Comovement of East Asian Stock Markets[1]

PARK Jinwoo[2]

(Abstract)

This paper examines the comovement of five equity markets in the East Asian region (i.e., Japan, China, Korea, Hong Kong, and Taiwan) and the dependence structure of these to the U.S. stock market. In particular, by separately investigating the U.S. influence on the night-time returns and the comovement of day-time returns in the East Asian stock market, this paper contributes to understanding the linkages across the East Asian and the U.S. stock markets. The results are summarized as follows. First, except China we find high cross-sectional correlation of the daily stock returns across the East Asian and the U.S. markets. A comparison of the results between the two sub-periods demonstrates a recent strengthening of the linkages. In particular, China records profound increases in its correlations with the other East Asian and the U.S. markets. Second, we find that with the exception of China the stock returns on the U.S. market exert a significant impact on the night-time market returns of Korea, Taiwan, Hong Kong, and Japan (in order). We also observe that a volatility surprise in the U.S. market affects the night-time return volatility in the stock markets of Taiwan, Korea, Hong Kong, and Japan (in order). Third, we find that there exist negative return spillover effects from the U.S. market to the day-time returns in the stock markets of Korea, Hong Kong, and Taiwan. In addition, spillover effects of daily return volatility from the U.S. market to the day-time return volatility of the stock markets of Korea, Taiwan, Japan, and Hong Kong (in order). Finally, we observe profound comovement of day-time stock returns across East Asian stock markets except for China. However, China exhibits significant increases in its correlations with the other East Asian markets between the two sub-periods.

Key words: East Asian stock markets, comovement, linkages, spillover effects, correlation

1. Introduction

The easing of barriers to the flow of capital across national boundaries has attracted a widespread interest in the study of international capital market relationships. The cross-national analysis of stock markets is an important issue because it may have significant implications for the question of possible diversification gains from international investments. It is also important because it may have significant implications for the development of international asset pricing theory, the financial policies of multinational firms, and the regulation of the markets and their mechanisms.

East Asian capital markets have experienced the phenomenal growth rates and have attracted a great deal of attention from investors in the global markets. Furthermore, the recent global financial crisis focused more attention on the linkages among the stock markets of East

[2] Professor, College of Business Administration, Hankuk University of Foreign Studies

Asian countries. However, the extant research on international capital market relationships has focused, primarily, on the financial markets of developed countries (e.g., see Arshanapalli and Doukas(1993), Becker, Finnerty, and Gupta (1990), Eun and Shim (1989), Hilliard (1979), and Joy, Panton, Reilly, and Martin (1976) Levy and Sarnat(1970)). Despite the growing importance of East Asian stock markets, less attention has been paid to Asian stock markets (e.g., see Ghoshi, Saidi, and Johnson (1999), Park and Fatemi (1993), and Wei, Liu, Yang, and Chaung (1995)).

This study investigates the question of linkages between the stock markets of East Asian countries. Specifically, this paper examines the comovement of five equity markets in the East Asian region (i.e., Japan, China, Korea, Hong Kong, and Taiwan) and the dependence structure of these to the U.S. stock market. In particular, this paper utilizes the data of night-time and day-time stock market returns. Due to time-zone difference between the U.S. and the East Asian countries, the U.S. stock market may have an influence on the East Asian night-time stock returns and the day-time stock returns of the East Asian markets may move together. The existing studies, which used the data of daily stock returns, could not investigate the U.S. influence on the night-time returns and the comovement of day-time returns in the East Asian stock markets. By separately investigating the U.S. influence on the night-time returns and the comovement of day-time returns in the East Asian stock market, this paper contributes to understanding the linkages across the East Asian and the U.S. stock markets.

Specifically, the following issues are investigated in this study. First, this paper examines the cross-sectional correlation of the daily stock returns across the East Asian and the U.S. markets. Second, using GARCH model, this paper investigates the spillover effects from the U.S. market to the East Asian night-time stock returns. Third, this paper investigates the spillover effects from the U.S. market to the East Asian day-time stock returns. Finally, this paper examines the comovement of the East Asian day-time stock returns.

The rest of the paper is organized as follows. The next section describes the data and methodology used in this study. Section 3 presents empirical results, which are divided into five parts; 1) daily stock market return patterns, 2) the cross-sectional correlation of the daily stock market returns, 3) spillover effects from the U.S. market to the East Asian night-time stock returns, 4) spillover effects from the U.S. market to the East Asian day-time stock returns, and 5) comovement of the East Asian night-time stock returns. Finally, summary and concluding remarks are presented in the last section.

