The Dynamics of Returns and Volatility in the Emerging and Developed Asian REIT Markets

Anh Khoi Pham
University of Western Sydney

Abstract
This paper examines the dynamics of return and volatility spillovers across the REIT markets of Japan, Singapore, Hong Kong, Malaysia, Taiwan, Thailand, and South Korea from June 2006 to May 2011. The emerging markets offer lower returns than the developed markets but lower risk as well. The emerging REIT index outperformed the developed REIT index on a risk-adjusted basis. The analysis suggests that correlations among Asian REIT markets are relatively low, ranging from 0.14 to 0.42 over the full-sample period. The results further indicate that correlations among emerging REIT markets are lower than that among developed markets. However, correlations are non-constant over time and increased during the recent Global Financial Crisis. The results from the EGARCH models show that there is a strong tendency for REIT returns to transmit from developed markets (e.g., Japan and Singapore) to emerging REIT markets. In regard to volatility transmission, the mechanism appears to be multidirectional.

Since their establishment in Japan in 2001, real estate investment trusts (REITs) have flourished rapidly across Asia. Asian REITs have become attractive investment vehicles for international funds seeking portfolio diversification (Newell, Liow, Ooi, and Zhu, 2005; Ooi, Newell, and Sing, 2006). As of July 2011, there were more than 95 listed REITs across Asia with a total market capitalization of U.S. $98.7 billion, accounting for 12% of the global REIT market and 5.1% of the global listed real estate securities market (Macquarie Equities Research, 2011). Apart from the success of REITs in the developed markets of Japan, Hong Kong, and Singapore, the last decade has also witnessed impressive growth of the emerging Asian REIT markets, which include Malaysia, Taiwan, Thailand, and South Korea, underpinned by impressive property developments and favorable demographic terms. Despite their growth prospects and increasing significance, investors still have little information and knowledge on these emerging Asian markets. Therefore, a comprehensive understanding of the interrelationships between the emerging and developed Asian REIT markets is crucial for the development of portfolio diversification, trading strategies, hedging, and risk management for investors.

The body of literature on REIT markets in Asia has been thin and modest as compared to that on the United States and Australia. Studies on the performance of Asian REITs in investment portfolios and their correlations with other financial assets had been carried out within a regional context (Chiang, So, and Tang, 2008; Quek and Ong, 2008; Cheok, Sing, and Tsai, 2011; Ong, Ooi, and Kawaguichi, 2011) or for specific countries such as Japan (Kutsuna, Dimovski, and Brooks, 2008; Su, Huang, and Pai, 2010), Singapore (Sing and Ling, 2003), Hong Kong (Newell, Wu, Chau, and Wong, 2010), Malaysia (Newell, Ting, and Acheampong, 2002: Lee and Ting, 2009; Newell and Osmadi, 2009, 2010; Hwa and Wai, 2011), Taiwan (Lin, 2007; Lee, Kuo, Lee, and Lin, 2011), Thailand (Pham, 2011a), and South Korea (Pham, 2011b). Other studies have investigated the linkages in international real estate securities, including the Asia Pacific region (Garvey, Santry, and Stevenson, 2001; Liow, Ho, Ibrahim, and Chen, 2009). These studies, however, concentrate on the listed property companies rather than REITs. The only published paper that examined the volatility transmission of REIT returns in Asia is that of Li and Yung (2007), who investigated the interactions between the Pacific (Australia, Hong Kong, Japan, and Singapore) and the Atlantic REIT markets (U.K. and U.S.). In general, the findings from previous studies can be summarized as: (1) Asian REITs offer diversification benefits to investors as they have low correlations with other asset classes; (2) the correlation structures are non-constant over time, and (3) there are significant mean and volatility spillover effects from the U.S. REIT market to the REIT markets in Japan, Hong Kong, and Singapore.

The primary purpose of this study is to examine the dynamic transmission of REIT returns and volatility between seven Asian REIT markets: Japan, Singapore, Hong Kong, Malaysia, Taiwan, Thailand, and South Korea from June 2006 to May 2011. The rationale for this research is motivated by a number of reasons. Firstly, since the early works of Markowitz (1952) on portfolio theory, the issue of market integration has become an important subject for both academics and investors. Previous studies on stock markets have provided evidence that markets that are geographically and economically close tend to influence one another and such integration or co-movements is a result of closer political and economic cooperation among countries. Thus, this paper seeks to understand the extent to which a certain movement in one REIT market affects subsequent movements in other REIT markets in Asia. Secondly, most of the previous studies mainly focused on the interactions between the U.S. and major Asian REIT markets, namely Japan, Hong Kong, and Singapore, while little attention has been paid to emerging markets, such as Malaysia, Taiwan, Thailand, and South Korea. Recent years have witnessed these four emerging markets enjoying rapid growth in market capitalization underpinned by strong economic growth and favorable regulatory changes. Therefore, the linkages of these emerging markets with developed markets in the region deserve closer attention. This study aims to answer the question on whether developed REIT markets influence emerging REIT markets in Asia. Thirdly, since a number of previous studies on stock markets found that international stock market correlations tend to increase during a financial crisis, this study examines whether REIT markets also experience the same phenomenon. In addition, the timeframe will be broken down into three sub-periods in order to analyze and compare REIT market interactions prior to, during, and after the recent Global Financial Crisis (GFC). Therefore, this study makes the following contributions to the existing literature on Asian securitized real estate: (1) provision of empirical evidence on the nature of information transmission and market linkages between Asian REIT markets at both the mean return and volatility levels; (2) extension of the current literature to four emerging REIT markets in Asia: Malaysia, Taiwan, Thailand, and South Korea;

and (3) provision of updated evidence on the effects of the GFC on the performance of REIT markets in Asia.

