

The dynamics of volatility for Asian listed property companies during the global financial crisis

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This paper examines the dynamics of return and volatility for listed property company markets across the major Asian countries over sub-periods based on the global financial crisis (GFC). The GFC and Eurozone crisis have shifted investors' focus to investment in the Asian region, making it an opportunistic and dynamic region in terms of property portfolio investment. As such, it is of interest to assess return and volatility levels in the Asian region during the global financial crisis. This paper uses EGARCH models to empirically examine the dynamic volatility of listed property companies in 12 Asian countries. The findings reveal that, for the past 15 years, Asia had experienced moderate volatility levels in term of investment in listed property companies, including during the GFC. This study contributes to the empirical literature on the volatility dynamics for Asian property market allocations in international real estate portfolios, especially during a major financial crisis. In particular, the findings from this study will be useful for international investors to better understand the volatility profile of Asian listed property companies during the GFC.

Keywords: GFC; listed property companies; Asian; returns; volatility

Introduction

This paper examines the significance and performance of Asian-listed property companies. The analyses also look at the impact of the Global Financial Crisis (GFC) on the property securities market in Asian countries. By establishing three different periods, pre-GFC, GFC and post GFC, sub-period performance is assessed to allow a fuller understanding of the dynamics of an Asian markets property portfolio. Furthermore, the analyses identify the dynamics of the Asian property securities market. The analyses also compare the Asian markets property portfolios within itself in terms of the role, performance, risk and return profile and volatility of markets.

The significance of global listed property companies has been widely discussed over the past decade. Prior investigation has considered various aspects of analysis to assess the performance of listed property companies in the form of statistical analysis, surveys, academic and industrial literature. Strong growth and outstanding risk-adjusted performance by securitised real estate markets has recently made international investors increasingly interested in real estate allocations in their portfolio. Further, the level of securitised property at the global level is approximately 19% (Australia), 26% (Hong Kong), 14% (Singapore), 7% (UK) and 14% (USA) (EPRA, 2012). Asian countries have made significant contributions to the growth in global property securities.

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Consequently, the significance and performance of the Asian-securitised real estate sector justifies interest from global investors.

Past literature considers the risk-return performance and correlation dynamics of global real estate securities. For instance, Liow and Adair (2009) examine the role of Asian real estate companies with regard to their value-added performance. An earlier study by Ooi and Liow (2004) also investigates performance of real estate stocks in seven developing markets in East Asia. Liow (2008) also assessed the international securitised real estate markets to validate the evidence of prior stock market long memory volatilities. Furthermore, Liow and Sim (2006) examined the risk and return of Asian real estate stocks from an American investors' viewpoint. A similar study has also been undertaken by Addae-Dapaah and Loh (2005) which examined the performance of emerging real estate markets against that of developed markets. Further research on risk-return performance was undertaken by Mei and Hui (2004) who examined the time variation of expected returns on Asian property stocks. The performance of listed property companies involving 13 Asian countries was also studied comprehensively by Nguyen (2011a). Jin, Grissom, and Ziobrowski (2007) examined the performance of mixed-asset portfolios for six Asian countries including Australia and New Zealand. Continuing research on the performance of global listed real estate companies has become increasingly important, especially to institutional investors. The global real estate securities market has significantly developed over the past decade, both in market capitalisation and the number of listed property companies, being set to continue to grow.

Much research has been undertaken on stock markets and US REITs as well as developed Asian countries such as Japan, Singapore and Hong Kong. As for emerging markets, such as China, Taiwan, South Korea, Malaysia and Indonesia, the literature and analysis on such markets is currently limited. Apart from providing an insight for this study based on each country's point of view, the inclusion of the US, UK and other developed countries in the study will provide an opportunity to make comparisons between the results from Asia and from each of those developed countries' real estate markets. Lim's research (2002) highlighted the importance of the South East Asian region. For the purpose of establishing an investment portfolio profile for listed property companies in Asian countries, a range of investment variables and analyses will be discussed in this research.

Significance Of Asian Listed Property Companies

The international investment market offers a wider choice for property investors and fund managers, with the Asian region providing many opportunities for investment. Foreign investment in Asian countries has been increasingly significant in recent years and is promising to recover after the downturn of the GFC. Asian countries have shown remarkable economic performance in recent years, despite being affected by several financial crises such as the GFC and the Eurozone crisis (see Table 1). This trend is evident through the increasing foreign capital flows in all economic areas and an improvement in the business environment in recent years. Real estate investment is strongly influenced by economic conditions, such as economic growth, inflation, interest rates, employment and financial crises. Asian countries have proven to be strong in terms of economic growth.

Following growth in investable funds, Asian property companies have attracted the attention of regional and international investors. With fast growing economies

Table 1. Summary of socio-economic background for pan-Asian countries: 2011.

Country	Land area (Sq. km)	Population (Millions)	Capital	Currency	Nominal GDP (USD bn)	Per capita GDP (USD)
Vietnam	331,688	87	Hanoi	Dong	104	1163
Thailand	513,115	67	Bangkok	THB	333	4957
Taiwan	36,191	23	Taipei	NTD	430	18,588
South Korea	99,897	489	Seoul	KRW	1015	20,907
Singapore	712.4	5	Singapore	SGD	233	46,015
Malaysia	330,252	28	Kuala Lumpur	MYR	238	8531.8
Japan	377,835	128	Tokyo	JPY	5877	45,904
Indonesia	1,920,000	237	Jakarta	IDR	708	3038
India	3,278,263	1210	New Delhi	INR	1648	1355
Hong Kong SAR	1104	7	Hong Kong	HKD	245	34,488
PR China	9,600,000	1355	Beijing	RMB	5985	4345

Source: Calculated from DTZ Asia, 2012.

throughout the region, Asia has several national markets that are mature in terms of market complexity, transparency and competitiveness (Nguyen, 2011). Recent years have seen a significant improvement in the level of maturity and transparency in the Asian property market (Chin, Topintzi, Hobbs, Mansour, & Keng, 2007). With improving maturity in the Asian markets, cities such as Shanghai, Beijing, Hong Kong, Singapore, Kuala Lumpur, Seoul and Tokyo have emerged as major global cities. Currently, Asian property markets comprise 50% of global property transactions, 46% by value of investable commercial property and 47% of cross-border investment in Asia (RCA, 2011). Commercial property in Asia comprised approximately US\$279 billion in value in 2010, as compared to only US\$147 billion in 2007 (RCA, 2011). These figures clearly show that Asia plays a significant role in the global commercial property market and has sophisticated commercial property and financial markets.

