.

Table no. 4 and Table no. 5 display the decomposition of forecast error variances of daily index returns for the selected Southeast Asian equity markets during the pre- and the post-global financial meltdown periods, respectively. The last five columns of each table show how the proportions of the total forecast error for each selected country are accounted for by its own price innovations and by the price shocks from the U.S., the Eurozone, Japan, and China. We have reported the daily variance decomposition forecast for two to 10 days ahead.

Table no. 4 – Forecast error decomposition of daily market returns: pre-crash period

County	Days Ahead	Own Innovation	US Innovation	Eurozone Innovation	Japan Innovation	China Innovation
Malaysia	2	98.944	0.252	0.000	0.040	0.764
	3	98.733	0.277	0.054	0.174	0.762
	4	98.729	0.278	0.055	0.174	0.763
	5	98.724	0.280	0.057	0.175	0.763
	6	98.724	0.281	0.057	0.175	0.763
	7	98.724	0.281	0.057	0.175	0.763
	8	98.724	0.281	0.057	0.175	0.763
	9	98.724	0.281	0.057	0.175	0.763
	10	98.724	0.281	0.057	0.175	0.763
Philippines	2	99.125	0.009	0.091	0.684	0.091
	3	98.895	0.135	0.126	0.753	0.091
	4	98.889	0.138	0.126	0.755	0.093
	5	98.887	0.138	0.127	0.755	0.093
	6	98.887	0.138	0.127	0.755	0.093
	7	98.887	0.138	0.127	0.755	0.093
	8	98.887	0.138	0.127	0.755	0.093
	9	98.887	0.138	0.127	0.755	0.093
	10	98.887	0.138	0.127	0.755	0.093
S. Korea	2	99.572	0.029	0.052	0.004	0.343
	3	98.904	0.075	0.309	0.150	0.562
	4	98.864	0.084	0.329	0.158	0.564
	5	98.862	0.084	0.329	0.160	0.564
	6	98.861	0.085	0.329	0.160	0.564
	7	98.861	0.085	0.329	0.160	0.564
	8	98.861	0.085	0.329	0.160	0.564
	9	98.861	0.085	0.329	0.160	0.564
	10	98.861	0.085	0.329	0.160	0.564
Taiwan	2	99.360	0.071	0.528	0.021	0.020
	3	98.980	0.072	0.845	0.049	0.054

County	Days Ahead	Own Innovation	US Innovation	Eurozone Innovation	Japan Innovation	China Innovation
	4	98.914	0.102	0.882	0.049	0.054
	5	98.912	0.102	0.883	0.049	0.054
	6	98.909	0.103	0.885	0.049	0.054
	7	98.909	0.103	0.885	0.049	0.054
	8	98.909	0.103	0.885	0.049	0.054
	9	98.909	0.103	0.885	0.049	0.054
	10	98.909	0.103	0.885	0.049	0.054
Thailand	2	99.124	0.602	0.110	0.130	0.033
	3	98.620	0.604	0.553	0.185	0.039
	4	98.541	0.645	0.574	0.200	0.039
	5	98.540	0.645	0.575	0.200	0.040
	6	98.538	0.645	0.576	0.200	0.040
	7	98.538	0.645	0.576	0.200	0.040
	8	98.538	0.645	0.576	0.200	0.040
	9	98.538	0.645	0.576	0.200	0.040
	10	98.538	0.645	0.576	0.200	0.040

Table no. 5 – Forecast error decomposition of daily market returns: post-crash period

County	Days Ahead	Own Innovation	US Innovation	Eurozone Innovation	Japan Innovation	China Innovation
Malaysia	2	98.602	0.304	0.237	0.820	0.037
	3	98.234	0.564	0.243	0.878	0.081
	4	98.212	0.568	0.249	0.878	0.093
	5	98.208	0.570	0.251	0.878	0.094
	6	98.207	0.570	0.251	0.878	0.094
	7	98.207	0.570	0.251	0.878	0.094
	8	98.207	0.570	0.251	0.878	0.094
	9	98.207	0.570	0.251	0.878	0.094
	10	98.207	0.570	0.251	0.878	0.094
Philippines	2	99.201	0.114	0.072	0.025	0.589
	3	98.397	0.516	0.441	0.025	0.620
	4	98.360	0.534	0.460	0.027	0.620
	5	98.356	0.536	0.460	0.027	0.620
	6	98.356	0.536	0.460	0.027	0.620
	7	98.356	0.536	0.460	0.027	0.620
	8	98.356	0.536	0.460	0.027	0.620
	9	98.356	0.536	0.460	0.027	0.620
	10	98.356	0.536	0.460	0.027	0.620
S. Korea	2	98.635	0.903	0.035	0.275	0.153
	3	98.328	1.029	0.059	0.275	0.309
	4	98.309	1.041	0.059	0.279	0.312
	5	98.308	1.041	0.060	0.279	0.312