2. Data and Methodology

2.1. Data

The data used are the daily rate of returns on the market indices of five East Asian countries and the U.S. We also use the night-time rate of returns and the day-time rate of returns, which is respectively measured by changes from the closing index on the previous trading day

to opening index on the next trading day and from opening index to closing index on the same trading day. The indices selected to represent each stock market are as follows: Nikkei225 for Japan, KOSPI for Korea, SSEC for China, Hang Seng for Hong Kong, TWII for Taiwan, and S&P500 for the U.S. The sample period covered in this paper is the six-year period from July 1, 2009 to June 30, 2015. In order to evaluate the stability of the results, this paper analyzes the data divided into two parts--period 1 (July 1, 2009 to June 30, 2012) and period 2 (July 1, 2012 to June 30, 2015)--as well as the full sample period. The data source is FnGuide.

2.2. Methodology

In addressing the question of international capital market interrelationships, the researchers have employed a variety of research methodologies. Earlier studies, such as those conducted by Levy and Sarnat (1970), Joy, Panton, Reilly, and Martin (1976), and Hillard (1979), were concerned principally with the contemporaneous and/or lagged correlations in the rates of return across equity markets in developed countries. Recent research into this topic has generally been more concerned with the transmission mechanisms of stock returns and variances across international equity markets. Eun and Shim (1989) evaluated the structures of interdependence among stock markets in nine major nations, using vector autoregression (VAR) analysis. Hamao, Masulis, and Ng (1990), on the other hand, evaluated the short-run interdependence of prices and price volatility across three major international markets (U.S., U.K., and Japan), using MA(1)-GARCH(1,1)-M model.

Following Hamao, Masulis, and Ng (1990), this paper utilizes correlation analysis and the extended GARCH (generalized autoregressive conditional heteroskedastic) model as an investigative technique. This paper adopts the GARCH(1,1) model using the results of AIC (Akaike's Information Criterion) and SBC (Schwartz-Bayesian Criterion) tests. Additionally, considering the autocorrelation of the conditional mean as determined by Ljung-Box statistics, the MA(1) process was included in the GARCH model.[3] As a consequence, the following MA(1)-GARCH(1,1) model was utilized in this paper:

$$R^i_t = \alpha + \varepsilon_t + \theta\varepsilon_{t-1}, \ \varepsilon_t | \Omega_{t-1} \sim N(0, h_t)$$
$$h_t = a + b\epsilon^2_{t-1} + ch_{t-1}$$

In this equation, R^i_t is the daily rate of return on stock market i, and h_t represents the conditional variance of R^i_t at day t. Ω_{t-1} refers to the set of all the available information up to day t-1.

As a second stage of modeling, this paper employs the following model in order to measure the spillover effects of mean and variance between stock markets.

---

[3] Ljung-Box statistics of six-day lag are 11.71 for the U.S., 11.39 for Japan, 11.80 for China, 16.85 for Korea, 16.94 for Hong Kong and 15.34 for Taiwan, which are all statistically significant at 0.05 level.

$$R_t^i = \alpha + \beta R_t^j + \epsilon_t + \theta\epsilon_{t\text{-}1}, \ \epsilon_t | \Omega_{t\text{-}1} \sim N(0, h_t)$$
$$h_t = a + b\epsilon_{t\text{-}1}^2 + ch_{t\text{-}1} + \delta\epsilon_{R_t^j}^2$$

In this equation R_t^i and R_t^j represent the daily rates of return on stock markets i and j, respectively. Additionally, the volatility shock, $\epsilon_{R_t^i}^2$ and $\epsilon_{R_t^j}^2$, which are estimated from the MA(1)-GARCH(1,1) model of stock markets i and j are added to the equation. Therefore, the coefficients, β and δ, measure the transmission effects of the mean and variance, respectively. In other words, the significance of these coefficients shows that information occurring in stock market j influences return and volatility in stock market i.