Listed property companies have become an increasingly important investment vehicle in Asia and internationally (Steinert and Crowe, 2001). Several Asian countries, such as Japan, Korea, Singapore, Hong Kong and Malaysia, also introduced REITs. However, most of the Asian real estate markets are still in the developing stage. As such, the markets may experience higher volatility compared to other mature markets such as the USA, UK and Australia. However, the Asian markets have shown strong performance over the last four years. Figure 1 depicts the total returns for Asian countries by currencies and sectors, clearly showing a wide range of returns from 0.1% to 23.9%. Over the last 4 years, the weighted local currency return for Pan Asia was 5.6% per year, comprising an income return of 5.1% per year and a capital return of just 0.5% per year (IPD, 2011). Despite having the worst performance in 2009, the property markets in Asia showed some recovery in 2010. In addition, Asian countries recorded higher returns than their counterparts in Europe and the US. In 2010, the Asian property market return was 17.2%, compared to the US 14.2%, and Europe 4.0% (IPD, 2011).

Previous studies have shown several results with different time lines. A recent study by Nguyen (2011a) revealed that, in spite of the various backgrounds and different

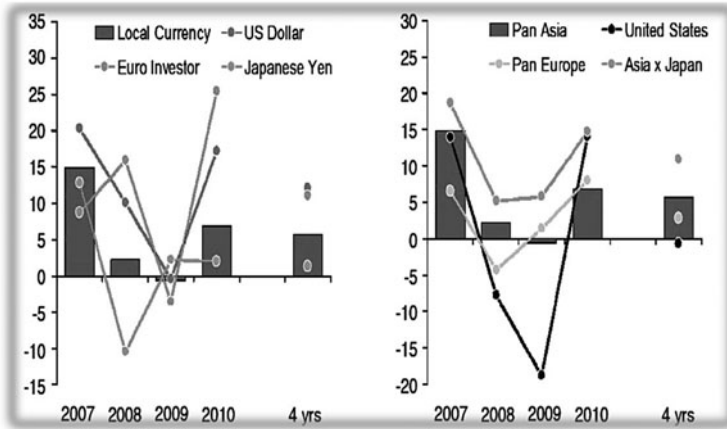


Figure 1. The Asian property market total return by country and currencies. Source: IPD (2011).

level of maturity and growth rate, all the Asian property markets are significantly growing and moving towards a region-wide market. Her study revealed that the lesser emerging Asian markets, such as China, India, Indonesia, Philippines, Sri Lanka and Vietnam, were the best performing over the period January 1999–December 2009 followed by the developing Asian markets (Singapore, Hong Kong and Japan). Emerging markets, such as Malaysia, South Korea, Taiwan and Thailand, had the lowest performance result over this period. Another study by Newell, Chau, Wong, and Liow (2009) investigated the performance of Asian countries based on an International Financial Centres (IFCs) classification. In their study, IFC markets, such as Hong Kong, Singapore and Tokyo, showed lower average annual return than most of the non-IFC markets (Bangkok, Jakarta, Kuala Lumpur, Manila, Shanghai and Taipei).

The introduction of REITs has provided a new investment vehicle for property investment in Asia, being introduced in the early 2000s. Several countries have established REIT regulations to accelerate investment in REITs, such as Japan, Singapore, Hong Kong, Malaysia, Taiwan, Thailand and South Korea. The successful REIT markets such as Japan and Singapore have triggered other major Asian countries, such as India and China, to follow suit. The Philippines and Indonesia are progressing in establishing a REIT market. There are significantly different structures between listed property companies and REITs. For REITs, each country has its own structure which aims to boost the growth of the REIT market. Table 2 presents the structure of Asian REITs. Every Asian country's REITs have their own regulation and structure. For instance, some countries including most of Asia, set up an external management structure, whereas Hong Kong, South Korea and Taiwan set up both internal and external structures.

Listed real estate securities can be regarded as one of the most important indirect vehicles for real estate investment, providing investors with liquidity, sector divisibility and diversification with low transaction costs (Chin et. al., 2007). REITs are generally considered less risky due to their lower level of debt and higher dividend yields, while listed property companies' exposure to development tends to be higher and dividend yields tend to be lower (Chin et. al., 2007). For example, in Malaysia, the real estate

Table 2. Asian REIT legislation overview.

	Japan	Singapore	Hong Kong	South Korea	Taiwan	Thailand	Malaysia
Structure	Trust or corporate	Collective investment scheme	Unit trust	Corporate restructuring, entrusted management, development-specialised, self-managed	Trust	Closed-end	Unit trust
Management Structure	External	External	Internal/External	Internal	Internal/External	External	External
% Invested in real estate	75% of assets must be invested in real estate	70% of deposited property should be invested in real estate or real estate related assets.	Only invest in real estate	At least 70% in real estates or corporate restructuring related properties	Cash, government bonds, property, property-related right, beneficiaries securities or property.	Must invest at least 75% of NAV in property	At least 50% of a fund's total asset value must be invested in real estate and/or single purpose companies at all times.
Geographical restrictions	No	No	No	No	No	Thailand only	No
Property developments	Restricted- at least 50% of total assets are income producing and unlikely be sold within one year	Property developments and investments in uncompleted projects should not exceed 10%	Prohibited	Allow	Allow	May acquire properties over 80% completed but prohibited to invest in dormant land	Prohibited but may enter into conditional forwards purchase agreement
Leverage	No restrictions	Over 35% of total assets permitted with disclosed credit rating	Capped at 45% of gross asset value	REITs are permitted to have exceptional borrowing up to 100% of equity capital, upon special approval of shareholders	Varies based on credit rating	Not more than 10% of NAV	50% of total asset value

(Continued)

Table 2. (Continued).

	Japan	Singapore	Hong Kong	South Korea	Taiwan	Thailand	Malaysia
Dividend payout	At least 90% of distributable income to qualify for tax deduction	At least 90%	At least 90%	At least 90%	At least 90%	At least 90%	Not specified in the M REIT guideline

Source: CBRE (2010).

securities market is largely dominated by listed property companies known as property shares and REITs (Lee and Ting, 2009). Listed property companies have historically been active participants in the underlying direct property markets (Nguyen, 2011a). The structure of listed property companies may be viewed from the advantages and disadvantages of investment, as tabulated in Table 3. Generally, the cost for entry and exit for listed property companies is quite low with high levels of liquidity and transparency, but with leverage. When there is an abundant supply of properties, listed property companies are also able to enhance returns via market timing. Investment in listed property companies can be considered to be within an efficient market.

REITs in Asia have shown tremendous growth over the last decades, being a major growth driver for property investment. Japan has led the REITs market in Asia in terms of market capitalisation, together with Hong Kong and Singapore. The development of Asian REITs is further supported by favourable changes in regulatory structures in recent years (Pham, 2013). Table 4 shows the total market capitalisation of Asian REITs. Over the past 8 years, Japan consistently led the REITs market by recording the highest market capitalisation amongst the Asian countries. Some REIT markets in countries such as Malaysia and Taiwan are only small, being difficult to invest within due to their size and to investor sentiment, as highlighted by Huerta, Jackson, and Ngo (2015). The authors found that institutional investor sentiment was a significant factor in explaining REIT returns, adding that this factor has a stronger impact on the small capitalisation REIT market.