County	Days Ahead	Own Innovation	US Innovation	Eurozone Innovation	Japan Innovation	China Innovation
	6	98.308	1.041	0.060	0.279	0.312
	7	98.308	1.041	0.060	0.279	0.312
	8	98.308	1.041	0.060	0.279	0.312
	9	98.308	1.041	0.060	0.279	0.312
	10	98.308	1.041	0.060	0.279	0.312
Taiwan	2	99.890	0.024	0.000	0.081	0.004
	3	98.988	0.494	0.124	0.293	0.100
	4	98.951	0.523	0.131	0.294	0.100
	5	98.949	0.524	0.131	0.295	0.101
	6	98.949	0.524	0.131	0.295	0.101
	7	98.949	0.524	0.131	0.295	0.101
	8	98.949	0.524	0.131	0.295	0.101
	9	98.949	0.524	0.131	0.295	0.101
	10	98.949	0.524	0.131	0.295	0.101
Thailand	2	99.533	0.060	0.041	0.354	0.012
	3	97.728	1.355	0.113	0.776	0.029
	4	97.660	1.397	0.137	0.775	0.031
	5	97.650	1.401	0.141	0.776	0.031
	6	97.649	1.401	0.142	0.776	0.031
	7	97.649	1.402	0.142	0.776	0.031
	8	97.649	1.402	0.142	0.776	0.031
	9	97.649	1.402	0.142	0.776	0.031
	10	97.649	1.402	0.142	0.776	0.031

As can be seen, during both the pre- and the post-global financial meltdown for each selected country, more than 98% of the movement in return is explained by its own random price innovations. The combined and individual impact of the price innovations from the U.S., the Eurozone, Japan, and China on the volatility of returns of selected countries is relatively trivial during either the pre- or the post-financial meltdown periods. However, the individual impact of the U.S. innovations is generally higher during the post-financial crisis, indicating that dependency of the Southeast Asian equity markets on U.S. equity has increased.

We employ a maximum likelihood approach to estimate GARCH (1,1) models (3) through (7) under three assumptions: (i) the return volatility of the endogenous country is only affected by internal ARCH and GARCH shocks, (ii) the return volatility of the endogenous country is influenced by both internal shocks and by shocks from one of the endogenous countries (i.e., the U.S., the Eurozone, Japan, and China) one at a time, and (iii) the return volatility is affected by internal shocks and by price innovations from the U.S., the Eurozone, Japan, and China all at the same time. We estimate GARCH (1,1) models under (i) through (iii) assumptions using the pre- and the post-global financial crisis data. The results are presented in Table no. 6 and Table no. 7, respectively.

Table no. 6 – Maximum likelihood estimates of GARCH models with shocks from US, Eurozone, Japan, and China: pre-crash period