The remainder of the paper is organized as follows. Section 2 provides details of the data and empirical methodology. Section 3 reports the test results on mean and volatility spillovers between the seven Asian REIT markets. Section 4 concludes the paper.

DATA AND METHODOLOGY

DATA AND PRELIMINARY ANALYSIS

The data employed in this study are the daily closing prices for REIT indices of seven REIT markets in Asia: Japan (JP), Singapore (SG), Hong Kong (HK), Malaysia (ML), Taiwan (TW), Thailand (TL), and South Korea (KO). The indices used are the Standard and Poor's REIT indices for Japan, Hong Kong, Singapore, and Taiwan, respectively. As REIT indices for Malaysia, Thailand, and South Korea are unavailable, value-weighted indices are constructed by the author to represent listed REITs of each market. In this study, Japan, Hong Kong, and Singapore are classified as developed REIT markets while the rest are categorized as emerging markets. Subsequently, three value-weighted indices are developed to represent developed, emerging, and Asian REIT markets, respectively. The Asian REIT index[1] consists of all listed REITs across seven markets as of May 2011. To avoid exchange rate disparities, all indices are commonly measured in term of US$. One of the key characteristic of REITs is that they have to distribute a majority of their net earnings to unit holders. Therefore, dividends are adjusted by using the total return indices for all indices. The returns (denoted by R_t) are continuously compounded and calculated as the difference in natural logarithms of the total return index value (denoted by P_t) for two consecutive trading days, i.e., $R_t = \ln(P_t) - \ln(P_{t-1})$. The period under analysis spans from June 20, 2006 to May 24, 2011. The sample period is chosen on the basis that it represents the longest common time period over which data for the seven REIT markets are available. The total number of observations included in the analysis after adjustment for heterogeneity is 1,286. All historical data are collected from Datastream.

Exhibit 1 illustrates the summary statistics for daily returns of the seven markets, as well as statistics testing for normality and autocorrelation over the period from June 20, 2006 to May 24, 2011. The highest average returns are those of Malaysia (0.053%) and Hong Kong (0.053%), followed by Singapore (0.049%) while the lowest are those of South Korea (0.000%) and Japan (0.012%). Average return of the developed REIT index (0.029%) is greater than that of the emerging REIT index (0.018%). In terms of volatility, as measured by the standard deviation, Japan (1.955%) and Singapore (1.877%) are the most volatile markets while Taiwan (0.739%) and Thailand (0.705%) are the least risky markets during the period under investigation. Interestingly, the developed REIT index (1.450%) is more volatile than the emerging REIT index (0.519%) during the full sample period. It would seem that the emerging markets offer lower returns to investors but lower risk as well. In terms of the risk-adjusted basis, the emerging REIT index is superior to the developed REIT index.

Exhibit 1
Descriptive Statistics of Asia REIT Index Returns for Full Sample Period

	Japan	Singapore	Hong Kong	Asia Developed	Malaysia	Taiwan	Thailand	South Korea	Asia Emerging	Asia
Mean (%)	0.012%	0.049%	0.053%	0.029%	0.053%	0.031%	0.041%	0.000%	0.018%	0.030%
Median (%)	0.037%	0.068%	0.011%	0.096%	0.042%	0.000%	0.040%	0.025%	0.032%	0.096%
Max. (%)	10.59%	20.42%	10.08%	8.03%	4.20%	7.60%	7.24%	13.15%	4.51%	7.37%
Min. (%)	−11.82%	−17.74%	−13.25%	−11.13%	−5.22%	−4.20%	−8.50%	−13.00%	−2.79%	−10.21%
Std. Dev. (%)	1.955%	1.877%	1.295%	1.450%	0.803%	0.739%	0.705%	1.831%	0.519%	1.353%
Skewness	−0.206	0.324	−0.794	−0.460	−0.341	1.222	−0.961	−0.502	0.010	−0.458
Kurtosis	7.801	22.685	20.150	9.807	7.420	20.252	31.145	11.700	10.503	9.587
Jarque-Bera	1,246	20,817	15,919	2,532	1,074	16,293	42,710	4,116	3,021	2,374
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The plots of daily returns for each market index from June 20, 2006 to May 24, 2011 are displayed in Exhibit 2. Visual inspection of the volatility of all series suggests that there are certain periods, particularly the GFC period, which have higher volatility and are riskier than others. Exceptionally in the case of Thailand, the volatility of returns was significantly higher during 2006 when the Thai coup d'état took place. In addition, these volatile periods seem to be concentrated and followed by periods of lower volatility. This reflects the ARCH or volatility clustering effects that commonly appear in financial time series. However, additional tests are discussed later that verify this phenomenon in the REIT index series.

The stationarity of all return series are examined using the Augmented Dickey-Fuller (ADF), Phillips-Person (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The test results in Exhibit 3 support that all time series are stationary and contain no unit roots. This means that the mean and variance of the Asian REIT return series are constant over time. Therefore, the series are suitable for further analysis on time-varying return and volatility transmissions.