3. Empirical Results

3.1. Descriptive Statistics

The descriptive statistics for the daily rates of return on the market indices of the U.S., Japan, China, Korea, Hong Kong, and Taiwan for the period from July 1 2009 to June 30 2015 are reported in Table 1. The majority of markets, with the exception of China, evidence positive mean returns owing to recovering from market collapses resulted from global financial crisis. Among those, Hong Kong and the U.S. recorded the highest average daily returns of 0.0432 and 0.0331, respectively. Korea, Japan, and Taiwan are next in the order, with mean returns of 0.0271, 0.0118, and 0.0026, respectively. In terms of market volatility, as measured by the standard deviation of daily stock market returns, China evidences the highest value, followed by Korea, Hong Kong, Taiwan, Japan, and the U.S. (in order).

<Table 1> Descriptive Statistics of Daily Stock Market Returns

	USA	Japan	China	Korea	Hong Kong	Taiwan
Entire Period (2009. 7. 1. ~ 2015. 6. 30.)						
Mean	0.0331	0.0188	-0.0145	0.0271	0.0432	0.0026
Median	0.0800	0.0400	0.0400	0.1200	0.0700	0.0100
Maximum	4.6200	4.1800	8.8900	5.5300	10.1800	5.4800
Minimum	-4.2400	-5.8200	-9.2600	-7.1800	-9.0500	-6.9100
Std. Dev.	0.9623	1.2962	1.7197	1.4135	1.3190	1.3135
Skewness	0.0051	-0.3857	-0.3830	-0.3963	-0.0733	-0.3054
Kurtosis	4.8667	4.2919	6.7246	4.5211	9.6696	5.9678
Jarque-Bera	183.4	119.1	760.9	154.8	2342.0	483.1
Observations	1263	1263	1263	1263	1263	1263
Period 1 (2009. 7. 1. ~ 2012. 6. 30.)						
Mean	0.0358	0.0259	-0.0594	0.0193	0.0279	0.0133
Median	0.0700	0.0500	-0.0700	0.0600	0.0200	-0.0200
Maximum	4.6200	3.5400	7.8900	4.8800	4.0500	5.4800
Minimum	-4.2400	-5.2300	-3.9600	-5.9000	-4.1800	-6.9100
Std. Dev.	0.9672	1.2330	1.2781	1.4899	0.9892	1.3324
Skewness	0.0954	-0.3858	0.8681	-0.2719	-0.0241	0.0757
Kurtosis	4.9369	4.2378	6.2535	4.0299	4.4192	6.2002

Jarque-Bera	99.0	55.6	355.3	35.4	52.7	268.2
Observations	627	627	627	627	627	627
Period 2 (2012. 7. 1. ~ 2015. 6. 30.)						
Mean	0.0304	0.0119	0.0298	0.0349	0.0582	-0.0079
Median	0.0800	0.0400	0.2400	0.1700	0.1500	0.0350
Maximum	4.1500	4.1800	8.8900	5.5300	10.1800	5.1200
Minimum	-3.0100	-5.8200	-9.2600	-7.1800	-9.0500	-6.7400
Std. Dev.	0.9583	1.3567	2.0647	1.3350	1.5787	1.2956
Skewness	-0.0865	-0.3806	-0.6827	-0.5585	-0.0966	-0.7152
Kurtosis	4.7921	4.2619	5.6038	5.1415	8.7015	5.6766
Jarque-Bera	85.9	57.6	229.1	154.6	862.4	244.1
Observations	636	636	636	636	636	636

The skewness of the stock market distribution indicates non-symmetric distribution. All the East Asian markets exhibit negative skewness. In addition, the kurtosis of the stock market distribution indicates fat tails as compared with normal distribution. All the markets in the sample show a large kurtosis. For all the market returns in the sample, therefore, Jarque-Bera statistics to test the normality of distribution reject the hypothesis that the stock market returns are distributed normally. Thus, these results indicate that in our time-series analysis of data it is appropriate to utilize a statistical model in which both autocorrelation and heteroskedasticity are considered.

3.2. Correlation Analysis of Daily Returns

Correlation analysis is the statistical methodology that has been utilized most frequently in previous studies to evaluate the comovement of stock markets. Therefore, this paper begins with a correlation analysis designed to examine the inter-dependence structure of five East Asian markets of Japan, China, Korea, Hong Kong, and Taiwan and the U.S. market. In this paper, considering the trading time lag between the Asian countries and the U.S., the lagged daily returns (t-1) are used for the U.S. stock market data. The results are provided in Table 2. Consistent with previous empirical evidence, the correlation coefficients across all the markets in the sample are shown to be significantly positive. This result indicates strong comovement across East Asian markets and the U.S. market over entire sample period from July 1, 2009 to June 30, 2015. However, in terms of intensity, there are some variations across the markets.