Country	α_1	β_1	δ_{US}	$\delta_{Eurozone}$	δ_{Japan}	δ_{China}	$\alpha_1+\beta_1$
Malaysia	0.283***	0.699***					0.982
	0.211***	0.598***	-0.087***				0.809
	0.216***	0.747***		-0.027***			0.963
	0.238***	0.709***			-0.047***		0.947
	0.280***	0.702***				-0.002	0.982
	0.361***	0.340***	-0.091***	-0.010***	-0.042***	-0.053***	0.701
Philippines	0.072***	0.873***					0.945
	0.068***	0.876***	-0.021				0.944
	0.069***	0.878***		-0.006			0.947
	0.061***	0.895***			-0.043***		0.956
	0.071***	0.878***				0.018	0.949
	0.082***	0.842***	-0.125***	0.114***	-0.027	0.021	0.924
S. Korea	0.077***	0.909***					0.986
	0.070***	0.914***	-0.078**				0.984
	0.063***	0.917***		-0.080***			0.980
	0.083***	0.880***			-0.130***		0.963
	0.077***	0.910***				0.002	0.987
	0.081***	0.884***	-0.007	0.02	-0.140***	0.02	0.965
Taiwan	0.100***	0.891***					0.991
	0.074***	0.913***	-0.095***				0.987
	0.052***	0.929***		-0.126***			0.981
	0.101***	0.871***			-0.124***		0.972
	0.103***	0.888***				-0.007	0.991
	0.195***	0.688***	0.282***	-0.201***	-0.192***	-0.081***	0.883
Thailand	0.083***	0.646***					0.729
	0.086***	0.634***	-0.062				0.720
	0.083***	0.638***		-0.009			0.721
	0.114***	0.465***			-0.240***		0.579
	0.065***	0.804***				0.091***	0.869
	0.103***	0.609***	0.026	0.033	-0.212***	0.106***	0.712

Note: ***Significant at the 1% level, **Significant at the 5% level, * Significant at the 10% level.

According to Table no. 6, under assumption (i), both coefficients of ARCH term (α_1s) and coefficients of GARCH term (β_1s) are statistically significant at the 1% level for all selected countries. This suggests that today's home country stock return volatility is affected by previous day's information about price innovation (ARCH effect) and by previous day's return volatility (GARCH effect). Furthermore, Table no. 6 reveals that under assumption (ii) ARCH and GARCH effects are significant for all endogenous countries. In addition, the price innovations from the U.S. and the Eurozone affect all of the endogenous countries except for the Philippines and Thailand. While endogenous countries are affected by their own shocks and shocks from Japan, China's price innovations do not influence any endogenous countries

except for Thailand. Finally, under assumption (iii) the price innovations in Malaysia and Taiwan are affected not only by their own innovations, but also are affected by all endogenous countries, implying these two countries are highly integrated with the international equity markets. Besides being affected by their own price innovations, the Philippines is affected by the U.S. and the Eurozone; however Thailand seems to be more integrated with Southeast Asian markets. The results also suggest the South Korea equity market is probably the most isolated market among the Southeast Asian markets pre-crisis because it is mostly affected by its own price innovations and some shocks from Japan.

Table no. 7 – Maximum likelihood estimates of GARCH models with shocks from US, Eurozone, Japan, and China: post-crash period

Country	α_1	β_1	δ_{US}	$\delta_{Eurozone}$	δ_{Japan}	δ_{China}	$\alpha_1+\beta_1$
Malaysia	0.103***	0.807***					0.910
	0.073***	0.851***	-0.027***				0.924
	0.088***	0.834***		-0.019***			0.922
	0.100***	0.807***			-0.023***		0.907
	0.105***	0.805***				-0.006	0.910
	0.084***	0.833***	-0.010	-0.005	-0.014*	0.004	0.917
Philippines	0.229***	0.692***					0.921
	0.184***	0.758***	-0.054***				0.942
	0.209***	0.725***		-0.027*			0.934
	0.193***	0.735***			-0.043***		0.928
	0.228***	0.682***				-0.022	0.910
	0.180***	0.759***	-0.039	0.007	-0.027	0.002	0.939
S. Korea	0.097***	0.886***					0.983
	0.083***	0.876***	-0.089***				0.959
	0.094***	0.873***		-0.043***			0.967
	0.096***	0.873***			-0.034***		0.969
	0.093***	0.882***				-0.011*	0.975
	0.084***	0.874***	-0.069***	-0.010	-0.009	-0.001	0.958
Taiwan	0.053***	0.930***					0.983
	0.032***	0.919***	-0.119***				0.951
	0.035***	0.917***		-0.076***			0.952
	0.052***	0.901***			-0.059***		0.953
	0.055***	0.920***				-0.017**	0.975
	0.030**	0.920***	-0.102***	-0.001	-0.018*	-0.001	0.950
Thailand	0.166***	0.794***					0.960
	0.179***	0.770***	-0.047***				0.949
	0.183***	0.774***		-0.033**			0.957
	0.157***	0.790***			-0.036*		0.947
	0.164***	0.791***				-0.012	0.955
	0.172***	0.773***	-0.006	-0.024	-0.020	-0.010	0.945

Note: ***Significant at the 1% level, **Significant at the 5% level, * Significant at the 10% level.

