THE VOLATILITY SPILLOVERS IN ASIAN LISTED PROPERTY COMPANIES IN DEVELOPED AND EMERGING MARKETS

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ABSTRACT

This paper uses exponential-generalised autoregressive conditional heteroskedasticity (EGARCH) model to examine empirically the volatility spillovers of listed property companies in 13 Asian country markets. The capitalisation-weighted index for 3 tiers of developed markets (Japan, Hong Kong, Singapore), emerging markets (Thailand, Taiwan, Malaysia, Korea) and lesser emerging markets (China, India, Indonesia, Philippines, Sri Lanka, Vietnam) were analysed. The results showed that property companies returns in individual countries have no excessive return compared to the stock index, are more aggressive than the respective local equity indices whilst lagged property companies returns provided little explanatory power in the current property returns. At the tier level, tier 1 determined its stable role in the region with significant spillovers to the other two tiers, and the heteroskedasticity in the tier series whilst tier 3 showed the significant, yet unstable role in the region. The tier 2 countries saw no spillover from the local stocks, yet received some impact from the US market. Tier 3 countries show reducing spillover factors from high spillover (China) to moderate (India and Indonesia) and low spillover (Vietnam, Philippines, and Sri Lanka), which reflects the low integration of these countries to the global market.

Keywords: listed property companies, Asia, developed markets, emerging markets, lesser emerging markets, volatility spillover

INTRODUCTION

In line with the emergence of Asian economies, property companies in Asia have been growing significantly in the recent years. In terms of market size, the four largest Asian property markets (Hong Kong: £199.4 billion; Japan: £70.0 billion; Singapore: £61.4 billion and China: £57.3 billion) are also seen in the global top 5, only behind the US property market (£224.4 billion) as at June 2010 (see Table 1). The significance of Asian property in the global context is clearly evident with its market value accounting for more than 44% of global market (Macquarie, 2010) and more than 11% of Asian stock markets as opposed to the world average of more than 5% (EPRA, 2010).

Besides the developed Asian property markets (Japan, Hong Kong, Singapore) and emerging markets (Malaysia, Korea, Taiwan, Thailand) that have drawn some attention from the global investors recently, the lesser emerging markets (China, India, Indonesia, the Philippines, Sri Lanka, Vietnam) have also been raising the awareness of their existence and drawing attention from the global investors. Thanks to their increasing stability in political conditions, the acceleration in economic growth, these local property markets have interactively been boosted.

In particular, considered as one of the lesser emerging markets in Asia yet an emerging global major player in the post-GFC period, China stood at the 2nd largest economy in the world after the US on the purchasing power parity basis. China has increased its involvement in the other major regional and global economies. Together with China, India is among the major economies of BRIC for their work force out of a huge population (1.3 billion and 1.2 billion for China and India respectively). Indonesia (240 million) is also the third largest population nation among the 13 Asian countries (CIA, 2010). The economic structure sees some similarity among these countries with the moderately low proportion for agriculture (10.6%, 17% and 15.3% for China, India and Indonesia respectively). China has a relatively balanced services – industrial ratio (42.6%, 46.8% respectively), with India (54.9%, 28.2%) and Indonesia (37.1%, 47.6%) somewhat varying in this regard (CIA, 2010; World Bank, 2010). Also categorised in the lesser emerging markets but in the lower levels, the Philippines, Sri Lanka and Vietnam have seen improved economic performance in the recent years. However, these countries saw high levels of uncertainty in economic performance during the post-GFC.

Whilst China has the Shanghai Stock Exchange ($2,705 billion, #6 globally) and Shenzhen Stock Exchange ($868 billion, #16), India has the Bombay Stock Exchange ($1,307 billion, #11) and National Stock Exchange of India ($1,225 billion, #14). They are significant Exchanges in terms of capitalisation and their impact on global securities investment. Similarly, Indonesia sees the Indonesia Stock Exchange ($215 billion, #30) being significant in the region (WFE, 2010).

Table 1: Significance of property securities markets in Asian countries: June 2010

Country	Number of property securities	Market capitalisation	Percentage of Asia market	Percentage of global market	World ranking (by £)
US	268	£224.4B	-	22.89%	1
Hong Kong	134	£199.4B	44.4%	20.3%	2
Japan	143	£70B	15.6%	7.1%	3
Singapore	65	£61.4B	13.7%	6.3%	4
China	80	£57.3B	12.8%	5.8%	5
India	42	£19.5B	4.3%	2.0%	11
Philippines	35	£9.2B	2.1%	0.9%	15
Taiwan	47	£9.1B	2.0%	0.9%	16
Malaysia	81	£8.7B	1.9%	0.9%	17
Thailand	52	£7.0B	1.6%	0.7%	22
Indonesia	40	£5.3B	1.2%	0.5%	26
Vietnam	5	£1.2B	0.3%	0.1%	40
South Korea	7	£0.3B	0.1%	0.0%	47
Sri Lanka	16	£0.2B	0.0%	0.0%	48
Total Asia	**747**	**£448.6B**	**100%**	**44.7%**	
Total Global	**1995**	**£980.4B**		**100%**	

Source: Macquarie Securities (2010)

In the least developed countries, the Philippine Stock Exchange ($86,349 million, rank #41 globally) is bigger than the New Zealand Exchange ($35,506 million, #46) with the Ho Chi Minh Stock Exchange ($26,525 million, #49) of Vietnam and the Colombo Stock Exchange ($9,547 million, #52) of Sri Lanka increasing their significance in the region. Each nation has unique features to lean on for development as well as to overcome in the progress for the higher level of sustained growth (WFE, 2010).

