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The dynamic linkage among the Asian REITS market

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This paper investigates the long-run relationship and short-term linkage among the Asian REIT markets before, during and after global financial crisis through the combination of Johansen Cointegration Test and Granger Causality Test. The results indicate that the existence of cross-border diversification opportunities remain even though the markets were cointegrated since the global financial crisis. Short-run causality tests show that the number of causality relationships decrease over the time. Overall, the results suggest that domestic REIT investors can achieve diversification benefits by incorporating certain international REITs into the domestic portfolio, but they need to review their portfolios periodically as the linkages among markets could change from time-to-time.

Keywords: real estate investment trust; Asia; cointegration; Granger causality; diversification; global financial crisis

Introduction

The diversification benefit of the Asian real estate investment trusts (REITs) has received considerable attention from portfolio managers and academics due to the rapid growth in majority of Asian REIT markets in recent years. Research has shown that Asian REITs are able to provide additional diversification benefits to mixed asset portfolios (Newell, Wu, Chau, & Wong, 2010; Newell & Peng, 2012; Peng & Newell, 2012; Pham, 2011; Pham, 2012).

To achieve further diversification, investors can incorporate international REITs into a domestic portfolio. For this reason, this study investigates the dynamic linkage among Asian REIT markets across time. Specifically, this study investigates whether their linkages vary across different time horizons, from the inception stage of the market until the post global financial crisis period.

Further, this study contributes to the existing literature from four significant aspects. First, this study specifically focuses on Asian REITs instead of property companies. REITs and property companies are different in term of the underlying structures. Past research has shown that both of them were weakly correlated (Newell et al., 2010; Newell & Peng, 2012; Peng & Newell, 2012; Pham, 2011; Pham, 2012). Thus, it is reasonable to argue that this study on REITs has distinctive differences with the research on property companies.

Second, this study complements that research which investigates the role of Asian REIT markets in mixed asset portfolios. From the investors' point of view, they will be interested to know whether they can construct a more diversified portfolio by incorporating different REIT markets into their portfolio. On the other hand, as compared with

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Kim (2009), this study focuses on an Asian REIT context and employs a large set of Asian REIT markets with a longer-time frame, which includes three developed (Japan, Singapore, Hong Kong) and four emerging (Malaysia, Thailand, Taiwan, South Korea) markets. Methodologically, a multivariate Johansen Cointegration Test is used instead of bivariate context to explore the linkage among Asian REIT markets in a broader perspective.

Furthermore, this study conducts exclusion tests on the cointegrated markets to identify the potential diversification benefit within a cointegrating vector. Both Yunus and Swanson (2007) and Liow (2008) employed the exclusion test in their study, where it was useful to identify the potential diversification benefit for a cointegrated listed property market.

Last, these data are being disaggregated into different sub-periods which include the pre-global financial crisis, the global financial crisis period and the post global financial crisis period. This is to assess the time varying linkage among the Asian REIT markets and subsequently assess the diversification benefit of the markets over the time.

Literature review

The growth of the Asian REIT markets has resulted in their becoming a significant investment vehicle in the mixed asset portfolio. Studies have been done to investigate their diversification benefits in a mixed asset portfolio across the global financial crisis. For instance, Newell et al. (2010) examined the performance of the Hong Kong REITs in a mixed asset portfolio finding that Hong Kong REITs provide a higher average annual return (3.45%) compared with shares (2.05%) and property companies (1.02%). From December 2005 until December 2008, Hong Kong REITs were weakly correlated with shares (0.40) and property companies (0.47). Further evidence indicates that the global financial crisis had a lesser impact on the Hong Kong REITs (−21.85%) compared to shares (−37.92%) and property companies (−38.71%). During the crisis, the correlation coefficient of 0.51 (Hong Kong REITs and shares) and 0.52 (Hong Kong REITs and property companies) indicate that Hong Kong REITs still provide diversification benefit to the portfolio.