METHODOLOGY

To investigate the dynamic transmission of returns and volatility in these Asian REIT markets, the Exponential Generalized Autoregressive Conditional Heteroskedastic (EGARCH) model is utilized. The EGARCH model, which was developed by Nelson (1991), is an extended form of the generalized ARCH model. ARCH-type models have been commonly used in modeling changes in the volatility of financial time series. A complete survey of the theory and application of ARCH models in finance can be found in Bollerslev, Chou, and Kroner (1992), Bera and Higgins (1993), and Pagan (1996), among others. Importantly, Engle and Ng (1993) and Stevenson (2002) have provided evidence in favor of the EGARCH model over other GARCH-type models. The advantage of EGARCH specification is that it allows for the testing of asymmetry impacts from positive and negative changes in REIT returns. The EGARCH specification employed in this study is written as follows:

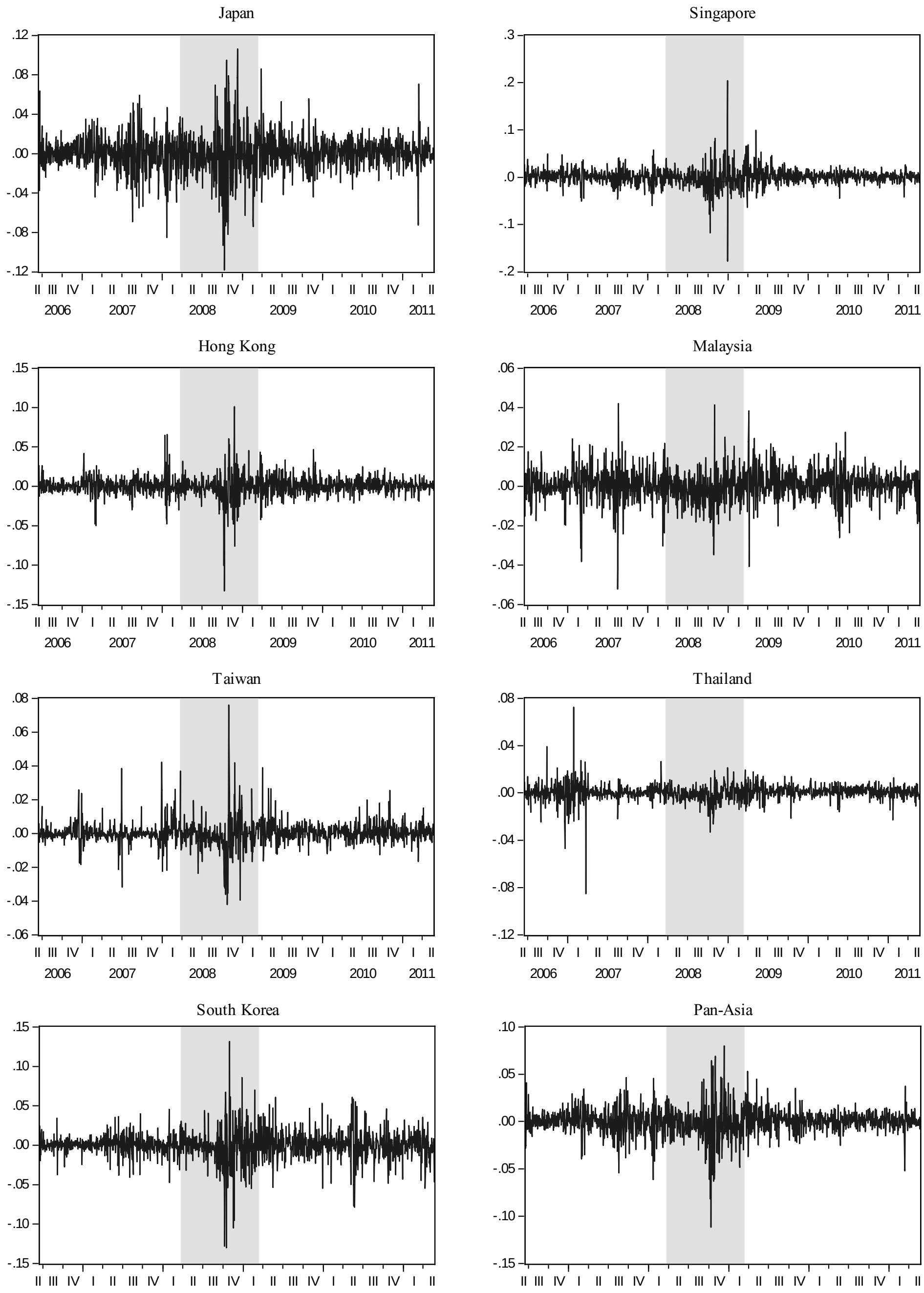
$$R_{i,t} = \alpha_i + \sum_{j=1}^{7} \beta_{i,j} R_{j,t-1} + \gamma_i u_{i,t-1} + \varphi_i D_{GFC} + u_{i,t}, \quad \text{for } i, j = 1, 2, \ldots, 7 \tag{1}$$