Importantly, research on these lesser emerging markets have not been significant as yet. This study attempts to fill the space in the picture of the lesser emerging markets using a tier index for the emerging markets.

Volatility has been a long discussed issue for both academics and investors. Volatility spillovers occur when changes in price volatility in one market (or asset class) produce a lagged impact on volatility in other markets (or asset classes), over and above local effects (Milunovich and Thorp, 2006). Volatility spillovers are both significant and widespread, well-identified in a number of studies across a range of securities markets and geographic locations in such property

securities context as the US and UK (eg: Stevenson, 2002; Cotter and Stevenson, 2006; Michayluk et al, 2006). In an Asia-Pacific context, a number of studies have investigated the volatility relationship across property markets, with little influence being found of significant evidence of cross-volatility spillovers among the Asian-Pacific markets (Garvey et al, 2001; Liow et al, 2005). A contrary finding about the interdependence and spillover amongst the Asian property securities was found by Mei and Hu (2000), Wilson and Zurbruegg (2004) and Liow (2008), with these relations varying over time. Similarly, Li and Yung (2007) found a significant international spillover of REIT volatility within the Pacific region with significant volatility transmissions between the Pacific and the Atlantic regions. Between direct and indirect property, Sing and Sng (2003) found no evidence of the ex-post return of the direct property incorporating the market volatility of property securities, but significant at the other direction.

Whilst there are a number of studies on volatility spillovers in property securities in the regional and global context, there are very few studies of this issue on the property securities in the Asian property markets, especially in terms of developed and emerging market tiers. With the emergence of regional and global investors in property, it is important to answer the question whether or not to diversify regionally or globally in Asia. To find the answer, this study assesses the volatility transmission between stocks and property securities on an individual country basis, across the tiers and with the benchmark markets, represented by the US, to understand the volatility linkages and transmissions within a market and across tiers in Asia.

This study examines the performance of property companies compared to local stocks and possible volatility spillovers in a local context. To analyse its performance in terms of the market development, tier indices under the capitalisation-weighted method are built from the 13 Asian countries for the developed tier (Japan, Hong Kong, Singapore), emerging tier (Thailand, Taiwan, Malaysia, Korea) and lesser emerging tier (China, India, Indonesia, Philippines, Sri Lanka, Vietnam). The US stocks and properties indices are added in this analysis as a global benchmark. The reasons for including US stocks and properties in this study are (1) the GFC was ignited from the US, (2) the US have significant relationships with the Asian economies. This is also consistent with Wilson et al (2007) that there is a unifying force across international property markets; this force may stem from the US.

This is the first study on an extended Asian property market basis in this topic addressing the volatility spillovers in both developed and emerging markets in the region, with particular attention to the lesser emerging markets in a tiered market context.

DATA AND METHODOLOGY

Data sources

To assess the volatility linkages between property securities and stocks, this study uses a monthly price index and market value of stocks and property securities data series for country markets in local currency, with the capitalisation-weighted index using exchange rate series to convert to a US Dollar basis. This conversion is consistent with the methodology from the previous study on the tier performance made by Nguyen (2011a). All data series are from January 1999 to December 2009, with the Vietnam data time span over a shorter period of July 2006 – December 2009. As such, this period excludes the impact of the Asian Financial Crisis of 1997-1998 and includes the Global Financial Crisis of 2008-2009 in the analysis. For the purpose of volatility spillover analysis requiring long time series, this study will only analyse the full period. Due to the wide extension of the country markets used in this study, only price series are available across the country markets. As such, price series are used instead of return series. Nevertheless, this limitation does not hinder the rigorous findings in this research, since Asian property markets are more based on capital gain rather than dividend income (Newell and Chau, 1996; Liow, 1997). The detailed data sources and statistical description of the data series used are presented in Table 2 and 3 respectively.

Methodology

The main empirical analysis is undertaken in a GARCH (General Autoregressive Conditional Heteroscedasticity) framework, which allows the simultaneous modelling of both the first and second moments of the return series and provides a more efficient means of modelling time series. Conventional econometric time series models assume that the variance of the error term is constant. As such, the first common test in this study is the stationary test.

Table 2: Data sources: capitalisation-weighted index

COUNTRY	DATA SERIES
JAPAN	TOPIX REAL ESTATE - PRICE INDEX
	TOPIX REAL ESTATE - MARKET VALUE
	JAPANESE YEN TO US $ NOON NY – EXCHANGE RATE
SINGAPORE	SINGAPORE-DS REAL EST INV,SVS – PRICE INDEX
	SINGAPORE-DS REAL EST INV,SVS - MARKET VALUE
	SINGAPORE $ TO US $ (SG) - EXCHANGE RATE
HONG KONG	HONG KONG-DS REAL EST INV,SVS – PRICE INDEX
	HONG KONG-DS REAL EST INV,SVS - MARKET VALUE
	HONG KONG $ TO US $ NOON NY - EXCHANGE RATE
MALAYSIA	KUALA LUMPUR SE PROPERTIES - PRICE INDEX
	KUALA LUMPUR SE PROPERTIES - MARKET VALUE
	MALAYSIAN RINGGIT TO US $ NOON NY
THAILAND	THAILAND-DS REAL EST INV,SVS – PRICE INDEX
	THAILAND-DS REAL EST INV,SVS - MARKET VALUE
	THAI BAHT TO US $ NOONNY – EXCHANGE RATE
TAIWAN	DJTM TAIWAN REAL ESTATE – PRICE INDEX
	DJTM TAIWAN REAL ESTATE - MARKET VALUE
	TAIWAN NEW $ TO US $ NOON NY - EXCHANGE RATE
SOUTH KOREA	KOREA SE CONSTRUCTION - PRICE INDEX
	KOREA SE CONSTRUCTION - MARKET VALUE
	SOUTH KOREAN WON TO US$ (KO) - EXCHANGE RATE