On the other hand, Newell and Peng (2012) investigated the performance of Japan REITs in mixed asset portfolios. From October 2001 to February 2011, the average annual return of Japan REITs (7.11%) was higher than property companies (4.64%), shares (1.03%) and bonds (1.04%). On the other hand, the correlation between Japan REITs and shares (0.58) was lower than the correlation between property companies and shares (0.81). Furthermore, the sub-period analysis also reveals that Japan REITs achieved a higher average annual return (14.35%) compared to property companies (7.5%), shares (3.55%) and bonds (1.76%) after the global financial crisis, while the correlation of Japan REITs with shares compared to the correlations of shares with property companies were consistently lower over the pre-crisis (0.19 vs 0.7), crisis (0.78 vs 0.9) and post-crisis periods (0.77 vs 0.85).

In Thailand, Pham (2011) investigates the role of Thailand REITs in mixed asset portfolios from pre-crisis until post-crisis. Over the study period, Thailand REITs have the lowest annualized mean return (0.50%) compared to shares (13.10%), property companies (3.35%) and bonds (4.6%). Meanwhile, the correlation between the Thailand REITs with shares (0.67) and property companies (0.67) was moderately strong. However, this correlation value is lower than the correlation of shares and property companies (0.83), implying that Thailand REITs offer better diversification benefits than

property companies to the mixed asset portfolio. Even though Thailand REITs encountered negative returns during the pre-crisis and crisis period, they rebounded to a positive value after the crisis. On the other hand, the sub-period correlation analysis reveals that REITs hada weak relationship with shares (0.46) and property companies (0.43) before the crisis. The correlation increased to 0.86 (REIT and shares) and 0.89 (REIT and property companies), respectively, during the crisis. However, the correlation between them has dropped significantly to 0.39 (REIT and shares) and 0.28 (REIT and property companies) after the crisis, suggesting a potential diversification benefit to the portfolio.

For the Taiwan REITs market, its average annual return from February 2006 to January 2011 was 5.40%, which is lower than property companies (18.90%) and shares (6.96%) (Peng & Newell, 2012). However, the sub-period analysis reveals that the annual return of Taiwan REITs has grown from 1.57% in pre-crisis to 4.12% in crisis and 10.94% post crisis. More importantly, Taiwan REITs were among the two assets that generated positive annual returns during the crisis. The sub-period inter-asset correlation showed that the correlation between Taiwan REITs and property companies and shares was decreasing over the time. Even though the correlation increased to 0.616 (REIT and property companies) and 0.643 (REIT and shares) during the crisis, the post-crisis relationship has dropped to a level even lower than pre-crisis.

Pham (2012) analysed an overall correlation among Asian REITs from June 2006 to May 2011, dividing the Asian REITs markets into developed markets and emerging markets based on their market capitalisation. The results showed that the correlation among the emerging Asian REIT markets was weak as compared to developed Asian REIT markets, suggesting a potential diversification opportunity among the emerging Asian REIT markets.

To investigate the linkage among real estate markets, researchers employed the Johansen Cointegration Test to examine the long-run linkage among non-stationary series. For instance, Yunus and Swanson (2007) observed that a long-run relationship existed among listed property companies in United States, Australia, Hong Kong, Japan and Singapore. On the other hand, Liow (2008) investigated the long-run relationship among property companies in US, UK and Asian property companies before, during and after Asian Financial Crisis finding that the interdependence among markets changed over time.

However, studies on the long-run relationship among Asian REITs are limited. For instance, Kim (2009) has investigated Japan REITs, Korea REITs, US REITs and Australian REITs to determine the impact of the global financial crisis on their linkages in a bivariate context, finding that the Asia Pacific REIT sectors were weakly cointegrated among others. However, the linkage among the whole Asian REIT markets and their linkage during the post crisis period were not clear. Thus, this study will seek to enhance investor's knowledge by using a larger dataset and a multivariate Johansen Cointegration Test approach.

Data and methodology

The data consist of the daily total return index for the seven Asian REIT markets that were retrieved from Datastream. The Standard and Poors REIT Index was employed for Singapore, Hong Kong, Japan, Malaysia and Taiwan, while a REIT Index for Thailand and South Korea was constructed by using a value-weighted method.