Recently, due to the debt crisis in Europe and the US, investors have tried to find new opportunities to invest in Asian countries. A combination of negative real interest rates and appreciating real exchange rates makes continuing to invest in Asian real estate an attractive option for investors (JLL, 2011). In the medium to long-term period, Asian economies will be underpinned by six socio-economic trends which in turn will drive Asian property markets: demographics, rising income levels, infrastructural developments, tourism and economic restructuring (DTZ, 2011). Figure 2 shows the global property securities market at September 2011, clearly illustrating Asian countries in the lead when looking at the two major benchmarking performances, being number of companies and market capitalisation. Asian countries have shown remarkable performance, especially post-GFC, with a total of US\$130 billion invested in Asia-Pacific regional countries on cross-border investment influx (CBRE, 2011).

Table 3. Advantages and disadvantages of listed property companies.

Advantages	Disadvantages
Low entry and exit costs	Reduced portfolio diversification benefits as performance is highly correlated with shares
High liquidity and transparency	Negligible control
Diversified exposure	Most companies employ leverage
Access to expert management	
National, regional and global benchmark	
Range of style-core, value-adding and opportunistic	
Ability to enhance returns via market timing	
Abundant supply	
Efficient market place	
Traded on stock exchange	

Table 4. Size of REIT market capitalisation in Asia 2012 (USD Million).

Country	Dec 2007	Dec 2008	Dec 2009	Dec 2010	Dec 2011	Dec 2012	Dec 2013
Japan	41,197	28,396	27,835	45,167	37,810	50,193	71,199
Singapore	15,913	7435	17,551	23,975	23,847	36,391	40,301
Hong Kong	8614	5951	9591	12,376	12,432	17,554	17,189
Malaysia	1276	971	1283	3073	3765	6474	6808
Taiwan	1531	1350	1635	1882	2045	2636	2759
Total	68,530	44,104	57,895	86,473	79,899	113,247	138,255

Source: Atchison and Yeung (2014).

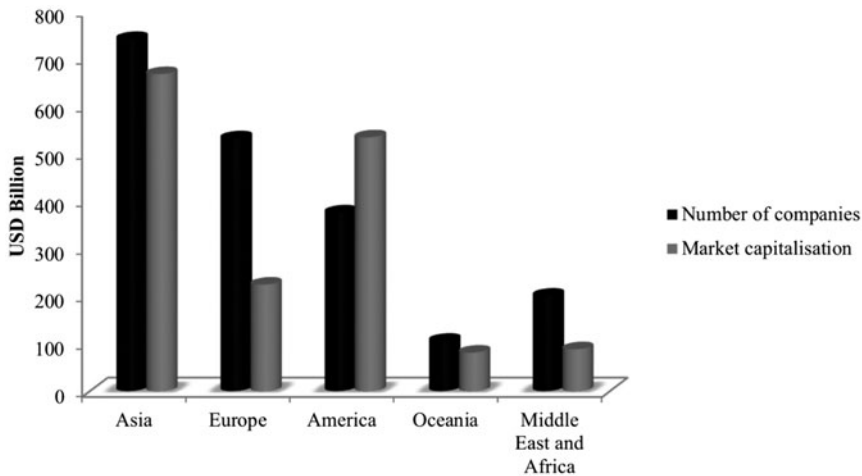


Figure 2. Global property securities composition by continents: September 2011.

Source: Author's calculation from Macquaries Securities (2011).

Cushman and Wakefield (2011) identify the outlook for the Asian region markets to be strong growth, as illustrated in the GDP growth forecast for 2011 and 2012. This indicates that, although the Asian region was hit by several financial crises such as the Asian financial crisis (AFC), the GFC and the recent Eurozone crisis, it remains dynamic in terms of growth. However, as the market is still volatile, investors are interested in the impact of the crisis on the market, in particular on the property securities market. Issues affecting performance, diversification and volatility remain the main concern amongst investors.

Liow, Ooi, and Gong (2005) investigated cross-market dynamics in property stock markets for several countries in Asia and Europe as the subject for their case studies. Their analysis attempted to analyse the relationship between equally weighted Asian and European regional property stock indices. Their findings suggest that conditional volatility in some countries' property stock market is mainly influenced by their own past volatility. The theory of risk or volatility is further explained by Liow and Webb (2006) who emphasise the more common risk factors within a country rather than across countries. They determined that at least one common property securities market factor is moderately correlated with the world property market and to a lesser extent with the world stock market. Subsequently, research by Liow (2010) examined a

hypothesis based on three main determinants of firm value for real estate companies, being growth, profitability and leverage. The author also examined financial variables in explaining and predicting the level of two measures of success of the stock market: Sharpe Ratio and Jensen's Alpha. The findings revealed that successful real estate companies (i.e.: those with positive JI and above-average SI performances) are generally larger in size and command attractive market valuations relative to their underlying book value. They are usually profitable and are likely to take advantage of positive financial leverage effects, contributing to higher SGR and profitable growth in the longer term.

Liow and Sim (2006) created a risk-return profile of Asian real estate stocks, comprising ten Asian countries plus the UK and US for benchmarking comparisons. Their findings revealed that most of the Asian real estate stock markets are still in the developing stage and so have low return on investment compared to their counterparts in the UK and US. They have also experienced a higher level of volatility. The analysis sheds light on the attractiveness of Asian real estate stock markets, extending the mixed-asset portfolio analysis conducted by Jin et al. (2007). The analysis included the Asia-Pacific markets which comprise Asia, Australia and New Zealand, from the perspective of US investors. The findings revealed that, over the period 1998–2005, the Asia-Pacific markets experienced the highest rate of return and the highest variance from common stocks. In addition, during the post-AFC period, emerging markets provided a higher return coupled with higher volatility than that from advanced markets in developed countries.

Ooi and Liow (2004) produced a risk-adjusted performance profile of real estate stocks between developing markets in Asia. Panel regression was used to identify how firm-specific attributes and time-varying factors affected the risk-adjusted returns. The results indicate that real estate stocks in Hong Kong and Singapore were the most profitable on a risk-adjusted basis. Furthermore, real estate stock markets in Hong Kong, Indonesia, Malaysia, Singapore and Thailand under-performed the general stocks between 1992 and 2002. The analysis also suggested a bright prospect for REIT stocks in Asian countries.

Whether Asian real estate markets have had an impact on or added value to global investment portfolios remains to be investigated, with some previous research focussing on this issue. For instance, Liow and Adair (2009) produced a complete profile of Asian property companies' performance over the period 1996–2005. The study assessed risk-adjusted performance, value-added, diversification benefits and the impact on Asian, UK and US investors. The findings revealed the increasing role of Asian property portfolios on global property markets. Although Asian real estate securities have failed to contribute to the mixed-asset portfolios of Asian shares, bonds and cash in terms of improved risk-return performance and enhanced portfolio diversification benefits, Asian real estate companies potentially provide important real estate investment opportunities for international property fund managers.