(Continued)

Table 2: Data sources: capitalisation-weighted index (continued)

COUNTRY	DATA SERIES
CHINA	SHANGHAI SE REAL ESTATE - PRICE INDEX SHANGHAI SE REAL ESTATE - MARKET VALUE CHINESE YUAN TO US $ NOON NY - EXCHANGE RATE
SRI LANKA	SRI LANKA-DS REAL EST INV,SVS - PRICE INDEX SRI LANKA-DS REAL EST INV,SVS - MARKET VALUE SRI LANKAN RUPEE TO US$ NOON NY - EXCHANGE RATE
INDIA	S&P CNX CONSTRUCTION - PRICE INDEX S&P CNX CONSTRUCTION - MARKET VALUE INDIAN RUPEE TO US $ NOON NY - EXCHANGE RATE
INDONESIA	JAKARTA SE CNSTR.PROPERTY - PRICE INDEX JAKARTA SE CNSTR.PROPERTY - MARKET VALUE INDONESIAN RUPIAH TO US $ (TR) - EXCHANGE RATE
PHILIPPINES	PHILIPPINE-DS R/E HLD & DVLP - PRICE INDEX PHILIPPINE-DS R/E HLD & DVLP - MARKET VALUE PHILIPPINE PESO TO US $ (PH) – EXCHANGE RATE
VIETNAM	AUTHOR'S COLLECTION AND CALCULATION FROM HCMC STOCK EXCHANGE AND BLOOMBERG VIETNAMESE DONG TO US $ (TR) - EXCHANGE RATE

Stationary test

This test is to examine if two or more time series are integrated of the same order and in a linear combination style. The augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1981) and Philips-Perron (PP) (Phillips and Perron, 1988) tests are used to determine the existence of unit roots. The ADF and PP tests are performed using the following regression:

$$\Delta P_t = \alpha + \beta P_{t-1} + \sum_{i=2}^{m} \gamma_i \Delta P_{t-i} + e_t \quad (1)$$

where P_t is the natural logarithm of price index. If β is not significantly different from zero, a unit root exists and the series is not stationary. If this is the case, a test for second moment is conducted in the same manner as follows:

$$\Delta R_t = \alpha + \beta R_{t-1} + \sum_{i=2}^{m} \gamma_i \Delta R_{t-i} + e_t \quad (2)$$

where $R_t=P_t-P_{t-1}$. If β is significantly different from zero, the R_t series is stationary and the time series is integrated at the first order.

Mean returns and volatility spillovers between stocks and property companies

The returns linkages between property companies and stocks are determined as the following equation:

$$R_t = a_0 + \sum a_p R_{t-p} + a_2 R_{stock} + \omega_t \quad (3)$$

where p, the highest lag in a country model, is determined with the highest determination ratio (R^2) and the lowest AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion). This model comes from the fact that property companies are considered as stocks and thus have the contemporary impact from the overall stock market. The degree of lag in property companies indicates the specific characteristics of each country market. The output has indicated that one lag is dominating across the market, although some are insignificant.

When testing for an explanatory power of lagged stock returns on the current property returns, all the thirteen countries showed insignificant impact. The results of this model are not presented here to keep focused on the significant model only. As such, this research presents only the current stock return on property return. This overall determined the current linkages of return property and stock index only.

When autocorrelations in residuals are found, the Exponential GARCH (EGARCH) (1,1) is used to detect the significant asymmetry and GARCH impacts in each market. An advantage of EGARCH over GARCH is that it is ideally suited to test the possibility of asymmetries in the volatility transmission mechanism. In other words, news generated in one market is evaluated in terms of both size (the quantity) and sign (the quality) by other markets. The conditional variance model for the property companies in an individual country market context can be specified as follows:

$$\log(h_t^2) = c_4 + c_5 \left| \frac{\omega_{t-1}}{h_{t-1}} \right| + c_6 \frac{\omega_{t-1}}{h_{t-1}} + c_7 \log(h_{t-1}^2) + c_8 \omega_{stock}^2 \quad (4)$$

This model allows for a time-varying conditional variance and that the conditional variance is modelled as a function of its past values and exogenous variables. If c_6=0, the model is symmetric. When c_6 <0, positive shocks (good news) generate less volatility than negative shocks (bad news). This model has also been tested for one lag of squared residual stock (ω^2_{t-1}) which was found insignificant across the markets and therefore was dropped out for simplicity.

To thoroughly assess the impact of the lagged volatilities of the local stocks, US stocks and US property companies on the thirteen property markets' performance, an EGARCH model is applied with one lag in all external variables (e.g.: local stocks, US stocks, US property companies) no matter if the data series are heteroskedastic. This allows the detection of possible changing significance in volatility when external variables are considered. The conditional variance model is as follows:

$$\log(h_t^2) = c_4 + c_5 \left| \frac{\omega_{t-1}}{h_{t-1}} \right| + c_6 \frac{\omega_{t-1}}{h_{t-1}} + c_7 \log(h_{t-1}^2) + \sum_8^{10} c_i \omega_{i,t-1}^2 \quad (5)$$

where C_8, C_9 and C_{10} are the coefficients for lagged residual of the local stock index, US stock index and US property index respectively. The inclusion of lagged volatility of the US stocks and US property companies, together with lagged volatility of the local stocks, did not change significantly the explanatory power in the mean returns. However, the coefficients of the conditional variance changed significantly.