All indexes were expressed in domestic currency to avoid fluctuation of the index due to exchange rate risk. In addition, these data were taken natural logarithm prior to conducting the analysis. The study period commenced from 3 November 2006 until 31 December 2014. In addition, these data were disaggregated into three groups to measure their linkage across time:

i) pre-global financial crisis period: 03 November 2006–31 August 2007;
ii) global financial crisis period: 01 September 2007–30 June 2009; and
iii) post-global financial crisis period: 01 July 2009–31 December 2014.

The date for the global financial crisis was determined by reference to the other literature on Asian REIT markets. According to Pham (2011), the global financial crisis ran from September 2007 to March 2009, while Pham (2012) set the date of global financial crisis from 17 March 2008 to 6 March 2009. On the other hand, Peng and Newell (2012) set the crisis period from September 2007 to June 2009, as do Newell and Peng (2012). Consequently, this study set the crisis period similar to that literature so that the results can complement their findings on the role of Asian REITs in mixed asset portfolios.

Descriptive statistics

The average risk (proxied by standard deviation) and return for the Asian REIT markets are tabulated in Table 1. Over the study period, Hong Kong has the highest average daily return of 0.055% while Taiwan has the lowest average daily return of 0.007%. During the crisis, most of the market indices display a negative return except Hong Kong and Taiwan. Many of them have become more volatile in this period as indicated by their higher standard deviation values. Last, all of the markets experience recovery after the crisis. Some of the markets do outperform by displaying an average daily return that was even higher than their average daily return in pre-crisis period (Hong Kong, Thailand, South Korea).

Table 1. Descriptive statistics.

	Japan	Singapore	Hong Kong	Malaysia	Thailand	Taiwan	South Korea
Panel A: Average daily return (%)							
Overall Study Period	0.012	0.02	0.055	0.024	0.049	0.007	0.009
Pre-crisis	0.078	0.103	0.010	0.061	-0.001	-0.026	0.304
Crisis	-0.129	-0.124	0.008	-0.005	0.016	-0.043	-0.115
Post-crisis	0.057	0.062	0.083	0.030	0.071	0.033	0.005
Panel B: Average daily Standard deviation (%)							
Overall Study Period	1.755	1.5	1.244	1.092	0.699	0.504	2.536
Pre-crisis	1.676	1.454	1.046	1.628	0.613	0.665	3.432
Crisis	2.672	2.505	1.777	0.918	0.902	0.549	3.672
Post-crisis	1.219	0.798	0.990	1.032	0.615	0.446	1.608

Source: Authors.

Unit root test

The Augmented Dickey-Fuller (ADF) test was employed to assess the stationarity of the data prior to implementing the Johansen Cointegration Test. The specification of the ADF test is shown below:

$$\Delta x_t = \gamma x_{t-1} + \sum_{i=1}^{n} (\delta_i \Delta x_{t-i}) + \varepsilon_t \quad (1)$$

where:

γ represents the coefficient presenting process root
n is the lag order of the first-differences autoregressive process
δ_i are the estimated parameters
ε_t is assumed to be the white noise
The hypothesis can be written as

$$H_0 : \gamma = 0$$

$$H_1 : \gamma < 0$$

If $\gamma = 0$, it indicates that x_t is a non-stationary time series. In contrast, the series is stationary if $\gamma < 0$.

Johansen Cointegration Test

Johansen Cointegration Test was employed to assess the existence of long-run relationships among non-stationary variables or I(1). According to Granger (1986), economic variables will not drift too far apart even though they can drift apart in the short run. The following equation was specified to assess long-run relationships using the Johansen (1988, 1991) method:

$$\Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma \Delta X_{t-i} + \prod X_{t-k} + \varepsilon_t \quad (2)$$

Based on the Johansen's model, ε_t is a sequence of zero-mean p-dimensional white noise vectors. Variables are included in X_t and it is a p x 1 vector. Γ and $\prod$ denotes p x p matrix that contains information about the rank. When Rank ($\prod$) = p, it means that vector p is stationary; while rank ($\prod$) = 0 implying the absence of long-run relationship among variables. For 0 < rank ($\prod$) < p, there will be r cointegrated relationship. The trace statistic was employed to determine the number of co-integrating vectors, with null hypothesis of r cointegration relationship and r + 1 cointegration relationship for alternative hypothesis.