Nguyen (2011a) segregated Asian property markets into two categories in her analysis, being developed and emerging markets. The analysis presented the performance of 13 Asian property markets, being divided into three tiers: tier 1 (Japan, Singapore and Hong Kong – developed markets); tier 2 (Malaysia, South Korea, Taiwan and Thailand – emerging markets); and tier 3 (China, Indonesia, Sri Lanka, Vietnam and the Philippines – lesser emerging markets). The study revealed that, over the period January 1999–December 2009, the best performing tier was the lesser emerging market tier with the developed market tier marginally underperforming tier 3. Tier 2 showed

the lowest performance over this period. Overall, the study revealed that all Asian markets are significantly growing towards a region-wide market.

The recent GFC, as well as the AFC, caused greater focus on risk analysis across Asian countries. Risk or volatility analysis is essential to minimise loss for investors and to predict market outlooks, not only for investors but also for governments in each country. Real estate has a traditional perception of being low risk due to the fact that it is a tangible asset. Volatility is time varying and may be predictable, hence the analysis in this area is often based on the historical record of asset performance. Several researchers have focused on risk or volatility analysis in property markets and have specifically targeted the Asian markets.

Wilson, Stevenson, and Zurbruegg (2007) concentrated on measuring the spill-over effect across Asian property stocks. Four Asian countries, Hong Kong, Japan, Malaysia and Singapore, were selected as case studies. The purpose of the research was to understand the degree of commonality between and the spill-over effect behaviour across property markets. The findings revealed that the developing crisis was being captured in the price dynamics of the securitised real estate sector earlier than reported in previous empirical studies of the general stock. The results highlighted that contagion across Asian markets started to occur in October 1997. The AFC triggered some research to further explore the impact of the crisis on the real estate market, in particular risk analysis to minimise the impact of the crisis on the stock market and especially on the real estate finance market. For example, Mei and Hui (2000) examined the conditional premium risk of Asian real estate stocks, highlighting the issue of contagion of Asian real estate markets. In their findings, the authors noted strong evidence of time varying risk premiums, suggesting property development based on constant discount rates mis-specified the cost of capital. In addition, using multi-country models, the authors suggest that conditional excess returns in many crisis economies appear to move quite closely with each other.

Several researchers have investigated volatility research in Asian real estate stock markets. For instance, Liow, Chen, and Liu (2011) explored the volatility convergence in Asia-Pacific securitised real estate markets. Their paper investigated whether a group of Asia-Pacific securitised real estate markets have displayed a similar common time-varying volatility over the period 2005–2009. Theirs was the first paper to investigate common volatility in real estate and volatility spillover. Their findings revealed the presence of ARCH effects in almost all real estate securities series, indicating that Asian real estate time-varying volatilities need to be incorporated in searching for volatility convergence. In addition, their analysis indicated the presence of at least one common time-varying variance component and thus partial volatility convergence amongst the eight Asia-Pacific real estate securities markets (including Australia).

Research methodology

This research focusses on 12 Asian property companies in 12 national-securitised real estate markets, being Malaysia (MY), Singapore (SG), Indonesia (IN), Thailand (TH), Japan (JP), the Philippines (PH), Vietnam (VN), China (CN), Hong Kong (HK), Taiwan (TW) and South Korea (SK). These countries are selected to give a full range of Asian real estate markets, which they have been less thoroughly analysed in past research. In addition, these Asian markets are generally aggressive with higher systematic and idiosyncratic risk (Liow and Sim, 2006). The study period is from January 1998 to December 2012 and the monthly returns for real estate securities are extracted

from DataStream for each country. In addition, all returns are generated using local currencies to avoid currency hedging.

This research will analyse the performance of the property securities market in the Asian region from 1998 to 2012 for listed property companies. Risk-adjusted performance analysis will be used to assess the added value of Asian listed property companies. Sub-period analysis is divided into three phases: pre-GFC; during the GFC; and post-GFC:

- (1) Pre- GFC: January 1998–December 2006
- (2) GFC: January 2007–December 2010
- (3) Post- GFC: January 2011–December 2012

being aimed to identify the dynamics of Asian listed property companies as well as the impact of the financial crisis on the securitised property market.

This analysis discusses the changes in performance in terms of returns, risks, Sharpe ratios and correlations over each of the three sub-periods. Furthermore, the changes will be analysed from the perspective of causality and dynamic of volatility using econometric techniques. The results will contribute to a broader understanding of the impact of the GFC.

Furthermore, the impact of the GFC on the Asian property markets will be investigated to understand the level of volatility of the market during the crisis. Performance analysis will use local currencies, as international investors typically implement their own currency hedging strategies to control currency risk. Regional portfolio diversification benefits will be assessed using correlation analysis.

EGARCH represents a useful technique to model excess conditional kurtosis in stock return indices based on a generalised exponential distribution (Nelson, 1991). There are only few studies using EGARCH to investigate the volatility of listed property companies. For example, Nguyen (2012) used EGARCH modelling to empirically examine the volatility spill-overs of listed property companies in 12 Asian markets, while Pham (2012) examined the dynamics of return and volatility spill-overs across the Asian REITs markets. However, the focus of these studies was the general Asian viewpoint without attention to the GFC issue.

The EGARCH model, developed by Nelson (1991), is an extended form of the generalised ARCH model. ARCH-type models have been commonly used in modelling changes in the volatility of financial time series. The advantage of the EGARCH specification is that it allows for the testing of an asymmetry impact from positive and negative changes in asset portfolios returns. In addition, the EGARCH model also captures the leverage effect of market volatility, which arises when asset portfolio price falls and the debt-equity ratio increases causing portfolio price to be more volatile. The EGARCH model is better able to measure this phenomenon.

The model was first introduced to assess the leverage effects that are the down movements, being more influential for predicting volatility than the upward movements. The EGARCH model may be represented as follows:

$$\log \sigma_t^2 = \omega + \sum_{i=1}^p \beta_i \log \sigma_{t-1}^2 + \sum_{i=1}^p \alpha_i |\varepsilon_{t-1}| + \sum_{i=1}^p \gamma_i \varepsilon_{t-1}$$

$$\sigma_{t-1}^2 = 1 \sigma_{t-1}^2$$

where: $\log \sigma_t^2$ = natural logarithm difference of the total return indices, $k - 1$ = set of time, $\log \sigma_{t-k}^2$ = conditional variance, $\sum_{k=1}^q \beta$ = change in return.