<Table 2> Correlation Coefficients of Daily Stock Market Returns

Entire Period (2009. 7. 1. ~ 2015. 6. 30.)					
	USA(t-1)	Japan	China	Korea	Hong Kong	Taiwan
USA(t-1)	1.000					
Japan	0.441**	1.000				
China	0.099**	0.175**	1.000			
Korea	0.370**	0.645**	0.184**	1.000		
Hong Kong	0.414**	0.588**	0.318**	0.612**	1.000	
Taiwan	0.368**	0.532**	0.166**	0.650**	0.545**	1.000

Period 1 (2009. 7. 1. ~ 2012. 6. 30.)					
	USA(t-1)	Japan	China	Korea	Hong Kong	Taiwan
USA(t-1)	1.000					
Japan	0.415**	1.000				
China	0.016	0.070	1.000			
Korea	0.318**	0.587**	0.078*	1.000		
Hong Kong	0.361**	0.521**	0.089*	0.596**	1.000	
Taiwan	0.290**	0.460**	0.011	0.610**	0.530**	1.000
Period 2 (2012. 7. 1. ~ 2015. 6. 30.)					
	USA(t-1)	Japan	China	Korea	Hong Kong	Taiwan
USA(t-1)	1.000					
Japan	0.467**	1.000				
China	0.155**	0.238**	1.000			
Korea	0.429**	0.709**	0.269**	1.000		
Hong Kong	0.466**	0.640**	0.406**	0.666**	1.000	
Taiwan	0.447**	0.601**	0.272**	0.697**	0.582**	1.000

* 5% significance level, ** 1% significance level

When we examine the correlation coefficients of daily stock returns between the U.S. and five East Asian markets, Japan records the highest value, at 0.441, followed by Hong Kong, Korea, and Taiwan at 0.414, 0.370, and 0.368, respectively. However, China exhibits the lowest value at 0.099. Across East Asian markets, Japan exhibits profound correlations with Korea, Hong Kong, and Taiwan at 0.645, 0.588, and 0.532, respectively. However, the correlation coefficient between Japan and China is not significant. China has significantly positive correlation with Hong Kong, Korea, and Taiwan at 0.318, 0.184, and 0.166, respectively. In addition, the correlation coefficients across Korea, Hong Kong, and Taiwan are significantly positive, ranging over 0.5.

To assess the stability of the results, this paper analyzes the data divided into two sub-periods: July 1, 2009-June 30, 2012 and July 1, 2012-June 30, 2015. First of all, we find that for all the cases in the sample, the correlation coefficients increase from the first period to the second period. The U.S. influence on the East Asian markets increased and the cross correlations among East Asian markets also increased. In particular, China recorded noticeable increases in correlations. For example, China evidenced insignificant correlation coefficients with the U.S., Japan, and Taiwan and weak correlation coefficients with Hong Kong and Korea during the first sub-period. However, all the correlation coefficients between China and the U.S. and the rest of East Asian markets became significant during the second sub-period. These results demonstrate that the comovement of the East Asian stock markets and their inter-dependence structures with the U.S. have strengthened over time.

3.3. Spillover Effects from the U.S. Market to the East Asian Night-time Stock Returns

All the prior empirical research, which investigates the linkages across stock markets of developed countries, unanimously agrees that the U.S. market plays a leading role. Our results also indicate that the U.S. market has a significant influence on the East Asian markets. Thus,

using the extended GARCH model, in which the U.S. market returns are included as exogenous variables, this paper analyzes the spillover effects from the U.S. to five East Asian markets including Japan, China, Korea, Hong Kong, and Taiwan. However, if the market is efficient, the U.S. market influence on the East Asian markets should be fully reflected during night time since the U.S. market closes before the opening of East Asian markets. Thus, this paper investigates the U.S. influence on the night-time returns and the day-time returns in the East Asian stock market, separately. The results of spillover effects from the U.S. market to the East Asian night-time stock returns are reported in Table 3.