Volatility spillovers across the tiers

This section assesses the volatility spillover in the property-only context at a tier level. It assesses the possible volatility spillover from the cross-tiers and the US property companies. Following the EGARCH model as in the country context, the mean and conditional variance equations are as follows:

$$R_t = a_0 + a_1 R_{t-1} + \omega_t \quad (6)$$

$$\log(h_t^2) = c_4 + c_5 \left| \frac{\omega_{t-1}}{h_{t-1}} \right| + c_6 \frac{\omega_{t-1}}{h_{t-1}} + c_7 \log(h_{t-1}^2) + \sum_8^{10} c_i \omega_{i,t-1}^2 \quad (7)$$

where C_is are coefficients of the two cross-tiers and the US property securities.

EMPIRICAL RESULTS AND DISCUSSION

Stationarity and unit root tests

Tables 3 and 4 present the tests for unit root on shares and property companies over the period of Jan. 1999 – Dec. 2009. The overall conclusion throughout the data statistics is that most of the data series are statistically significant non-stationarity in the level. However, the first difference series show statistically significant stationarity in both ADF and PP criteria, with the exception of Vietnam, where only PP criterion is significant at 1% level and ADF is statistically insignificant. This indicates a unit root but cointegration existence in the first difference of these data series. Thus, we can use these data series for our analysis as discussed in the methodology section.

Table 3: Data statistics description: Jan. 1999 – Dec. 2009

	Std. Dev.	Skew	Kurtosis	Probability
US property securities	58.89	0.67	2.21	0.0013
US stocks	193.52	-0.28	2.25	0.0891
T.1 index	81.87	0.93	2.66	0.0001
T.2 index	80.00	0.88	2.74	0.0002
T.3 index	304.98	1.15	2.83	-

Diagnostic tests for heteroskedasticity in the individual country context

In an individual country context, an equation to estimate the explanatory power of stocks returns and lagged property companies returns on the current property companies performance as discussed in the methodology section is made. The diagnostic tests for serial correlations (heteroskedasticity) are then conducted. Table 5 presents the diagnostic test for heteroskedasticity with the LM statistics, Breusch-Pagan-Godfrey and ARCH statistics in the country context. The statistic results are varying across the markets. This recognises Hong Kong, Malaysia, Thailand, China, India, Indonesia and Sri Lanka experienced heteroskedasticity at a statistical significance level, with Thailand showing significance in all three criteria, while China showing statistical significance in one criteria (ARCH statistics significant at 10%).

For those country data with hesteroskedasticity, an ARCH model to adjust for this characteristic is executed accordingly. The results of the EGARCH model for these countries are presented and then come the volatility from stocks to property companies across the markets of the thirteen countries.

Mean return and volatility spillovers in the individual country context

Table 6 presents the clustering in returns on property companies and volatility transmission on shares to property companies in the thirteen country property markets. All the country markets saw a positive and statistically significant explanatory power of stocks returns on the property companies returns at the 1% significance level. Particularly, this impact saw a magnitude level at 1.00 or greater in all countries with the exception of Sri Lanka (0.99) and Vietnam (0.98), where this impact is less than but close to 1.00. This implies higher returns recognised on property than on stocks when the market conditions are advantaged and vice versa, with more loss on property seen when the markets are declining. As such, when the stock markets are positive, investing in property brings more returns than the overall market performance does (see column C_3, Table 6). This finding is consistent with the previous study by Hoesli and Serrano (2007), where they determined high coefficient beta of stocks on property in Singapore, Hong Kong and at a lower degree, in Japan and the US, for which they attributed this feature to the high property developers in the first two countries.

On the other hand, a less significant clustering on lagged property companies returns was seen across the Asian property companies markets. A small magnitude impact of lagged property companies returns was also seen throughout the country markets as opposed to the significant magnitude impact from stock returns. In addition, not all of these lagged

property impacts are statistically significant. At a 1% statistical significance level of lagged property companies returns was seen in Malaysia and Thailand. Also at the 1% significance level, but a defensive impact was seen in Indonesia (coefficient = -0.121), while in Taiwan this explanatory power was significant at the 5% level. The last country market at 10% significance was the Hong Kong market, where property companies return can be explained by 5.6% changes in its lagged property companies. This impact level of lagged property companies return in Hong Kong is the lowest among the significant impact seen in the above mentioned countries (i.e.: Malaysia, Thailand, Indonesia and Taiwan) in absolute terms. Other countries in this study showed both the lower magnitude and insignificant impact of lagged property companies returns on current property companies performance (see column C_2, Table 6).

Table 4: Test for unit root on data series – property companies: Jan. 1999 – Dec.2009

	Level Series		First Difference	
Name	**ADF**	**PP**	**ADF**	**PP**
HK	-0.043	-0.043	-1.526***	-0.843***
Singapore	-0.018	-0.018	-0.804***	-0.762***
Japan	-0.022	-0.022	-0.680**	-0.877***
Korea	-0.015	-0.015	-0.769***	-1.014***
Malaysia	-0.109***	-0.051	-0.928***	-0.700***
Taiwan	-0.033	-0.033	-0.874***	-0.770***
Thailand	-0.024	-0.024	-0.875***	-0.835***
China	-0.010	-0.010	-0.717***	-0.861***
India	-0.005	-0.005	-0.844***	-0.826***
Indonesia	-0.033	-0.033	-1.142***	-0.976***
Philippine	-0.027	-0.027	-0.837***	-0.889***
Sri Lanka	0.016	-0.018**	-0.760**	-0.934***
VN	-0.098	-0.098	-0.790***	-0.736***
Tier 1	-0.017	-0.017	-0.913***	-0.779***
Tier 2	-0.015	-0.015	-0.902***	-0.912***
Tier 3	-0.005	-0.005	-0.526**	-0.712***