Table no. 7 reports the GARCH models in the post-financial crisis period. We find that ARCH and GARCH effects are still significant when we study Southeast Asian county in isolation of international equity markets. However, the Philippines and Thailand become more integrated with U.S. and Eurozone equity markets during the post-financial crisis period. Further analyses show that, in general, the Southeast Asian equity markets have become less integrated with international equity markets as we find fewer numbers of coefficients are significant under assumption (iii). Finally, as Table no. 6 and Table no. 7 show, the sum of α_1 and β_1 is less than unity, suggesting the impact of price innovations on market volatility has a persistent effect on conditional variance in all countries.

4. SUMMARY AND CONCLUSION

In this paper, we employ two sets of econometric models, VAR and GARCH, to investigate the impact of the 2008 global financial crisis on the transmission of price innovations from the U.S., the Eurozone, Japan, and China as exogenous countries, to selected Southeast Asian equity markets as endogenous countries. The results indicate the post-crisis period has generally brought higher correlations of returns among countries of the sample, especially between the U.S. stock market and selected Southeast Asian economies. Additionally, the findings suggest price innovations from the U.S. and the Eurozone affect all of the endogenous countries except the Philippines and Thailand in the pre-crisis period. However, it is observed that endogenous countries are significantly more influenced by their own shocks rather than shocks from outside the region during both the pre- and the post-financial crisis periods.

One interesting finding is China does not have any statistically significant effect on any of the countries except Thailand. This is contrary to the expectation that China should affect many or all of the endogenous countries due to proximity and being the second largest economy in the world. With this said, China mainly exports with little importing from low cost labor countries, and this may be a reason China has little effect. Another possible explanation may be China's stock market has not developed or integrated into the world economy at the same extent as the U.S. or the Eurozone stock markets.

Of the endogenous country group, Malaysia, South Korea, and Taiwan are affected by all of the exogenous countries in pre- and post-crisis, except in the case of China, which only influences South Korea and Taiwan during the post-crisis. These three countries have more matured capital markets and have been part of the global economy for many years. We also observe that the Philippines and Thailand become more integrated with the U.S. and the Eurozone equity markets during the post-crisis. This may be due to the dependence of these countries on the U.S. and the Eurozone both economically and politically.

The significant transmission of price innovations from the U.S. and the Eurozone to Southeast Asian equity markets may be due to the global strength and dominance of the U.S. and the Eurozone economies, and increased trade between endogenous counties and the U.S. and the Eurozone. Consequently, one can conclude despite the fact that the 2008 global financial crisis originated from the U.S. and spread over the globe, the Southeast Asian countries, to a significant degree, continue to be internationally integrated.

The findings of this study provide valuable information to the international portfolios managers regarding the makeup and diffusion of price innovations among Southwest Asian stock markets, which may help them to construct optimal portfolios. The results may also aid the policy makers in the formulation of international finance and trade policies.

References

Afnouch, A., and Hammami, S., 2014. Contagion durning the 2008 financial crisis: The case of BRIC group financial markets and five developed markets. *Journal of Business Studies Quarterly, 6*(2), 159-186.

Aktan, B., Mandaci, P. E., Kopurlu, B. S., and Ersener, B., 2009. Behaviour of emerging stock markets in the global fnancial meltdown: Evidence from Bric-A. *African Journal of Business Management, 3*(7), 396-404. DOI: http://dx.doi.org/10.5897/AJBM09.121

Bailey, W., and Stulz, R. M., 1990. Benefits of international diversification: The case of Pacific Basin stock markets. *Journal of Portfolio Management, 16*(4), 57-61. DOI: http://dx.doi.org/10.3905/jpm.1990.409287

Baltzer, M., Cappiello, L., De Santis, R. A., and Manganelli, S., 2008. Measuring Financial Intergration in New EU Member States. *European Central Bank Occasional Paper, 81*.