<Table 3> Spillover Effects from the U.S. to East Asian Night Stock Returns

$$NR_t^i = \alpha + \beta R_{t\text{-}1}^{USA} + \varepsilon_t + \theta\varepsilon_{t\text{-}1} \quad \varepsilon_t | \Omega_{t\text{-}1} \sim N(0, \ h_t),$$

$$h_t = a + b\varepsilon_{t\text{-}1}^2 + ch_{t\text{-}1} + \delta\varepsilon_{R_{t\text{-}1}^{USA}}^2$$

	Japan	China	Korea	Hong Kong	Taiwan
	Entire Period (2009. 7. 1. ~ 2015. 6. 30.)				
α	0.0390**	-0.0164**	0.0503**	0.0216*	0.1387**
β	0.5287**	0.0052	0.7550**	0.5648**	0.6569**
θ	-0.0410	0.0031	-0.0962**	-0.0320	0.0471
a	0.0064*	0.0006**	0.0095**	0.0033**	0.0181**
b	0.0576**	0.0794**	0.0880**	0.1126**	0.1098**
c	0.8811**	0.9366**	0.8256**	0.8697**	0.7012**
δ	0.0044*	0.0001	0.0152**	0.0045*	0.0521**
R²	0.5781	0.0011	0.6700	0.4954	0.5501
	Period 1 (2009. 7. 1. ~ 2012. 6. 30.)				
α	0.0556**	0.0035	0.0546**	-0.0109	0.1554**
β	0.4934**	-0.0185	0.7574**	0.4980**	0.6170**
θ	-0.0403	0.0716	-0.1259**	0.0000	0.1171*
a	0.0047	0.0656**	0.0068*	0.0042*	0.0148**
b	0.0659*	0.0986	0.0766**	0.0761**	0.2261**
c	0.8838**	0.5833**	0.8795**	0.8854**	0.7000**
δ	0.0037	-0.0057**	0.0069	0.0027	0.0262**
R²	0.5299	-0.0058	0.6401	0.5674	0.4732
	Period 2 (2012. 7. 1. ~ 2015. 6. 30.)				
α	0.0213	-0.0249*	0.0516**	0.0636**	0.1452**
β	0.5618**	0.0407**	0.7600**	0.7173**	0.7379**
θ	-0.0481	-0.0066	-0.0493	-0.0915*	-0.0715
a	0.0086	0.0003	0.0177**	0.0083**	0.0227**
b	0.0512*	0.0645**	0.0807**	0.1565**	0.0061
c	0.8719**	0.9527**	0.7040**	0.8067**	0.6963**
δ	0.0062*	-0.0005	0.0348**	0.0172*	0.0679**
R²	0.6270	0.0269	0.7016	0.5364	0.6382

* 5% significance level, ** 1% significance level

As mentioned earlier, the coefficients, β and δ, are used to measure the transmission mechanisms of return and volatility, respectively. First, we note that with the exception of China, the β coefficients are all significantly positive at the 1% level, thereby implying that the stock returns on the U.S. market exert a significant impact on the night-time market returns of Japan, Korea, Hong Kong, and Taiwan. Among those, Korea is most sensitive to the daily changes of U.S. market returns, and Taiwan, Hong Kong, and Japan are next in order in terms of U.S. influence. However, the results are not stable over time. We find that the U.S. influence on the night-time returns of five East Asian markets increase from the first period to the second period. In particular, China recorded noticeable increases in the U.S. influence. For China the β coefficient became significantly positive at the 1% level during the second sub-period whereas it was not significant during the first sub-period. Also, Hong Kong shows a large increase in the β coefficient from 0.4980 for the first sub-period to 0.7173 for the second sub-period.

In Table 3, we note that for the entire sample period the   coefficients are significantly positive for East Asian markets except China, thereby implying that a volatility surprise in the U.S. market affects the night-time return volatility in the stock markets of Taiwan, Korea, Hong Kong, and Japan (in order). However, U.S. market volatility exerts no impact on return volatility in the stock market of China.

3.4. Spillover Effects from the U.S. Market to the East Asian Day-time Stock Returns

Due to the time-zone difference between the U.S. and the East Asian markets, the daily changes in the U.S. stock market should be fully reflected on the opening prices of the East Asian markets while they have no impact on the day-time returns of the East Asian markets. Table 4 shows the results of spillover effects from the U.S. market to the East Asian day-time stock returns.