This model allows for a time-varying conditional variance, with the conditional variance modelled as a function of its past values and exogenous variables. When this coefficient is typically negative, positive return shocks generate less volatility than negative returns shocks. As such, it can be seen that markets are more volatile when there is bad or negative news. The EGARCH model is asymmetric because the level of $\frac{\varepsilon_t}{\sigma_t} - 1$ is included with coefficient γ_1 . This is due, in large part, to EGARCH's accommodation of asymmetric volatility of leverage effect which refers to one of the explanations of asymmetric volatility where increases in volatility are associated more often with large negative returns than with equally large positive returns (Brandt and Jones, 2006). The authors added that, although the leverage effect can be generated by other members of GARCH family, the model explains exponential specification because of its familiarity and the simplicity with which volatility asymmetry can be introduced.

Findings and discussion

This section will discuss the findings from the analysis of Asian property company performance over the period January 1998–December 2012.

Table 5 presents the risk-adjusted performance analysis for listed property companies in Asian countries over the period January 1998–December 2012. Over this period, South Korea performed best in terms of Sharpe Index, followed by Philippines and China. Interestingly, the top three countries, according to the Sharpe Index measure, obtained results close to each other indicating competitiveness between these three countries over the period. From a listed property companies' performance viewpoint over the period, Thailand, Taiwan and India comprised the bottom three being amongst those Asian countries with the lowest Sharpe Index. Other countries, such as Vietnam, China, Hong Kong, Malaysia, Singapore and Japan, were showing moderate performance over the period of January 1998–December 2013. The results also show that developed countries with property portfolios in strong markets, such as Japan and

Table 5. Pan-Asian portfolio performance analysis: January 1998–December 2012.

	Average return (%)	Average risk (%)	Sharpe index (%)	Index rank
<i>Listed property companies</i>				
China	12.32	45.24	0.42	3
Hong Kong	17.23	35.23	0.31	5
Indonesia	7.31	45.32	0.18	6
Japan	3.29	52.34	-0.04	9
South Korea	18.27	38.43	0.48	1
The Philippines	16.18	41.28	0.43	2
Singapore	4.19	22.13	0.03	8
Taiwan	3.18	31.78	-0.10	11
Thailand	5.04	27.28	-0.07	10
India	0.28	15.27	-0.31	12
Vietnam*	17.28	39.49	0.38	4
Malaysia	1.42	35.82	0.05	7

*Data for Vietnam is beginning from 2007.

Singapore, were only able to perform at a moderate level during this period due to the impact of the three major financial crises; AFC, GFC; and the Eurozone crisis.

Previous research showed mature and developed countries, such as Singapore, Japan and Hong Kong, could sustain property growth in spite of the impact of a financial crisis such as the AFC. Nevertheless, emerging countries, such as Malaysia, Thailand and Indonesia, showed impressive growth in property portfolio investment with several studies exhibiting these countries' remarkable Sharpe Index ranking. The findings of previous research also provided limited information on the impact of the GFC on the performance of Asian listed property companies. Most of the studies conducted were prior to GFC or had limited focus, such as Newell and Razali (2009) whose focus was limited to the impact of the GFC on cross-border investment and commercial property transactions.

Therefore, this study originally investigates the performance of Asian listed property companies specifically during the GFC period. The results reveal that mature markets, such as Singapore, Hong Kong and Japan, failed to be in the top position in terms of the Sharpe Index ranking. Emerging markets, such as South Korea, Philippines and China, were in the top position. It is believed that these markets will provide wide-ranging opportunities for institutional investors to invest in the property securities market.

Potential for diversification

Table 6 presents the pan-Asia listed property companies' correlation matrix over the period January 1998–August 2012. The average correlation for Asian listed property companies was $r = 0.52$. Over this period, only a few countries have shown a high correlation, such as Thailand and China ($r = 0.52$) and Taiwan and India ($r = 0.83$). The results from these countries indicate lesser potential for diversification benefits.

The correlation for all countries ranged between $r = -0.81$ (Singapore and Taiwan) to $r = 0.83$ (Taiwan and China), indicating some potential for diversification of listed property companies' portfolios over the period January 1998–December 2012. For example, range correlation of Japan's listed property companies with other pan-Asian countries was between $r = -0.31$ and $r = 0.42$; Hong Kong's range correlation between $r = -0.31$ and $r = 0.41$; Indonesia ($r = -0.18$ to $r = 0.42$) and South Korea ($r = -0.24$ to

Table 6. Pan-Asia listed property companies' correlation matrix: January 1998–December 2012.

	MY	JP	SG	HK	TH	CN	ID	TW	SK	IN	VT
Malaysia	1.00										
Japan	0.16										
Singapore	0.08	-0.07									
Hong Kong	-0.12	-0.31	0.04								
Thailand	0.45	0.09	0.46	0.03							
China	0.31	0.11	0.37	-0.15	0.52						
Indonesia	0.11	0.04	0.04	-0.16	0.39	0.11					
Taiwan	-0.14	0.02	-0.81	0.04	-0.73	-0.23	-0.02				
South Korea	0.02	0.01	-0.03	0.41	-0.11	-0.24	-0.18	0.11			
India	0.27	0.42	0.08	0.39	0.03	0.31	0.42	0.83	0.30		
Vietnam	0.01	0.29	0.31	0.02	0.39	0.42	0.02	0.21	0.21	0.04	

Note: MY = Malaysia, JP = Japan, SG = Singapore, HK = Hong Kong, TH = Thailand, CN = China, ID = India, TW = Taiwan, SK = South Korea, IN = Indonesia, VT = Vietnam.

$r = 0.41$). These ranges were low, thus indicating some potential for diversification between these countries.

Overall, the analysis shows the majority of Asian listed property companies offer diversification benefits in the context of pan-Asian countries over this period. This period suggests most pan-Asian countries show potential for diversification amongst each other, in terms of listed property companies' investment portfolios. However, analysis by Newell et. al. (2009) revealed property companies have shown less potential for diversification with major Asian countries over the period Q4 1998–Q1 2007. However, the study was conducted prior to the GFC taking place, such that the results would be significantly different if the GFC had been taken into account in the analysis. The analysis also showed that, although the results in terms of Sharpe Index performance are not good for certain countries, some countries portfolios are able to offer some diversification benefits for investors. For example, Malaysia, Hong Kong and Taiwan were amongst the bottom ranked in Sharpe Index ranking but were able to show potential for diversification amongst Asian listed property companies' portfolio investment.

Dynamic of volatility test

An understanding of volatility in a mixed-asset portfolio context is important for determining the cost of capital and identifying investment and leverage decisions. Substantial changes in volatility will have a significant impact on financial markets as well as on investors in terms of risk aversion. The strong growth and remarkable risk-adjusted performance amongst pan-Asian countries in the last decade has caught the attention of international investors. However, in comparison to the considerable amount of literature that examines the performance of pan-Asian countries, far less is understood about the performance from an Asian investors' viewpoint.

As such, this analysis will focus on Asian countries in terms of dynamic of volatility test. It should be noted that the period of study covers the GFC in 2008–2009. The volatility in global capital markets rose considerably during the GFC; hence it is interesting to study the role of the listed property company market during this period. If listed property companies have become more closely related during the crisis period, it is possible that this period is associated with common volatility components, relative to other full-period models. Using a monthly return of listed property companies from January 1998 to December 2012, this study assesses volatility for 11 pan-Asian countries. This study will employ an EGARCH technique to assess the dynamic of volatility.