Chakrabarti, G., 2011. Financial crisis and the changing nature of volatility contagion in the Asia-Pacific region. *Journal of Asset Management, 12*(3), 172-184. DOI: http://dx.doi.org/10.1057/jam.2011.29

Cheung, Y. L., and Ho, Y. K., 1991. The intertemporal stability of the relationships between the Asian emerging equity markets and the developed equity markets. *Journal of Business Finance & Accounting, 18*(2), 235-253. DOI: http://dx.doi.org/10.1111/j.1468-5957.1991.tb00591.x

Dimpfl, T., and Jung, R. C., 2012. Financial market spillovers around the globe. *Applied Financial Economics, 22*(1), 45-57. DOI: http://dx.doi.org/10.1080/09603107.2011.597721

Forbes, K. J., and Rigobon, R., 2002. No contagion, only interdependence: Measuring stock market comovements. *The Journal of Finance, 57*(5), 2223-2261. DOI: http://dx.doi.org/10.1111/0022-1082.00494

Gębka, B., and Serwa, D., 2006. Are financial spillovers stable across regimes?: Evidence from the 1997 Asian crisis. *Journal of International Financial Markets, Institutions and Money, 16*(4), 301-317. DOI: http://dx.doi.org/10.1016/j.intfin.2005.03.002

Heymans, A., and da Camara, R., 2013. Measuring spill-over effects of foreign markets on the JSE before, during and after international fiancial crisis. *South African Journal of Economic and Management Sciences, 16*(4), 418-434.

Islam, R., 2014. Comparing financial contagion and volatility spill over and structural break within major Asian economies pre and post global recession to that of Asian crisis. *Journal of Applied Business and Economics, 16*(4), 92-111.

Kenani, J. M., Purnomo, J., and Maoni, F., 2013. The impact of the global financial crisis on the integration of the Chinese and Indonesian stock markets. *International Journal of Economics and Finance, 5*(9), 69-81. DOI: http://dx.doi.org/10.5539/ijef.v5n9p69

Koch, P. D., and Koch, T. W., 1991. Evolution in dynamic linkages across daily national stock indexes. *Journal of International Money and Finance, 10*(2), 231-251. DOI: http://dx.doi.org/10.1016/0261-5606(91)90037-K

Longin, F., and Solnik, B., 2001. Extreme correlation of international equity markets. *The Journal of Finance, 56*(2), 649-676. DOI: http://dx.doi.org/10.1111/0022-1082.00340

Nam, J. H., Yuhn, K. H., and Kim, S. B., 2008. What happened to Pacific-Basin emerging markets after the 1997 financial crisis? *Applied Financial Economics, 18*(8), 639-658. DOI: http://dx.doi.org/10.1080/09603100701222275

Ng, A., 2000. Volatility spillover effects from Japan and the U.S. to the Pacific-Basin. *Journal of International Money and Finance, 19*(2), 207-233. DOI: http://dx.doi.org/10.1016/S0261-5606(00)00006-1

Peša, A. R., and Festić, M., 2012. Testing the "EU announcement effect" on stock market indices and macroeconomic variables in Croatia between 2000 and 2010. *Prague Economic Papers, 21*(4), 450-469. DOI: http://dx.doi.org/10.18267/j.pep.434

Shachmurove, Y., 2005. Dynamic linkages among the emerging Middle Eastern and the United States markets. *International Journal of Business, 10*(1), 103-132.

Stoica, O., Perry, M. J., and Mehdian, S., 2015. An empirical analysis of the diffusion of information across stock markets of Central and Eastern Europe. *Prague Economic Papers, 24*(2), 192-210. DOI: http://dx.doi.org/10.18267/j.pep.508

Wongswan, J., 2006. Transmission of information across international equity markets. *Review of Financial Studies, 19*(4), 1157-1189. DOI: http://dx.doi.org/10.1093/rfs/hhj033

Yalama, A., 2009. Stock market linkages in emerging markets: Evidence from Turkey and Brazil. *Banks and Bank Systems, 4*(3), 71-78.

Yamamoto, S., 2014. Transmission of US financial and trade shocks to Asian economies: Implications for spillover of the 2007 - 2009 US financial crisis. *The North American Journal of Economics and Finance, 27*, 88-103. DOI: http://dx.doi.org/10.1016/j.najef.2013.12.002

Notes

[1] http://data.worldbank.org/indicator/ny.gdp.mktp.cd?page=1.

[2] http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx.

[3] http://www.world-exchanges.org/home/index.php/statistics/monthly-reports.

[4] The ADF test results are not reported in this paper to conserve space, the tests are available by the authors upon request.