$$u_{i,t} | \Omega_{t-1} \sim iid\ N(0, h_{i,t})$$

$$\log(h_{i,t}) = \delta_i + \sum_{j=1}^{q} \zeta_{i,j} \left| \frac{u_{i,j,t-j}}{\sqrt{h_{i,j,t-j}}} \right| + \eta_i \frac{u_{i,t-j}}{\sqrt{h_{i,t-j}}} + \sum_{j=1}^{p} \theta_{i,j} \ln h_{t-j}$$
$$+ \sum_{j=1}^{7} \lambda_{i,j} u_{i,t-1} + \pi_i D_{GFC}, \quad \text{for } i, j = 1, 2, \ldots, 7 \text{ and } i \neq j \tag{2}$$

where $R_{i,t}$ is the natural logarithm difference of the total return price indices and i = 1, 2, 3, 4, 5, 6, 7 (1 = Japan, 2 = Singapore, 3 = Hong Kong, 4 = Malaysia, 5 = Taiwan, 6 = Thailand, 7 = South Korea). For market i^{th}, Ω_{t-1} is the information set

Exhibit 2
Plots of REIT Index Returns for Full Sample Period



Notes: Shaded areas imply the period during the Global Financial Crisis.

Exhibit 3
Unit Root Tests for Asia REIT Return Series

		Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
ADF	C	−27.278***	−36.066***	−37.122***	−36.196***	−20.280***	−36.240***	−37.070***
	C and T	−27.272***	−36.052***	−37.123***	−36.193***	−20.308***	−36.289***	−37.064***
PP	C	−35.510***	−36.150***	−37.131***	−36.198***	−28.796***	−36.287***	−37.371***
	C and T	−35.504***	−36.136***	−37.135***	−36.195***	−28.798***	−36.323***	−37.370***
KPSS	C	0.159	0.226	0.183	0.241	0.203	0.405**	0.106
	C and T	0.128*	0.226***	0.102	0.188**	0.066	0.162**	0.087

Notes: C and T denote use of constant and time trend in these tests.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

at time $(t - 1)$ and $h_{i,t}$ is the conditional variance. Conditional on Ω_{t-1}, $u_{i,t}$ is assumed to be normal distributed with a zero mean and variance $h_{i,t}$.

Equation (1) describes the conditional mean returns of seven Asian REIT markets, where they can be affected by historical own innovations (own-mean spillovers) when $i = j$ and cross-market returns (cross-mean spillovers) when $i \neq j$. The term $\beta_{i,j}$ measures the direct effect that a change in return to the j^{th} market would have on the i^{th} market. In order to resolve the problem with serial autocorrelation, an MA(1) term is introduced to capture the dependency of current returns (R_t) on immediate past own errors (u_{t-1}).

The D_{GFC} dummy variable is incorporated in the model to evaluate the effects of the GFC on each market. The dummy variable takes the value one in the period from March 17, 2008 to March 6, 2009 and zero otherwise. While it is still unclear about the exact dates of the start and end of the GFC, the March 17, 2008 is used as the beginning of the GFC in this study, since it was the date Bear Stearns was taken over by J.P. Morgan. The March 6, 2009 is chosen as the end for the GFC, because it was the date that the Asian REIT index rebounded strongly from its trough since the start of the GFC.

Equation (2) reflects the EGARCH representation of the variance of $u_{i,t}$. According to the EGARCH specification, the conditional variance of the returns in each market is an exponential function of past own, cross-market standardized innovations and past own conditional variance. After considering the Akaike Information Criterion (AIC) and diagnostics on standardized residuals of different parsimonious models, an EGARCH(2,2) model is fitted for the analysis. The parameter η_i measures the asymmetric volatility transmission mechanism. When $\eta_i = 0$, then a positive shock (good news) has the same effect as the negative shock (bad news) of the same magnitude; when $-1 < \eta_i < 0$, then a negative shock increases volatility more than a positive shock; and when $\eta_i < -1$, a negative shock increases volatility while a positive shock reduces volatility. The persistence of volatility is measured by $\theta_{i,j}$. Volatility spillovers from the j^{th} market to the i^{th} market are measured by $\lambda_{i,j}$. Statistically significant values of $\lambda_{i,j}$ suggest that past volatility shocks in cross-market influence the current volatility of the i^{th} market. The term π_i measures the impact of the GFC on REIT volatility. If π_i is positive and statistically significant, it indicates that the crisis affects Asian REIT returns making them more volatile.

EMPIRICAL FINDINGS

CORRELATION ANALYSIS

The correlation analysis is conducted to provide some preliminary insights into the financial contagion of the Asian REIT markets. The correlation matrix of all series from June 21, 2006 to May 24, 2011 is depicted in Exhibit 4. The results show that all correlation coefficients are statistically significant at the 1% level. Correlation coefficients among Asian REIT indices are relatively low, ranging from 0.139 to 0.419. The comparatively high correlations between Singapore and Hong Kong (0.419) might be caused by strong economic and financial linkages between the two countries as

Exhibit 4
Correlation Matrix of Asia REIT Index Returns for the Full Sample Period

	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Japan	1.000						
Singapore	0.301***	1.000					
Hong Kong	0.335***	0.419***	1.000				
Malaysia	0.191***	0.405***	0.253***	1.000			
Taiwan	0.192***	0.332***	0.257***	0.305***	1.000		
Thailand	0.149***	0.218***	0.166***	0.250***	0.195***	1.000	
South Korea	0.204***	0.325***	0.209***	0.304***	0.308***	0.139***	1.000

Notes:
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

both are the major financial centers of the region. The lowest correlations are that between Thailand and South Korea (0.139), followed by Thailand and Japan (0.149). The relatively low correlations between Asian REIT markets indicate potential benefits from regional diversification across Asian REITs. As the average correlation coefficient of the emerging markets (0.25) is lower than that of the developed markets (0.35), investors could certainly achieve greater within-industry diversification benefits by investing in emerging market REITs rather than developed market REITs.