Table 7 presents the findings from the EGARCH (1,1) model for listed property companies in pan-Asian countries over the period January 1998–August 2012. From the findings γ is negative for Japan, South Korea, Taiwan, Indonesia, Thailand, India and Vietnam. As such, the null hypothesis is rejected at the 5% level and hence some leverage effect is present. Nevertheless, for South Korea the p -value is not significant and hence the presence of the leverage effect is not accepted. The findings also reveal that the value of β for certain countries, such as Malaysia, Japan, Taiwan, India, Thailand, Indonesia and Vietnam, is close to 1, indicating high persistence with slow decay of volatility shock over this period. However, the EGARCH (1, 1) specification failed to model the volatility for India, as failure to improve likelihood was encountered. The model of EGARCH (1, 1) specification also failed to model other countries, such as Singapore, South Korea, China, Hong Kong, Japan and Taiwan.

Table 7. Diagnostic for EGARCH (1, 1) model for listed property companies in pan-Asian countries.

Countries	MY	SG	JP	SK	CN	TW	HK	IN	TH	ID	VT	PH
<i>Mean equation</i>												
C	0.001 (0.043)	0.001 (0.000)**	0.0004 (0.017)**	0.001 (0.000)**	0.005 (0.018)**	0.002 (0.000)**	0.002 (0.038)**	0.004 (0.001)	0.0002 (0.014)	0.002 (0.000)**	0.003 (0.015)	0.002 (0.038)
<i>Variance equation</i>												
ω	0.120 (0.000)	-0.551 (0.000)**	-0.475 (0.000)**	-0.372 (0.000)**	-0.478 (0.000)**	-0.550 (0.000)**	-0.692 (0.000)**	-0.492 (0.000)	-0.482 (0.000)	-0.381 (0.000)**	-0.481 (0.001)	0.118 (0.000)
α	0.180 (0.000)	0.248 (0.000)**	0.270 (0.000)**	0.221 (0.000)	0.273 (0.000)**	0.225 (0.000)**	0.242 (0.000)**	0.232 (0.000)	0.264 (0.000)	0.212 (0.000)	0.265 (0.000)	0.172 (0.000)
γ	-0.130 (0.006)	0.030 (0.023)	-0.004 (0.561)**	-0.050 (0.002)**	0.007 (0.021)**	-0.038 (0.028)**	0.082** (0.001)	-0.029 (0.012)	-0.002 (0.013)	-0.048 (0.005)**	-0.005 (0.554)	-0.122 (0.000)
β	0.840 (0.000)	0.534 (0.000)**	0.965 (0.000)**	0.972 (0.000)**	0.643 (0.000)**	0.958 (0.000)**	0.523 (0.000)**	0.972 (0.000)	0.972 (0.000)	0.962 (0.000)**	0.982 (0.000)	0.821 (0.000)

**Indicates failure to improve likelihood.

p-values are given in parenthesis.

Note: MY = Malaysia, SG = Singapore, JP = Japan, SK = South Korea, CN = China, TW = Taiwan, HK = Hong Kong, IN = Indonesia, TH = Thailand, ID = India, VT = Viet-

nam, PH = The Philippines, P
 $\log \sigma_i^2 = \omega + \sum \beta_j \log \sigma_{t-1}^2 + \sum \alpha_j |e_{t-1}| + \sum \gamma_j e_{t-1}$ for $i, j = 1, 2, \dots, 7$ and $i \neq i$
 $i = 1$ $i = 1$ $\sigma_{t-1}^2 = 1$

Table 8. Summary of results from EGARCH (1, 1) model: January 1998–December 2012.

Countries	EGARCH
Malaysia	Successful to model
Singapore	Failed to model
Japan	Failed to model
China	Failed to model
Hong Kong	Failed to model
South Korea	Failed to model
Taiwan	Failed to model
Thailand	Successful to model
Indonesia	Successful to model
India	Failed to model
Vietnam	Successful to model
Indonesia	Successful to model
The Philippines	Successful to model

Overall, the results show that the majority of pan-Asian countries exhibited high volatility over the period of study. For this reason, the two financial crises during the period of study must be taken into account with the addition of the latest crisis, being the Eurozone Debt Crisis. Amongst pan-Asian countries, Vietnam was the highest in terms of volatility with the EGARCH (1,1) model successful in modelling the volatility as being statistically significant. This is followed by Indonesia and Thailand.

The EGARCH model performs well in capturing the volatility dynamics of pan-Asian countries. Several Asian countries, such as Malaysia, Japan, South Korea, Taiwan, Indonesia, Thailand, India and Vietnam, have shown a negative γ value as well as a β value close to 1, which indicates a leverage effect and high persistence with a slow decay of volatility shocks for listed property companies. The results indicate that the majority of pan-Asian countries were in high volatility over this period, with Vietnam once more having the highest volatility in the EGARCH analysis. This was followed by Indonesia and Thailand. These results were almost similar with the findings from a previous study by Nguyen (2012) which saw China, India and Indonesia displaying a high number of volatility dynamic factors in the property market. However, the study only explored volatility transmissions between shares and property companies. The findings of volatility dynamics using the EGARCH model by Liow et. al. (2005) revealed the existence of volatility shocks in certain Asian property markets, such as Singapore, Japan and Malaysia, during their case study period of November 1987–May 2003. A summary of the results for the Asian countries is tabulated in Table 8.

Global financial crisis

The GFC of 2008/2009 began in the USA due to the sub-prime crisis and had enormous ramifications for the global economy. The cause of the GFC was attributed to an array of financial derivatives which drove the sub-prime mortgage boom and subsequently affected the housing and banking systems as well as consumer and investor demand. With the USA economy badly damaged by the sub-prime crisis, the GFC arose and as a consequence the world economy was confronted with contraction.

Financial markets play an important role in fostering the growth of economies in developed and emerging countries. Real estate financial markets have been growing so

much so that they have become part of the pillars of the economy in many countries. A number of studies have shown a strong link between the real estate sector and the GFC. Damyanyk and Hemert (2011) explain that, since 2000, subprime mortgages had been very risky, but the true riskiness was hidden by rapid house price appreciation. Speculative bubbles also contributed to the crisis which changed public opinion about the market, having an immediate impact on the demand. The financial crisis became widespread and there was no doubt that the Asian region suffered from the real effects of the crisis. Many Asian countries have small derivatives markets, small interbank markets and rely heavily on international private lending, using strict controls or government intervention in banking regulation and foreign exchange.

This section aims to contribute to the understanding of the impact of the crisis by examining empirically the significance and performance of Asian listed property companies. In particular, this study is concerned with the diversification benefits and dynamics of volatility across the pan-Asian real estate portfolio markets. This study will provide a useful look at how pan-Asian markets reacted to the crisis by assessing the post-crisis performance. The findings are significant to property fund managers as it is important for them to be aware of influencing events within one specific market, as well as events in other cointegrated markets.