*** , ** *are significance at <1%, <5% respectively*

Table 5: Diagnostic test in the country context

	LM statistics	Breusch-Pagan-Godfrey	ARCH statistics
Singapore	0.039	0.243	0.185
Hong Kong	10.506***	6.208***	1.122
Japan	1.728	0.567	2.447
Malaysia	0.093	3.170**	3.220*
Taiwan	0.922	1.25	2.026
Thailand	6.388**	4.875***	3.299*
South Korea	2.029	1.465	0.894
China	0.916	1.286	3.103*
India	2.087	1.245	7.338***
Indonesia	11.934***	2.122	2.902*
Philippines	0.83	0.275	0.294
Vietnam	3.19	0.401	0.264
Sri Lanka	2.504	4.005**	0.034
With US property securities			
Tier 1	0.032	0.009	0.046
Tier 2	12.477*	0.743	0
Tier 3	0.502	1.576	0.046
With US stocks			
Tier 1	1.102	0.569	0.46
Tier 2	6.741**	0.213	1.291
Tier 3	1.943	1.055	0.005

*, **, *** *are significance at <1%, <5%, <10% respectively.*

Table 6: Volatility spillovers on properties: Jan. 1999 – Dec. 2009

	Coefficient				EGARCH				
Countries	Constant	Property companies returns t-1	t-2	Stock returns	C4	C5	C6	C7	C8
	(C1%)	(C_2)		(C3)					
Singapore	-0. 03		-0.047	1.148***					
Hong Kong	-0. 28	0.056*		1.089***	-7.454***	-0.101	0.148	0.012	293.571***
Japan	0. 34	0.012		1.107***					
Malaysia	-0. 85**	0.136***		1.129***					
Taiwan	-0. 07	0.142**		1.264***					
Thailand	-0. 25	0.103***		1.188***	-7.549***	-0.018	0.056	-0.014	297.436***
S.Korea	-0. 46	-0.080		1.055***					
China	-0. 58	0.036		1.052***	-7.228***	0.090	-0.019	0.012	186.466***
India	0. 02	0.066		1.301***					
Indonesia	-0. 02	-0.121***		1.063***	-5.954***	-0.093	-0.009	-0.043	52.095***
Philippines	-0. 14	0.025		1.182***					
Vietnam	2.28*	0.038		0.977***					
Sri Lanka	-0. 41	-0.060		0.987***	-7.430***	0.208	0.081	-0.047	201.230***

****, **, * are significance at <1%, <5%, <10% respectively.*
EGARCH coefficients are referred to text in methodology section from equation:

$$\log(h_t^2) = c_4 + c_5 \left| \frac{\omega_{t-1}}{h_{t-1}} \right| + c_6 \frac{\omega_{t-1}}{h_{t-1}} + c_7 \log(h_{t-1}^2) + c_8 \omega_{stock}^2$$

Table 7: Volatility spillovers on property companies: Jan. 1999 – Dec. 2009

	Coefficient			EGARCH						
Countries	**Constant**	**Property companies returns t-1**	**Stock returns**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
	(C_1%)	**(C_2)**	**(C_3)**							
Singapore	0.117	0.034	1.132***	-11.603***	0.180	-0.033	-0.788***	8.704	-56.002	6.279
Hong Kong	-0.135	0.01	1.089***	-0.444***	-0.267***	0.056	0.914***	30.062***	-7.837	-4.394*
Japan	0.610	0.037	1.369***	-0.038***	-0.151***	0.018	0.976***	19.545***	-39.362***	0.400
Malaysia	-0.91***	0.115***	1.120***	-5.105	0.506	0.064	0.272	19.456	75.134*	-18.650
Taiwan	-0.47	0.177***	1.322***	-5.697**	0.675**	0.055	-0.044	9.357	-51.744	22.480
Thailand	-0.53	0.114***	1.196***	-0.474	-0.286**	-0.111	0.903***	3.412	57.274*	-8.514
S.Korea	-0.09	-0.090*	1.066***	-0.317	-0.373*	-0.190**	0.868***	0.602	10.803	-11.173*
China	-0.69*	0.076	1.017***	-0.200	-0.262**	-0.043	0.925***	10.231***	-66.233***	6.948**
India	0.61	0.104***	1.534***	-6.254***	1.171***	0.150	-0.225	-24.040**	-19.070	-45.193***
Indonesia	-1.05	-0.214***	1.187***	-8.132***	0.267*	0.343***	-0.779***	-2.718	38.339	-12.506
Philippines	-0.27	0.010	1.190***	-4.813***	-0.142	0.172	0.282	15.745	105.008*	-1.083
Vietnam	1.85***	0.028	0.886***	-4.587***	-2.452***	0.423	0.067	62.522**	183.699	-15.635
Sri Lanka	-1.00	-0.108	0.894***	-5.510***	0.621**	0.026	-0.003	3.699	-186.391***	21.820

****, **, * are significance at <1%, <5%, <10% respectively.*

EGARCH coefficients are referred to text in methodology section from equation:

$$\log(h_t^2) = c_4 + c_5 \left| \frac{\omega_{t-1}}{h_{t-1}} \right| + c_6 \frac{\omega_{t-1}}{h_{t-1}} + c_7 \log(h_{t-1}^2) + \sum_{8}^{10} c_i \omega_{i,t-1}^2$$

C_8: local stock index, C_9: US stock index, C_{10}: US property index

The overall impact of the lagged property companies return on the current property companies return was insignificant and low magnifying. This is indicative of an insignificant impact of the historical information on property companies performance. In other words, the past performance of the property companies market carried little information, provided low adjustments on its present performance as opposed to the respective local stock market, which carried more information, and had higher adjusting power on the property companies performance. Importantly, the performance of property companies is more aggressive than the current stock market. On the one hand, this finding indicates that property companies performed like the small and growth stocks, thus growing faster in the boom market and falling faster in the bust market, which is consistent with the finding by Chatrath et al (2000) for REITs' beta being similar to small cap stock beta. On the other hand, it indicates property companies in Asian markets were more risky and volatile due to high proportion of property activities in Asia is development (Newell and Chau, 1996, Liow, 1997). As such, this finding is consistent with those in the previous study by Hoesli and Serrano (2007).