In order to account for the dynamic nature of covariance and possible structural breaks caused by the GFC, the full sample is further divided into three sub-samples; the pre-GFC period of June 21, 2006 to March 16, 2008, the GFC period of March 17, 2008 to March 6, 2009, and the post-GFC period of March 7, 2009 to May 24, 2011. The results are presented in Exhibit 5 with the last two panels (C and D) showing the percentage changes in correlations over three sub-periods. Comparing between the pre-GFC and GFC periods, the average pair-wise correlation has risen significantly by 110%. The largest increase in correlation is witnessed between Thailand and South Korea, followed by Thailand and Japan. The results suggest that Asian REIT markets, especially Thailand, became increasingly interconnected during the GFC, hence losing their diversification potential. Turning the attention to the post-GFC period from March 7, 2009 to May 24, 2011, bivariate correlations decreased by an average of 25% as compared to the GFC period, but still at high levels as compared to the pre-GFC period.

In summary, the sub-period analysis reveals that the correlations between Asian REITs are non-constant over time and the GFC caused a structural break in Asian REIT returns. Asian REIT markets became more interdependent during the GFC, thus lowering their diversification potential. They have gained back some diversification potential since March 7, 2009, but have yet to reach the levels seen prior to the GFC. The results are consistent with previous findings by Kim (2009) and Newell, Wing,

Exhibit 5
Correlation Matrix of Asia REIT Index Returns: Sub-period Analysis

	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Panel A: Pre-GFC—June 21, 2006 to March 16, 2008							
Japan	1.000						
Singapore	0.409***	1.000					
Hong Kong	0.383***	0.443***	1.000				
Malaysia	0.297***	0.449***	0.353***	1.000			
Taiwan	0.164***	0.215***	0.200***	0.152***	1.000		
Thailand	0.058	0.138***	0.112**	0.159***	0.115**	1.000	
South Korea	0.272***	0.197***	0.139***	0.215***	0.162***	0.024	1.000

	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Panel B: GFC—March 17, 2008 to March 6, 2009							
Japan	1.000						
Singapore	0.324***	1.000					
Hong Kong	0.385***	0.454***	1.000				
Malaysia	0.208***	0.358***	0.255***	1.000			
Taiwan	0.223***	0.351***	0.334***	0.358***	1.000		
Thailand	0.303***	0.246***	0.256***	0.336***	0.220***	1.000	
South Korea	0.262***	0.384***	0.293***	0.387***	0.384***	0.252***	1.000

	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Panel C: Post-GFC—March 7, 2009 to May 24, 2011							
Japan	1.000						
Singapore	0.147***	1.000					
Hong Kong	0.186***	0.321***	1.000				
Malaysia	0.077*	0.441***	0.174***	1.000			
Taiwan	0.139***	0.375***	0.143***	0.430***	1.000		
Thailand	0.120***	0.330***	0.152***	0.323***	0.312***	1.000	
South Korea	0.091**	0.307***	0.130***	0.321***	0.283***	0.169***	1.000

	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Panel D: Percentage difference between pre-GFC and GFC correlations							
Japan							
Singapore	−21%						
Hong Kong	0%	3%					
Malaysia	−30%	−20%	−28%				
Taiwan	36%	64%	67%	136%			
Thailand	419%	78%	129%	111%	91%		
South Korea	−4%	95%	111%	80%	138%	963%	

Exhibit 5 (continued)
Correlation Matrix of Asia REIT Index Returns: Sub-period Analysis

	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Panel E: Percentage difference between GFC and post-GFC correlations							
Japan							
Singapore	−55%						
Hong Kong	−52%	−29%					
Malaysia	−63%	23%	−32%				
Taiwan	−38%	7%	−57%	20%			
Thailand	−60%	34%	−41%	−4%	42%		
South Korea	−65%	−20%	−56%	−17%	−26%	−33%	

Notes:
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

Kei, and Hiang (2009) in regards to the impact of the GFC on Asian real estate securities.

VOLATILITY CLUSTERING EFFECTS

The results of the Ljung-Box (LB) and heteroscedasticity tests for up to 24 orders are reported in Exhibit 6. The LB Q statistics indicate significant autocorrelations in all seven return series. This justifies the inclusion of the lag terms in the mean equation (1). In addition, there is a strong evidence of ARCH effects in the residuals, as suggested from the ARCH test results. This means that there is significant volatility clustering effects in the REIT return indices. Large changes in REIT returns tend to be followed by large changes, while small changes tend to be followed by small changes. This phenomenon is quite similar to observations in previous studies in financial time series. The presence of time-varying volatility in the series further affirms the suitability of an EGARCH model in analyzing the dynamic volatility of Asian REIT markets.