Risk-adjusted performance

Over recent years, the Asian region has attracted international attention for its extraordinary economic performance. However, the GFC in 2008/2009 had an inevitable impact on Asia's economic performance, including the property securities market. Table 9 presents the impact of the GFC on listed property companies amongst pan-Asian countries. During the crisis, most pan-Asian countries saw a negative average return, reflecting the significant impact of the GFC. The negative annual returns also reflected high risk for all pan-Asian countries. Singapore was the only country that was able to show a positive Sharpe ratio point, although it still showed a negative average return. The results indicate that, during the crisis period, Singapore, China and Hong Kong were amongst the top-performing pan-Asian countries. Meanwhile, Philippines and Malaysia were amongst the lowest performing countries over the GFC period.

Table 9. Performance of Listed Property Companies in pan-Asian countries: Global financial crisis.

GFC	Annual return	Annual risk	Risk/return ratio	Sharpe ratio	Ranking
China	-38.89	57.55	-1.48	-0.71	2
Japan	-54.36	39.43	-0.73	-1.39	9
South Korea	-41.23	49.79	-1.21	-0.89	6
Taiwan	-37.16	57.00	-1.53	-0.67	4
Singapore	-51.33	34.18	-0.67	0.32	1
The Philippines	-48.19	29.21	-0.61	-1.75	10
Indonesia	-33.52	31.77	-0.95	-1.18	7
India	-50.59	78.58	-1.55	-0.78	5
Vietnam	n/a	n/a	n/a	n/a	-
Thailand	-42.75	37.44	-0.88	-1.20	8
Hong Kong	-26.95	40.39	-1.50	-0.71	2
Malaysia	-39.54	19.60	-0.50	-2.13	11

*Data for Vietnam is beginning from 2007.

Potential of diversification

To examine the diversification benefits of Asian property companies across Asia, inter-correlation matrices amongst listed property companies in Asian countries for the period of January 1998–December 2012 were assessed, as tabulated in Table 10. The data show all correlations being statistically significant, at less than 5% level of significance.

Japan and China, Hong Kong and China and Japan and Hong Kong showed low correlation indicating the potential for diversification. Meanwhile, Hong Kong and Singapore, Singapore and India and Indonesia and India showed high correlation and therefore less potential for diversification. Overall, from the correlation analysis, the average correlation for all pan-Asian countries was $r = 0.55$ over the crisis period. The findings also indicate that most of the pan-Asian countries showed low correlation. This indicates that, during the financial crisis, most of listed property companies in pan-Asian countries were able to show potential for diversification. From the investor's viewpoint, this could be beneficial in terms of investment diversification within the majority of pan-Asian property securities markets.

Dynamic of volatility test – GFC

The dynamic of volatility of listed property companies in Asian countries during the pre-crisis period is assessed using an EGARCH (1,1) specification model. Table 11 exhibits the results from the EGARCH (1,1) specification model. The EGARCH analysis is aimed at assessing volatility by modelling the conditional kurtosis in portfolios' returns based on a generalised exponential distribution.

This section discusses the volatility dynamic analysis of listed property companies in pan-Asian countries. The EGARCH model developed by Nelson (1991) allows the conditional mean and volatility to be estimated jointly as well as testing the leverage effect in modelling time-varying volatility. Overall, the EGARCH (1,1) model failed to model the volatility. This indicates that the GFC had a significant impact in terms of volatility on listed property companies in Asian countries. Furthermore, all countries were successful in modelling volatility using the EGARCH (1,1) specification during the GFC. The findings also revealed that Japan had the highest persistence in terms of volatility, as well as a slow decay of volatility shocks for all sub-periods. The results correlate with the current situation in Japan which has been in recession over the last decade.

Table 10. Asian listed property companies' correlation matrix: global financial crisis.

	MY	JP	SG	HK	TH	CN	ID	TW	SK	IN
Malaysia	1.00									
Japan	0.48	1.00								
Singapore	0.56	0.64	1.00							
Hong Kong	0.65	0.67	0.74	1.00						
Thailand	0.56	0.35	0.76	0.47	1.00					
China	0.34	0.01	0.68	0.29	0.11	1.00				
Indonesia	0.68	0.28	0.65	0.56	0.53	0.47	1.00			
Taiwan	0.46	0.34	0.65	0.44	0.57	0.45	0.35	1.00		
South Korea	0.46	0.31	0.71	0.41	0.66	0.36	0.50	0.43	1.00	
India	0.71	0.60	0.73	0.69	0.66	0.10	0.72	0.31	0.49	1.00

Table 11. Diagnostic for EGARCH (1, 1) model for listed property companies in pan-Asian countries: Global financial crisis.

Countries	MY	SG	JP	SK	CN	TW	HK	IN	TH	ID	VT	PH
<i>Mean equation</i>												
C	0.001 (0.027)	0.001 (0.024)	0.001 (0.018)	0.002 (0.012)	0.003 (0.018)	0.001 (0.018)	0.001 (0.014)	0.001 (0.012)	0.001 (0.009)	0.001 (0.008)	0.002 (0.008)	0.001 (0.004)
<i>Variance equation</i>												
ω	-0.121 (0.000)	-0.378 (0.000)	-0.648 (0.000)	-0.184 (0.000)	-0.274 (0.000)	-0.398 (0.000)	-0.286 (0.000)	-0.168 (0.000)	-0.442 (0.000)	-0.152 (0.000)	-0.286 (0.000)	0.391 (0.000)
α	0.119 (0.000)	0.169 (0.000)	0.074 (0.000)	0.074 (0.000)	0.069 (0.000)	0.053 (0.000)	0.029 (0.000)	0.038 (0.000)	0.015 (0.001)	0.013 (0.001)	0.012 (0.000)	0.118 (0.000)
γ	-0.062 (0.000)	-0.028 (0.018)	-0.001 (0.541)	-0.018 (0.001)	-0.014 (0.019)	-0.025 (0.031)	-0.017 (0.000)	-0.014 (0.011)	-0.002 (0.013)	-0.004 (0.001)	-0.001 (0.541)	-0.018 (0.000)
β	0.921 (0.000)	0.848 (0.000)	0.953 (0.000)	0.949 (0.000)	0.820 (0.000)	0.978 (0.000)	0.751 (0.000)	0.850 (0.000)	0.935 (0.000)	0.850 (0.000)	0.941 (0.000)	0.843 (0.000)

**Indicate failure to improve likelihood.

p-values are given in parenthesis.