A constant parameter defining property companies returns is insignificant throughout the thirteen country markets with the exception of Malaysia (5% statistical significance) and Vietnam (10% statistical significance). The overall magnitude of these constants are small also (less than 0.3%), with most of them being negative. Because these constant parameters are statistically insignificant and small in magnitude, they are almost negligible (see column C1, Table 6).

Overall, property companies returns in individual countries showed that they have no excessive return compared to the stock index, and are more aggressive than the respective local equity indices. On the other hand, lagged property companies returns provided little explanatory power in the current property returns. When testing for an impact of lagged stock returns on the current property companies returns, all the thirteen countries showed insignificant impact. The results of this model are not presented here to keep focused on the significant model only. As such, this research presents only the current stock return on property companies return. This overall determined the current linkages of property return and stock index only.

Regarding the volatility spillovers in the EGARCH part, Table 6 presents the conditional variance of the country markets where heteroskedasticity was found in diagnostic tests (i.e.: Hong Kong, Thailand, China, Indonesia and Sri Lanka). A significant impact of the stocks volatility on the property companies (see column C_8, Table 6) was seen in Hong Kong, Thailand, China and Sri Lanka (at 1% level). The constant parameters (C_4) were statistically significant at the 1% level in these five countries also. However, all other parameters (C_5, C_6, C_7) were insignificant in the EGARCH model. This indicates that the return models inherited from the stock volatility (ω^2). As such, the only factor to have a significant impact on the non-stationary volatility of the property companies is the squared residual return on stock exponentially. That is property companies return volatility is multiplied at $e^{c_8\omega^2_{stock}}$. In this EGARCH model, the impact of lagged volatility was not statistically significant on the current volatility of property companies returns.

To thoroughly assess the impact of the lagged volatilities of the local stocks, US stocks and US property on the thirteen property companies markets' performance, Table 7 presents the returns and volatility spillovers from the local stocks, US stocks and US property companies on the thirteen individual country markets in the EGARCH model. With the lagged volatility spillovers from local stocks, US stocks and US property securities, the magnitude (size) of the coefficients C_1, C_2 and C_3 have changed.

Particularly, the statistical significance is unchanged, except for South Korea (C_2 was more significant with bigger absolute value from -0.0802 to -0.0902) and China (C1 was more significant and bigger absolute value from -0.58% to -0.69%), with biggest change in Vietnam (C_1 was more significant and smaller absolute value from 2.28% to 1.85%). Hong Kong was the only country to see reducing significance levels on the lagged property companies returns (C_2 statistically insignificant in the second model). A moderately smaller change in size from stock returns was seen in Singapore (C_3=1.1315 from 1.1480), Malaysia (C_3=1.1195 from 1.1291), China (C_3=1.0172 from 1.0521), Vietnam (C_3=0.8858 from 0.9772) and Sri Lanka (C_3=0.8941 from 0.9874). These are the countries that saw a reducing impact of stocks in the existence of lagged volatility spillover from local stocks, US stocks and US property companies. The other countries (Japan, Taiwan, Thailand, South Korea, India, Indonesia and the Philippines) saw increasing impact from the local stock returns while Hong Kong saw this unchanged.

All the volatility spillovers are one-lag, e.g.: $\log(h_t^2) = c_4 + c_5\left|\frac{\omega_{t-1}}{h_{t-1}}\right| + c_6\,\frac{\omega_{t-1}}{h_{t-1}} + c_7\,\log(h_{t-1}^2) + \sum_8^{10} c_i\,\omega_{i,t-1}^2$

C_8: local stock index, C_9: US stock index, C_{10}: US property index

In this lagged volatility-only model, South Korea and Indonesia saw asymmetric leverage effects. Particularly, South Korea saw a negative effect (C_6 = -0.1895 significant at 5%), which means good news will generate less volatility than

bad news, whilst Indonesia saw a positive effect (C_6=0.3429, significant at 1%), meaning good news will generate more volatility than bad news.

The lagged self-impact was seen to be 1% statistically significant in Singapore (C_7 = -0.7880), Hong Kong (C_7 = 0.9141), Japan (C_7 = 0.9755), Thailand (C_7 = 0.9034), South Korea (C_7 = 0.8679), China (C_7 = 0.9247) and Indonesia (C_7 = 0.7789), while the lagged residual of local stocks saw 1% statistical significance in Hong Kong (C_8 = 30.0617), Japan (C_8 = 19.5453), China (C_8 = 10.2310) and 5% statistical significance in India (C_8 = -24.0403), and Vietnam (C_8 = 62.5219).

Statistically significant volatility spillovers from US stocks and US property companies were less common. Particularly, the lagged residual of US stocks 1% significantly affected Japan (C_9 = -39.3623), China (C_9 = -66.2329) and Sri Lanka (C_9 = 186.3909), 10% significantly affected Thailand (C9 = 57.2736) and the Philippines (C_9 = 105.0076). On the other hand, the lagged residual of the US property companies 1% significantly affected India (C_{10} = -45.1925), 5% significantly affected China (C_{10} = 6.9481), 10% significantly affected Hong Kong (C_{10} = -4.3935) and South Korea (C_{10} = -11.173). As such, Taiwan is the only country that saw an insignificant impact from such observed factors as asymmetry (C_6), lagged volatility (C_7), lagged residual of local stocks (C_8), US stocks (C_9) and US property (C_{10}).