CROSS-MARKET RETURN AND VOLATILITY SPILLOVERS

The estimated coefficients and standard errors for the conditional mean return equations are presented in Panel A of Exhibit 7. The results suggest that the lagged returns from Singapore have a significant return spillover effect (measured by the term β_{ij}) to all other Asian REIT markets. The mean returns of Japan influence the markets in Malaysia and Taiwan substantially. Significant bi-directional mean spillover coefficients between Hong Kong and Singapore are detected, confirming the strong market linkage between the two countries, as witnessed in the correlation analysis. Among the emerging markets, there are unidirectional mean spillovers from Thailand

Exhibit 6
Test for Serial Correlation and Heteroscedasticity

	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
$Q(4)$	16.117 (0.001)***	9.042 (0.029)**	2.498 (0.476)	39.495 (0.017)**	13.512 (0.004)***	2.612 (0.455)	9.461 (0.024)**
$Q(12)$	34.293 (0.000)***	37.978 (0.000)***	27.385 (0.004)***	12.779 (0.308)	30.389 (0.001)***	21.481 (0.029)**	22.721 (0.019)**
$Q(24)$	54.951 (0.000)***	69.761 (0.000)***	37.585 (0.028)**	3.317 (0.345)	56.721 (0.000)***	56.305 (0.000)***	49.023 (0.001)***
$Q^2(4)$	387.360 (0.000)***	240.580 (0.000)***	254.320 (0.000)***	157.290 (0.000)***	142.420 (0.000)***	13.646 (0.003)***	170.910 (0.000)***
$Q^2(12)$	916.810 (0.000)***	305.800 (0.000)***	320.070 (0.000)***	172.870 (0.000)***	289.140 (0.000)***	23.623 (0.014)**	493.790 (0.000)***
$Q^2(24)$	1,204.300 (0.000)***	353.100 (0.000)***	502.800 (0.000)***	226.420 (0.000)***	405.790 (0.000)***	59.579 (0.000)***	800.430 (0.000)***
ARCH(24)	1.979 (0.003)***	13.922 (0.000)***	14.099 (0.000)***	1.546 (0.045)**	9.635 (0.000)***	1.845 (0.008)***	1.894 (0.001)***

Notes: Figures in parentheses are the probabilities.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

Exhibit 7
EGARCH Model: Mean and Volatility Spillovers between the Asian REIT Markets for the Full Sample Period

Japan		Singapore		Hong Kong		Malaysia		Taiwan		Thailand		South Korea	
Panel A: Parameter estimation for conditional mean equations													
α_1	0.000	α_2	0.001***	α_3	0.000*	α_4	0.001***	α_5	0.001	α_6	0.001***	α_7	0.000
β_{11}	0.571***	β_{21}	0.023	β_{31}	−0.003	β_{41}	0.017**	β_{51}	−0.021***	β_{61}	−0.001	β_{71}	0.009
β_{12}	0.156***	β_{22}	0.418*	β_{32}	0.054***	β_{42}	0.043***	β_{52}	0.036***	β_{62}	0.035***	β_{72}	0.080***
β_{13}	0.057	β_{23}	−0.068*	β_{33}	−0.953***	β_{43}	−0.012	β_{53}	0.021	β_{63}	−0.014	β_{73}	−0.051
β_{14}	0.128**	β_{24}	0.000	β_{34}	0.053	β_{44}	−0.049	β_{54}	0.025	β_{64}	−0.018	β_{74}	0.021
β_{15}	0.059	β_{25}	−0.003	β_{35}	−0.033	β_{45}	−0.008	β_{55}	0.985***	β_{65}	0.002	β_{75}	0.058*
β_{16}	0.035	β_{26}	−0.015	β_{36}	0.012	β_{46}	0.053**	β_{56}	0.012	β_{66}	0.995***	β_{76}	0.044
β_{17}	−0.008	β_{27}	−0.009	β_{37}	0.001	β_{47}	−0.025	β_{57}	−0.015*	β_{67}	−0.005	β_{77}	−0.191
γ_1	−0.679***	γ_2	−0.340	γ_3	0.972***	γ_4	0.002	γ_5	−0.949***	γ_7	−0.999***	γ_7	0.020
φ_1	−0.003**	φ_2	−0.004***	φ_3	0.000	φ_4	−0.002***	φ_5	−0.004***	φ_6	−0.002***	φ_7	0.000
Panel B: Parameter estimation for conditional variance equations													
δ_1	−0.395***	δ_2	−0.326***	δ_3	−0.113***	δ_4	−1.230***	δ_5	−0.254***	δ_6	−0.101***	δ_7	−0.910***
ζ_{11}	0.281***	ζ_{21}	0.340***	ζ_{31}	0.451***	ζ_{41}	0.277***	ζ_{51}	0.315***	ζ_{61}	0.454***	ζ_{71}	0.276***
ζ_{12}	−0.114	ζ_{22}	−0.100**	ζ_{32}	−0.396***	ζ_{42}	0.144**	ζ_{52}	−0.198***	ζ_{62}	−0.383***	ζ_{72}	0.147***
η_1	−0.037	η_2	−0.102***	η_3	0.012	η_4	0.076***	η_5	−0.018**	η_6	0.034***	η_7	−0.006
θ_{11}	0.973***	θ_{21}	0.471***	θ_{31}	1.577***	θ_{41}	0.222**	θ_{51}	1.459***	θ_{61}	1.497***	θ_{71}	−0.018**
θ_{12}	−0.005	θ_{22}	0.513***	θ_{32}	−0.584***	θ_{42}	0.684***	θ_{52}	−0.476***	θ_{62}	−0.502***	θ_{72}	0.947***
		λ_{21}	−1.033	λ_{31}	−0.125	λ_{41}	−0.810	λ_{51}	−0.230	λ_{61}	1.125	λ_{71}	0.260
λ_{12}	−5.394***			λ_{32}	−2.969***	λ_{42}	−5.984***	λ_{52}	2.333***	λ_{62}	0.484	λ_{72}	−1.260**
λ_{13}	3.110*	λ_{23}	−4.258**			λ_{43}	−7.166***	λ_{53}	−4.613***	λ_{63}	−3.616***	λ_{73}	1.754
λ_{14}	−2.593	λ_{24}	−2.602	λ_{34}	2.481**			λ_{54}	−0.558	λ_{64}	−3.332***	λ_{74}	−5.190***
λ_{15}	1.619	λ_{25}	4.274	λ_{35}	1.434	λ_{45}	−2.720			λ_{65}	0.920	λ_{75}	−1.986
λ_{16}	−2.610	λ_{26}	3.487	λ_{36}	−0.907	λ_{46}	5.756	λ_{56}	0.301			λ_{76}	−6.534***
λ_{17}	2.233*	λ_{27}	4.280***	λ_{37}	−0.202	λ_{47}	0.574	λ_{57}	−2.548***	λ_{67}	−1.246***		
π_1	0.016	π_2	0.043**	π_3	0.002	π_4	−0.026	π_5	0.012*	π_6	−0.011*	π_7	0.044*