Note: MY = Malaysia, SG = Singapore, JP = Japan, SK = South Korea, CN = China, TW = Taiwan, HK = Hong Kong, IN = Indonesia, TH = Thailand, ID = India, VT = Vietnam, PH = The Philippines.

$$\log \sigma_t^2 = \omega + \sum_{i=1}^P \beta_i \log \sigma_{t-1}^2 + \sum_{i=1}^P \alpha_i |e_{t-1}| + \sum_{i=1}^P \gamma_i e_{t-1} \text{ for } i, j = 1, 2, \dots, 7 \text{ and } i \neq j$$

Very limited previous research has employed the EGARCH model to examine dynamic of volatility or volatility spill-overs in the real estate markets in Asia. Nguyen (2011b) examined the listed property companies in developed and emerging markets using the EGARCH model over the period of August 2006–December 2006. Her findings revealed the impact of lagged volatility was not statistically significant on the volatility of property companies' returns for Hong Kong, Thailand, China, Indonesia and Sri Lanka. Some of the results were similar to the results of this research; however Nguyen's analyses have not taken into account the impact of the GFC. As such, the outcome has significant differences. A similar study approach was done by Pham (2012) on Asian REITs over the period of June 2006–May 2011. The study revealed the p -value was greater than 0.05 for all countries, with the exception of South Korea, supporting the EGARCH models for all series. The findings also suggested that, during the GFC, all REITs in Asian countries responded negatively with the exception of Malaysia and Thailand. These, however, are different to the listed property companies' response to the GFC in the findings of this research. According to the EGARCH model analysis, Malaysia and Thailand's listed property companies responded negatively. Similar to Pham's (2011) study, several authors attempted to study volatility from different aspects by employing the EGARCH model. Amongst others, Li, Lin, and Jin (2012) and Zhou and Kang (2011) examined international REIT volatility, including some Asian REITs as a case study, while Lee (2009) assessed house price volatility in Australia by employing the EGARCH model.

Furthermore, Liow et. al. (2005) examined cross-market dynamics in Asian property stock markets in terms of long-run and short-term relationships. Using an EGARCH model, the findings reveal that the AFC had an adverse impact on Asian property stocks, in particular its impacts on the markets of Singapore and Malaysia were highly significant. Japan had the highest negative impact from the crisis. By comparing the results from Liow et. al. (2005) and these research findings, the time difference is clearly different, with Liow et. al. (2005) concentrating on the AFC. However, a conclusion can be drawn for both crises, Japan recorded highly in terms of a negative impact from the crisis. Another study that employed the EGARCH model in REITs was undertaken by Chang and Chou (2012) who use the EGARCH model in the mean equation examining REIT returns before and after the GFC. The findings reveal REITs for two Asian countries (Taiwan and Japan) were positive and significant during pre-crisis but not in the post-crisis period. The results for REITs for these two countries were similar with the results of the EGARCH (1,1) model for listed property companies' in Japan and Taiwan. However, research by Chang et. al. (2012) did not include an analysis during the GFC period.

Serrano and Hoesli (2010) employed the EGARCH model to examine the efficiency of the securitised real estate market in certain countries in Asia and Europe. The findings, which were based on the analysis of pre-GFC periods, indicate that the volatility of the securitised real estate market is higher in Asian countries, such as Hong Kong, Japan and Singapore, compared to their European counterparts. Although this analysis concentrated only on pan-Asian countries, the findings have some similarities, in particular for Japan which had a higher volatility compared to the other Asian countries during the GFC periods. While the EGARCH model is not the only class of models that are able to capture the dynamic of volatility of pan-Asian countries over the long time-series, it is also able to capture the most important stylised features of listed property companies' return volatility. The findings for dynamic of volatility using an EGARCH

model will contribute towards new empirical evidence of volatility over the past 14 years for Asian listed property companies.

Summary

The primary purpose of this research is to apply the available data on total return indices for listed property companies in Asian countries. Using the modern time series techniques and developed diagnostic tests, this research attempts to evaluate the performance and significance of listed property companies over the period January 1998–December 2012. A secondary objective is to examine the impact of the GFC on the dynamics of investment in listed property companies in Asia.

The implications for the property sector can be seen in different ways. First, investors will be well informed, since over the past 14 years listed property companies in Asian countries have faced major challenges due to several financial crises. Although several countries in Asia showed poor performance in terms of risk-adjusted return, listed property companies are still competitive when compared to other regions. Nevertheless, several countries, such as Vietnam, South Korea and China, emerged as leaders in listed property companies' portfolio investments through remarkable performance over the last 14 years. As such, investments in listed property companies in Asia are still able to offer moderate to high returns in the future after taking into account competitor risk and low to moderate annual returns.

Given other factors, such as stabilisation in politics, high transparency and less natural disasters in certain countries, the Asian region offers very good opportunities in property investment. Correlation analyses for listed property companies in comparison with other similar portfolio Asian countries suggest that the majority of listed property companies in Asian countries have the potential for diversification with each other.

The significance and performance of Asian listed property companies has also been analysed from the perspective of dynamic of volatility. This is because substantial changes in volatility will significantly impact the real estate markets as well as potential investors in listed property companies. The analysis is based on the advanced statistical technique of EGARCH which captures dynamic volatility trends of listed property companies in Asia, identifying volatility which was influential on the down movements. The results suggested that Malaysia, Japan, Taiwan, India, Thailand, Indonesia and Vietnam experienced high persistence with the slow decay of volatility shocks for listed property companies. As such, the results show that the majority of Asian countries experienced high volatility over the period of study. The results also suggested that Vietnam experienced the highest volatility level based on the EGARCH model.

In this challenging investment context, it is important to assess the impact of the GFC on major portfolios indexes. This is particularly so in Asia, given its significant growth and strong institutional investor support in recent years. By analysing the global portfolios' performances, specifically listed property companies, the impact of the GFC on property companies in Asia is assessed in this research.

The implications for property investment can be seen by focusing on risk-adjusted performance, through the creation of a ranking index for Asian listed property companies based on the GFC sub-periods. Furthermore, the sub-period analyses based on three distinct time periods (pre-crisis, crisis and post-crisis) clearly indicate the performance of listed property companies in Asia during these periods. The implications for the property market can be viewed from the perspective of how to sustain listed property companies during a financial crisis, in particular a crisis similar to the GFC. The

results indicate that almost all countries in Asia were impacted by the GFC and that, except for Singapore, other countries showed negative a Sharpe ratio point.

The potential for diversification was assessed with the aim of identifying diversification benefits from the investments that had been made in listed property companies' portfolios. The results suggested that, during the crisis, all Asian countries showed less potential for diversification compared to before and after the crisis.

The EGARCH model was also used to model the volatility dynamics for listed property companies in Asian countries. The analysis suggests that, amongst the Asian countries, Japan's listed property companies had the highest persistence and slowest decay in all sub-periods except during the crisis. However, during the crisis, Japan ranked second only after Taiwan. Overall, the EGARCH modelling tests of all the Asian countries showed Japan had the highest volatility level which corresponds with its slow economic growth in recent years.

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No potential conflict of interest was reported by the author.

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