In brief, whilst all the thirteen property companies country markets showed significant linkage to current stocks, only Hong Kong, Thailand, China, Indonesia and Sri Lanka showed heteroskedasticity, being significantly affected by the current residual from local stocks. All the thirteen property companies markets showed a significant impact from either asymmetry effects (South Korea, Indonesia), lagged volatility effects (Singapore, Hong Kong, Japan, Thailand, South Korea, China and Indonesia), lagged residual returns from local stocks (Hong Kong, Japan, China, India and Vietnam), lagged residual returns from the US stocks (Japan, China, Sri Lanka, Thailand and the Philippines) and lagged residual returns from the US property companies (India, China, Hong Kong and South Korea). Taiwan constantly saw no spillover impact in both models. These findings are consistent to and expand further from those in the previous study that property securities markets are linked at a less degree than those seen amongst the stock markets (Liow et al, 2008). Particularly, while Liow et al (2008) determine the linkages in property or stocks only, this research assessed the cross linkage between the property companies return and stock return in an expanded model.

The various findings have multiple implications in the investment strategy. The first common finding across the markets is the property companies return. They are aggressive compared to the local stock market even in such a traditional property companies market as Japan. The diversified performance amongst the markets is affected with their volatility linkages. While the asymmetric effects seen in South Korea and Indonesia remind the investors of the expected asymmetric reactions by the market participants, the volatility spillovers from the local stocks, US stocks and property companies also help investors in deploying their diversified portfolios, with a negative linkage increasing the diversification benefits whereas a positive increasing volatility and reducing diversification value.

Volatility spillovers across the tiers

In the property-only context, this section assesses the possible volatility spillover from the cross-tiers and US property companies. Table 8 presents the volatility transmission on US property companies and the three tiers to each tier in a capitalisation-weighted index. US property companies was found to have insignificant influence across the tiers. On the contrary, tier 1 has significant lagged volatility impact across the three tiers. The finding is quite interesting where the world-leading property had insignificant spillover impact but the developed property tier had significant impact on the regional tier, which provides implication for the investors in forecasting performance and deploying diversification strategy.

Compared the self-spillover among the three tiers, the self-volatility spillover of tier 1 was found highest, with lowest self-impact being tier 3. This can be explained by the offset effect of self-diversification amongst the tier 3 countries and thus eliminate the self-spillover in this tier (coefficient=0.9809; 0.8016; 0.5170 for self impact of tier 1, tier 2 and tier 3). When the markets turned down, both the reduced return and reduced capital of constituent markets have impact on the capitalisation-weighted index.

In particular, tier 1 received significant spillover impact from itself and tier 3. This indicates a significant role of tier 3 over tier 1. This surprising fact may be partly understood with the increasing significant economic relationship between the developed property companies markets (tier 1) and the less emerging property companies markets (tier 3), especially with such tier-leading countries as China, India and Indonesia.

Table 8: Volatility spillovers on property companies: Jan. 1999 – Dec. 2009

From lagged → / To ↓	Tier 1	Tier 2	Tier 3	US property companies
Tier 1	0.9809***	-1.6322	5.5340***	-2.7065
Tier 2	14.4265*	0.8016***	10.8557***	-3.1288
Tier 3	58.536***	-7.7541	0.5170***	30.5054

** **, **, * are significance at <1%, <5%, <10% respectively.*

EGARCH coefficients (C_7 and C_i) are extracted from equation:

$$\log(h_t^2) = c_4 + c_5\left|\frac{\omega_{t-1}}{h_{t-1}}\right| + c_6\frac{\omega_{t-1}}{h_{t-1}} + c_7\log(h_{t-1}^2) + \sum_{8}^{10} c_i\omega_{i,t-1}^2$$

i: cross tiers and US property securities

On the contrary, tier 2 saw a statistically insignificant impact of the lagged volatility to the other tiers in the region. However, it received significant spillover from tier 3 besides tier 1, with coefficient impact from tier 3 (coefficient=10.8557) less than from tier 1 (coefficient=14.4265).

Less emerged than tier 2, tier 3's volatility saw a statistically significant impact from the lagged volatility of tier 1 besides itself only. This indicates an increasingly important role of tier 3 over tier 2. Together with the above finding of the spillover from tier 3 to tier 1, the significant role of tier 3 in the region is further reinforced.

Overall, the degree of volatility spillovers showed statistical significance as well as the magnitude in the capitalisation-weighted index among the tiers, with insignificant impact from US property companies across the three tiers. Tier 1 determines its role in the region for its consistently significant spillovers to the other tiers. This may highlight the magnifying role of the sized capital in the capitalisation-weighted method, where China and India take the significant market shares in the region and globally. A similar assessment on the degree of volatility spillovers showed higher statistical significance and magnitude in the capitalisation-weighted index than in the equal-weighted index among the tiers, with the result available upon request of the author.

IMPLICATIONS AND CONCLUSIONS

This study has presented the empirical analysis of volatility spillover characteristics of the Asian property securities on the country and tier basis using capitalisation-weighted index over the period of Jan. 1999 – Dec. 2009. The thirteen Asian property companies markets were categorised into three tiers, with tier 1 (Japan, Hong Kong, Singapore) being the developed markets, tier 2 (Malaysia, Korea, Taiwan, Thailand) the emerging markets and tier 3 (China, India, Indonesia, Philippines, Sri Lanka, Vietnam) the lesser emerging markets.