Exhibit 7 (continued)

EGARCH Model: Mean and Volatility Spillovers between the Asian REIT Markets for the Full Sample Period

Japan		Singapore		Hong Kong		Malaysia		Taiwan		Thailand		South Korea	
Panel C: Diagnostics on standardized residuals													
Q(24)	21.221	*Q*(24)	26.705	*Q*(24)	26.895	*Q*(24)	23.374	*Q*(24)	24.670	*Q*(24)	24.511	*Q*(24)	38.411
p-value	0.507	*p-value*	0.223	*p-value*	0.215	*p-value*	0.381	*p-value*	0.313	*p-value*	0.321	*p-value*	0.016
$Q^2(24)$	27.079	$Q^2(24)$	19.104	$Q^2(24)$	25.517	$Q^2(24)$	21.226	$Q^2(24)$	15.901	$Q^2(24)$	14.381	$Q^2(24)$	32.714
P-value	0.208	*p-value*	0.639	*p-value*	0.273	*p-value*	0.507	*p-value*	0.821	*p-value*	0.887	*p-value*	0.066
ARCH(24)	1.302	ARCH(24)	0.802	ARCH(24)	1.118	ARCH(24)	0.902	ARCH(24)	0.664	ARCH(24)	0.512	ARCH(24)	1.322
P-value	0.150	*p-value*	0.738	*p-value*	0.315	*p-value*	0.601	*p-value*	0.889	*p-value*	0.976	*p-value*	0.137

Notes:

$$R_{i,t} = \alpha_i + \sum_{j=1}^{7} \beta_{i,j} R_{j,t-1} + \gamma_i u_{i,t-1} + \varphi_i D_{GFC} + u_{i,t}, \quad \text{for } i, j = 1, 2, \ldots, 7$$

$$\log(h_{i,t}) = \delta_i + \sum_{j=1}^{2} \zeta_{i,j} \left| \frac{u_{i,j,t-j}}{\sqrt{h_{i,j,t-j}}} \right| + \eta_i \frac{u_{i,t-j}}{\sqrt{h_{i,t-j}}} + \sum_{j=1}^{2} \theta_{i,j} \ln h_{t-j} + \sum_{j=1}^{7} \lambda_{i,j} u_{i,t-1} + \pi_i D_{GFC}, \quad \text{for } i, j = 1, 2, \ldots, 7 \text{ and } i \neq j$$

1 = Japan (JP), 2 = Singapore (SG), 3 = Hong Kong (HK), 4 = Malaysia (ML), 5 = Taiwan (TW), 6 = Thailand (TL), 7 = South Korea (KO).

*Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

and South Korea to Malaysia and bidirectional interactions between South Korea and Taiwan. In general, it is more likely for the mean returns to spill from developed REIT markets (e.g., Japan and Singapore) to emerging markets. This implies that investors were looking for price innovations from leading REIT markets such as Singapore and Japan to price REIT securities in other markets in the region. In addition, the returns of Japan, Hong Kong, Taiwan, and Thailand are highly correlated to their past values (β_{ij} when $i = j$) and past disturbance terms (γ_i), suggesting that historical innovations in those markets have strong influence over expected returns. In other words, Japan, Hong Kong, Taiwan, and Thailand REIT markets are not completely efficient and there are short-run momentums in REIT prices.