<Table 4> Spillover Effects from the U.S. to East Asian Day-time Stock Returns

$$DR_t^i = \alpha + \beta R_{t-1}^{USA} + \varepsilon_t + \theta\varepsilon_{t-1} \ \ \varepsilon_t | \Omega_{t-1} \sim N(0, \ h_t),$$

$$h_t = \alpha + b\varepsilon_{t-1}^2 + ch_{t-1} + \delta\varepsilon_{R_{t-1}^{USA}}^2$$

	Japan	China	Korea	Hong Kong	Taiwan
	Entire Period (2009. 7. 1. ∼ 2015. 6. 30.)				
α	-0.0166	0.0163	0.0157	0.0129	-0.1245**
β	0.0643	0.0646	-0.2338**	-0.0942**	-0.1822**
θ	-0.0758*	-0.0680*	0.0160	-0.0882*	-0.0692*
a	0.0088	0.0243*	0.0542**	0.0081*	0.0123*
b	0.0553**	0.0619**	0.0752**	0.0502**	0.0495**
c	0.9146**	0.9304**	0.8438**	0.9277**	0.9030**
δ	0.0253**	0.0045	0.0541**	0.0099*	0.0424**
R²	0.0128	0.0050	0.0330	0.0203	0.0316
	Period 1 (2009. 7. 1. ∼ 2012. 6. 30.)				

α	-0.0215	-0.0532	0.0038	0.0297	-0.1400**
β	0.0713	0.0502	-0.2767**	-0.1225**	-0.1647**
θ	-0.0592	-0.0715	0.0410	-0.0278	-0.1183*
a	0.0031	0.2148	0.0628**	0.0161	0.0124
b	0.0448**	0.0572*	0.0632**	0.0389*	0.0459**
c	0.9293**	0.8149**	0.8638**	0.9194**	0.9100**
δ	0.0234**	-0.0180	0.0433*	0.0077	0.0386**
R^2	0.0087	0.0022	0.0435	0.0262	0.0357
Period 2 (2012. 7. 1. ～ 2015. 6. 30.)					
α	-0.0108	0.1188*	0.0229	-0.0072	-0.1100**
β	0.0585	0.1422	-0.2000**	-0.0567	-0.1864**
θ	-0.0930*	-0.0886*	-0.0091	-0.1329**	-0.0305
a	0.0198	0.0152	0.0622*	0.0053	0.0157
b	0.0596**	0.0691**	0.0793**	0.0462**	0.0563**
c	0.8986**	0.9258**	0.8032**	0.9280**	0.8849**
δ	0.0301**	0.0304	0.0778*	0.0249*	0.0498**
R^2	0.0165	0.0052	0.0229	0.0161	0.0262

* 5% significance level, ** 1% significance level

It is interesting to observe that there exist negative return spillover effects from the U.S. market to the day-time returns in the stock markets of Korea, Hong Kong, and Taiwan at 1% significance level. These results suggest that opening prices of stock markets of Korea, Taiwan, and Hong Kong (in order) overreact to the daily changes in the U.S. stock market, resulting in the return reversals during the day-time trading. This type of return reversal does not occur in the markets of Japan and China.[4] In addition, spillover effects of daily return volatility from the U.S. market to the day-time return volatility of East Asian markets, which is measured by the coefficient of δ, exist in the markets of Korea, Taiwan, Japan, and Hong Kong (in order). These results indicate that daily return volatility in the U.S. market is transmitted to the day-time return volatility in the stock markets of Korea, Taiwan, Japan, and Hong Kong. However, U.S. market volatility exerts no impact on the day-time return volatility in the Chinese stock markets.

3.5. Correlation Analysis of Day-time Returns

In Table 2, we examined the correlation coefficients of daily stock returns across five East

---

[4] In order to test whether the overreaction appears only when the U.S. market is significantly moves, spillover effects from the U.S. market to the day-time returns in the East Asian markets are examined for the samples that are divided into two parts based on whether the U.S. market moves more than 1% in absolute value. The result exhibits that the overreaction of Korea, Taiwan, and Hong Kong to the U.S. market is more distinctive when the U.S. market is significantly moves. This interesting result owes to insightful referee's comment.

Asian markets, and observed the comovement of the East Asian stock markets. However, this comovement of stock market returns includes the U.S. market influence on the East Asian stock markets. As we observed earlier, most the U.S. influence on the East Asian markets is reflected on the night-time returns. Therefore, it is more relevant to examine the comovement of East Asian stock markets on the basis of the day-time returns instead of daily returns. In addition, as shown in Figure 1, the trading time between Japan and Korea is exactly the same and most part of the trading time of East Asian stock markets overlaps each other. Thus, day-time returns of East Asian stock markets exchanges influence each other. By examining the correlation coefficients of day-time stock returns across five East Asian markets, therefore, we investigate the comovement of East Asian stock markets.