The property companies return in a country market saw significant and greater than 1.00 linkage of stock returns across the markets, whilst the past property companies returns had insignificant and small magnitude effects. Property companies returns in Hong Kong, Malaysia, Thailand, Indonesia and Taiwan saw significant linkages with their lagged property returns. This has implications that the Asian property companies behave like the small and growth stocks in their local markets.

Without considering the lagged volatility contagions from the self market and the US markets, Hong Kong, Thailand, China, Indonesia and Sri Lanka saw significant volatility spillover from the respective local stock volatility on these property companies markets.

In a thorough assessment of volatility spillovers from local stocks and US assets, except for Taiwan where property companies received no significant spillover from any components of lagged self-volatility or lagged volatility of its local stocks, US stocks or US property companies, all of the other property country markets saw at least one of these components being significant.

The least impact receiving countries were Singapore (received lagged self-volatility impact), Malaysia, the Philippines, Sri Lanka (received lagged volatility impact from the US stocks) and Vietnam (received lagged volatility impact from local stocks).

Thailand property companies saw an impact from self-volatility and US stocks, while India received an impact from its local stocks and US property companies. Indonesia experienced both positive asymmetry and self-volatility. Hong Kong property companies received volatility impacts from itself, its local stocks and US property companies, while Japan also got volatility impacts from itself, its local stocks and US stocks. South Korea saw impacts from negative asymmetry, volatility from itself and US property companies. Last, China experienced volatility impacts from the four components: itself, its local stocks, US stocks and US property companies. These findings not only provide insightful understanding of local property companies and stock market dynamics in Asia; they also have implications for investment diversifying strategies.

The diversified performance on the markets is affected by their volatility linkages. While the asymmetric effects seen in South Korea and Indonesia remind investors of the expected reactions by the market participants, the volatility spillovers from local stocks, US stocks and US property companies also help investors in deploying their diversified portfolios, with a negative linkage increasing the diversification benefits, and a positive linkage increasing more volatility, thus reducing diversification value.

Table 9: Summary of country spillover characteristics

Countries	Asymmetry	Self-spillover	Local stock	US stocks	US property companies	Trends
Singapore	X	√	X	X	X	Self-spillover both index methods
Hong Kong	X	√	√	X	√	
Japan	X	√	√	√	X	
Malaysia	X	X	X	√	X	Not impact by local stocks
Taiwan	X	X	X	X	X	
Thailand	X	√	X	√	X	
South Korea	√	√	X	X	√	
China	X	√	√	√	√	Moderate to high spillover factors
India	X	X	√	X	√	
Indonesia	√	√	X	X	X	
Philippines	X	X	X	√	X	Low spillover factors
Vietnam	X	X	√	X	X	
Sri Lanka	X	X	X	√	X	

x: insignificant impact, ✓: significant impact

In a tier context, significant and magnifying spillovers were found amongst the tiers in the capitalisation-weighted index, with insignificant impact from US property companies across the tiers. Tier 1 determines its stable role in the region with significant spillovers to the other tiers, and the heteroskedasticity in the tier series. This indicates the significant, yet unstable, role of tier 3 countries in the region. It also highlights the magnifying role of the capital in the capitalisation-weighted method, where China and India take the significant shares in the region and globally.

The volatility spillover analysis highlights the stable performance of tier 1 and emerging role of tier 3, whilst it determines the insignificant impact of US property companies to the volatility of Asian property companies.

Table 9 provides a summary of the spillover features by these countries. This sees the highest consistency level in spillover effects among the tier 1 countries and lowest consistency level among the tier 3 countries. As all the developed property countries experienced a high self-spillover, it was also seen in this tier. Hong Kong and Japan saw significant spillovers from its local stocks and the US market but none was seen in Singapore. This seems to stem from the close economic relationships between Hong Kong and Japan than Singapore with the US economy. The tier 2 countries saw no spillover from the local stocks. Except for Taiwan where no significant impact was found, the other countries in tier 2 received some impact from the US market.

Although tier 3 countries saw high diversification throughout, the leading countries of this tier (i.e.: China, India and Indonesia) saw a high number of spillover factors (as in China) or moderate spillover factors (as in India and Indonesia), whereas the bottom-line countries of the tier (the Philippines, Vietnam and Sri Lanka) saw only one spillover factor throughout. Whilst this low spillover may reflect the unique characteristics of each individual property country market, it probably reflects the low integration of these countries to the global market. For example, the Philippines market saw only one spillover factor from US stocks. It is not very surprising that this is related to the country economic background, where the country economy has been leaning on the BPO industry and the remittance from the overseas Filipino workers (Nguyen, 2011b). Similarly, Vietnam has the boom stock market and foreign investment in recent years, which is believed to support property investment as a safe haven when the stock market is not producing profits. As such, this seems to be consistent with the spillover factor found in the Vietnam property market in this research. On the other hand, Sri Lanka has just recovered from the civil war and is still relatively isolated from the global market with little attention from the investors, which partly explains for its low spillover effects.

Nevertheless, there are some limitations in this study. The analysis of the 13 countries is limited in the volatility transmission between shares to property companies, whilst a number of other macro-economic variables may be appropriate as well. This assumes that those possible macro-economic variables are kept unchanged or were already reflected in the changing stock index. If this is not the case, a country-specific model may be more appropriate. Due to the short time span in data series across the country markets, an analysis across countries is unable to conducted, especially when the newly emerging countries such as Vietnam and Sri Lanka are included. These limitations promise a later analysis in the asymmetric volatility spillover amongst markets as well as different approaches in studying the different tiers.

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