The parameter estimation for the second moment interdependencies can be seen in Panel B of Exhibit 7. Statistically significant values of the ζ and θ parameters across all series confirm the strong presence of ARCH and GARCH effects in the REIT indices. The coefficients measuring asymmetry η_i reveal that Japan, Singapore, and Taiwan REIT returns contain significant asymmetry effects. This means negative news in those markets increase volatility more than positive news. In term of cross-market volatility, both Singapore and Hong Kong have significant volatility spillovers (measured by the parameter λ_{ij}) to other Asian REIT markets and between themselves. The volatility of Singapore transmits to Japan, Hong Kong, Malaysia, and South Korea, while Hong Kong influences Japan, Singapore, Malaysia, Taiwan, and Thailand. Interestingly, unlike the mechanism of mean returns, volatility spillovers do not appear to be unidirectional from developed to emerging markets. There are also some volatility feedback effects from emerging markets such as South Korea to Japan and Singapore, while shocks from Malaysia spillover to Hong Kong. Among the emerging markets, unidirectional spillovers are detected from Malaysia to Thailand and South Korea, from South Korea to Taiwan while bidirectional spillovers are recorded between Thailand and South Korea. In summary, Singapore, Hong Kong, and South Korea are the main volatility emitters in the region, with strong influences over other REIT markets. Malaysia and Thailand act as intermediary markets, while Japan and Taiwan are volatility receivers and do not influence any other country.

EFFECTS OF THE GLOBAL FINANCIAL CRISIS

As explained earlier, a dummy variable D_{GFC} is incorporated to analyze the effects of the GFC on Asian REIT markets. The values of φ_i and π_i measure the impacts of the GFC on mean returns and volatility of each market, respectively. The results show that the impacts of the GFC are not homogeneous across the region. The crisis significantly reduced the returns of all Asian REIT markets, with the exception of Hong Kong and South Korea. When it comes to conditional volatility, most Asian REIT markets react negatively to the crisis, whereas Thailand and Malaysia respond positively. The results imply that Thailand and Malaysia are subjected more to country-specific risks than global risks. This might be attributed to the fact that these two countries have more restrictive currency control regulations than the others. In addition, the GFC affects REIT markets significantly more in the second moment (volatility) than the first moment (mean returns), as the absolute value of dummy coefficients in the variance are greater than those in the mean equations.

DIAGNOSTIC CHECKS

Residual diagnostic tests summarized in Panel C of Exhibit 7 show that all EGARCH(2,2) models satisfactorily capture the interactions between the seven Asian REIT markets. The Ljung-Box statistics of up to 24 lags show no evidence of autocorrelation in the standardized residuals, with all *P*-values greater than 0.05, with the exception of South Korea at *Q*(24). Besides, the heteroscedasticity tests reject the presence of any ARCH effects in the residual series at 0.01 significance levels. The diagnostic tests therefore support that the EGARCH models have absorbed all autocorrelation, ARCH, and GARCH effects present in the original return series.

Conclusion

The last decade has witnessed a rapid growth of the REIT sector across Asia. However, the body of literature on REIT markets in Asia has been relatively modest as compared to that of the U.S. and Australia. Within the Asian context, this paper investigates the dynamic transmission of REIT returns and volatility between seven countries in Asia: Japan, Singapore, Hong Kong, Malaysia, Taiwan, Thailand, and South Korea employing the EGARCH modification. In addition, the effects of the GFC on REIT returns and volatility are also investigated using dummy variables. The data employed in this study are the daily closing prices for the total return REIT indices from June 20, 2006 to May 24, 2011. The findings have important implications for international investors in managing Asian REIT portfolios, and developing trading and risk management strategies.

The empirical results indicate that emerging markets offer lower returns to investors, but lower risk as well. The emerging REIT index outperformed the developed REIT index on a risk-adjusted basis. The correlation analysis suggests that correlations among emerging REIT markets are lower than that among developed markets. Therefore, investors could certainly achieve greater within-industry diversification by including emerging REITs in the property portfolio. However, the sub-sample analysis reveals that the correlation structures are non-constant over time and correlations increased significantly during the GFC, but since have only reduced gradually. As for the direction of return spillovers between Asian REIT markets, the results from the mean equations show that there is a strong tendency for REIT returns to transmit from the developed markets to emerging markets. For example, lagged returns from Singapore have significant spillover effects to other Asian REIT markets, while the mean returns of Japan influenced Malaysia and Taiwan substantially. This suggests that investors can use available information from Singapore and Japan to predict movements of REIT returns in other Asian markets. In addition, investors should take into account past own innovations in Japan, Hong Kong, Taiwan, and Thailand in developing forecasting models of REIT returns, as there are significant short-term price momentums in those markets.

On the other hand, the mechanism of volatility spillovers among Asian REIT markets is more complex than that of mean return spillovers. Volatility transmission appears to be multidirectional. The market can be divided into three clusters, with Hong Kong, Singapore, and South Korea being the main volatility emitters in the region, Japan and Taiwan are volatility receivers, while Malaysia and Thailand act as intermediary markets. The evidence of volatility linkages between Asian REIT markets implies that investors can utilize volatility innovations in Hong Kong, Singapore, and South Korea to predict the risk levels in other markets; in particular, Japan and Taiwan. In addition, investors can develop portfolio hedging strategies by combining markets with significantly negative volatility spillover coefficients, such as Hong Kong and Malaysia or Thailand and South Korea.

ENDNOTE

1. A detailed list of listed Asian REITs and index construction methodology is available from the author.

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Anh K. Pham, University of Western Sydney, Penrith NSW 2751 Australia or A.Pham@uws.edu.au.