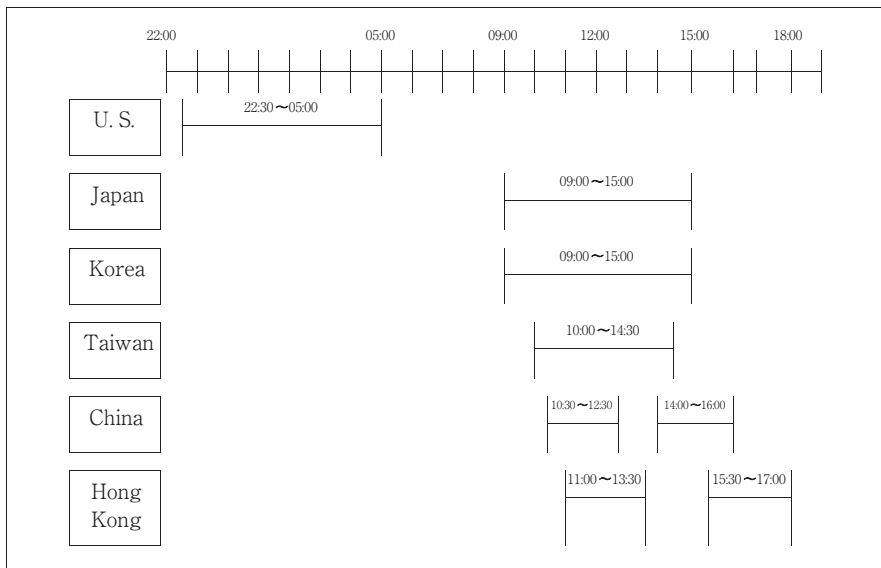<Figure 1> Trading Time of the U.S. and East Asian Markets (in Tokyo time)

Table 5 shows correlation coefficients of day-time stock returns across the East Asian stock markets. We observe the highest correlation between Korea and Taiwan at 0.530. The correlation between Japan and Korea is also very high at 0.518. Korea also exhibits profound correlation with Hong Kong at 0.426. These results indicate that the Korean stock market is very sensitive to the movement in the other East Asian markets. Japan also exhibits high correlation with Hong Kong and Taiwan at 0.338 and 0.322, respectively. In addition, Taiwan shows high correlation with Hong Kong at 0.374. However, China shows relatively low correlation with the other East Asian markets except its high correlation with Hong Kong at 0.250.

<Table 5> Correlation Coefficients of East Asian Day-time Stock Returns

Entire Period (2009. 7. 1. ～ 2015. 6. 30.)					
	Japan	China	Korea	Hong Kong	Taiwan
Japan	1.000				
China	0.137**	1.000			
Korea	0.518**	0.152**	1.000		
Hong Kong	0.338**	0.250**	0.426**	1.000	
Taiwan	0.322**	0.099**	0.530**	0.374**	1.000
Period 1 (2009. 7. 1. ～ 2012. 6. 30.)					
	Japan	China	Korea	Hong Kong	Taiwan
Japan	1.000				
China	0.070	1.000			
Korea	0.452**	0.092*	1.000		
Hong Kong	0.292**	0.091*	0.431**	1.000	
Taiwan	0.260**	0.002	0.506**	0.412**	1.000
Period 2 (2012. 7. 1. ～ 2015. 6. 30.)					
	Japan	China	Korea	Hong Kong	Taiwan
Japan	1.000				
China	0.177**	1.000			
Korea	0.596**	0.207**	1.000		
Hong Kong	0.373**	0.329**	0.442**	1.000	
Taiwan	0.387**	0.175**	0.561**	0.356**	1.000

* 5% significance level, ** 1% significance level

To assess the stability of the results, we divide the sample period into two sub-periods: July 1, 2009-June 30, 2012 and July 1, 2012-June 30, 2015. We find that for most cases in the sample, the correlation coefficients increase from the first period to the second period. In particular, China exhibits significant increases in its correlations with the other East Asian markets. For example, China evidenced insignificant correlation coefficients with Japan, and Taiwan and weak correlation coefficients with Hong Kong and Korea during the first sub-period. However, all the correlation coefficients between China and the rest of East Asian markets became significant during the second sub-period. In addition, Japan exhibits noticeable increase in its correlation with the other East Asian markets between the two sub-periods.

4. Summary and Conclusions

This paper examines the comovement of five equity markets in the East Asian region (i.e., Japan, China, Korea, Hong Kong, and Taiwan) and the dependence structure of these to the U.S. stock market. In particular, by separately investigating the U.S. influence on the night-time returns and the comovement of day-time returns in the East Asian stock market, this paper contributes to understanding the linkages across the East Asian and the U.S. stock markets.

The results are summarized as follows. First, except China we find high cross-sectional correlation of the daily stock returns across the East Asian and the U.S. markets. A comparison of the results between the two sub-periods demonstrates a recent strengthening of the linkages. In particular, China records profound increases in its correlations with the other East

Asian and the U.S. markets. Second, we find that with the exception of China the stock returns on the U.S. market exert a significant impact on the night-time market returns of Korea, Taiwan, Hong Kong, and Japan (in order). We also observe that a volatility surprise in the U.S. market affects the night-time return volatility in the stock markets of Taiwan, Korea, Hong Kong, and Japan (in order). Third, we find that there exist negative return spillover effects from the U.S. market to the day-time returns in the stock markets of Korea, Hong Kong, and Taiwan. In addition, spillover effects of daily return volatility from the U.S. market to the day-time return volatility of the stock markets of Korea, Taiwan, Japan, and Hong Kong (in order). Finally, we observe profound comovement of day-time stock returns across East Asian stock markets except for China. However, China exhibits significant increases in its correlations with the other East Asian markets between the two sub-periods.

In conclusion, this paper shows that with the exception of China the stock market movements of the East Asian countries are closely linked to one another, and are influenced significantly by the U.S. market. These linkages have strengthened over time as these markets have grown in size and as government regulations have eased. In particular, China recently exhibits its linkages to the other East Asian markets. The comovement of East Asian stock markets will grow strong as time has gone on. These results of this paper have some implications regarding the potential benefits from the diversification of portfolios into the East Asian equity markets. The benefits of such diversification appear to be rather small, as the linkages across the East Asian stock markets and the U.S. market are rather strong. Therefore, greater attention should be paid to the East Asian markets by global investors who seek to diversify their investment portfolios.

References

Arshanapalli, B. and J. Doukas. (1993). International Stock Market Linkages: Evidence from the Pre- and Post-October 1987 Period. *Journal of Banking and Finance*, Vol. 17, pp. 193-208.

Becker, K. G., J. E. Finnerty, and M. Gupta. (1990). The Intertemporal Relation between the U.S. and the Japanese Markets. *Journal of Finance*, Vol. 45, pp. 1297-1306.

Eun, C. S. and S. Shim. (1989). International Transmission of Stock Market Movements. *Journal of Financial and Quantitative Analysis*, Vol. 24, pp. 241-256.

Ghoshi, A., R. Saidi, and K. H. Johnson. (1999). Who Moves the Asia-Pacific Stock Markets - US or Japan? Empirical Evidence Based on the Theory of Cointegration. *Financial Review*, Vol. 34, pp. 159-170.

Hamao, Y., R. W. Masulis, and V. Ng. (1990). Correlations in Price Changes and Volatility across International Stock Markets. *Review of Financial Studies*, Vol. 3, pp. 281-307.

Hillard, J. E. (1979). The Relationship between Equity Indices on World Exchanges. *Journal of Finance*, Vol. 34, pp. 103-114.

Joy, O. M., D. B. Panton, F. K. Reilly, and S. A. Martin. (1976). Comovements of Major International Equity Markets. *Financial Review*, Vol. 11, pp. 1-20.

Levy, H. and M. Sarnat. (1970). International Diversification of Investment Portfolios. *American Economic Review*, Vol. 60, pp. 668-675.

Park, J. and A. M. Fatemi. (1993). The Linkages between the Equity Markets of Pacific-basin Countries and Those of the U.S., U.K., and Japan: a Vector Autoregressive Analysis. *Global Finance Journal*, Vol. 4, pp. 49-64.

Wei, K. C. J., Y. J. Liu, C. C. Yang, and G. S. Chaung. (1995). Volatility and Price Change Spillover Effects across the Developed and Emerging Markets. *Pacific-Basin Finance Journal*, Vol. 3, pp. 113-136.