If the series were cointegrated, the exclusion test was conducted to examine if there is any of the series that does not participate in the cointegrating space. This was done by setting the β matrix of the corresponding row for a particular series to be equal to zero.

Granger Causality Test

Even if markets are not cointegrated, the short-run linkage can still exists. The Granger Causality Test was used to examine the short-run linkage among the series. For the series that are stationary, I(0), and not cointegrated, the vector autoregressive (VAR) model is used (Granger, 1969).

$$x_{1t} = a_o + \sum_{i=1}^{k} \alpha_{1i} x_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} x_{2t-i} + \varepsilon_{1t} \tag{3}$$

$$x_{2t} = a_o + \sum_{i=1}^{k} \alpha_{1i} x_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} x_{2t-i} + \varepsilon_{2t} \tag{4}$$

On the other hand, the VAR modal in first difference will be applied to the series that are non-stationary, I(1), and not cointegrated.

$$\Delta x_{1t} = a_o + \sum_{i=1}^{k} \alpha_{1i} \Delta x_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta x_{2t-i} + \varepsilon_{1t} \tag{5}$$

$$\Delta x_{2t} = a_o + \sum_{i=1}^{k} \alpha_{1i} \Delta x_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta x_{2t-i} + \varepsilon_{2t} \tag{6}$$

Last, a vector error correction model is used for the series that are non-stationary, I(1) and cointegrated. The vector error correction model was adjusted to present the error correction term (ECT) from the cointegration relationship (Engle & Granger, 1987).

$$\Delta x_{1t} = a_o + \sum_{i=1}^{k} \alpha_{1i} \Delta x_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta x_{2t-i} + \emptyset_{y_{2t}} ECT_{y_{1,t-1}} + \varepsilon_{1t} \tag{7}$$

$$\Delta x_{2t} = a_o + \sum_{i=1}^{k} \alpha_{1i} \Delta x_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta x_{2t-i} + \emptyset_{y_{1t}} ECT_{y_{1,t-1}} + \varepsilon_{2t} \tag{8}$$

Referring to Equations (3)–(8), x_t denotes a matrix of endogenous variables, a_o is a vector of constant, α_i represent beta coefficients for the endogenous variables with k number of lags and ε_t is the white noise error term.

An hypothesis was formed to test the causality relationship. If the null hypothesis is rejected, it means that one series Granger cause another series as shown below.

H_0: $\alpha_{21} = \alpha_{22} = \ldots = \alpha_{2k} = 0$

H_1: at least one of the α not equal to 0.

Result and discussion

Unit root test

Unit root test reveals that most of the Asian REIT markets appear to be integrated at order one over the time period (Table 2). Since the Thailand REIT market appears to be stationary at level in the pre-crisis period, it was then excluded from the cointegration test for the pre-crisis period. Overall, this is similar to the finding of Yunus and Swanson (2007), where the international property indices were non-stationary data-generating processes (DGPs).

Johansen Cointegration Test

The Johansen Cointegration Test was conducted on the non-stationary series to examine whether the markets were cointegrated together. First, the optimum lag length was selected based on the Aikaike Information Criterion (AIC) for the Vector Autoregressive (VAR) model. Table 3 displays the result for Johansen Cointegration Test. For instance, if null hypothesis of r = 0 is rejected, it means the existence of at least one cointegrating vector among the series. The cointegrating relationship was observed for

Table 2. Unit root test.

	Level	First Difference
Panel A: Overall Study Period		
Japan	0.830	0.000***
Singapore	0.215	0.000***
Hong Kong	0.952	0.000***
Malaysia	0.875	0.000***
Taiwan	0.997	0.000***
Thailand	0.964	0.000***
South Korea	0.473	0.000***
Panel B: Pre-crisis	**Level**	**First Difference**
Japan	0.908	0.000***
Singapore	0.604	0.000***
Hong Kong	0.091*	0.000***
Malaysia	0.688	0.000***
Taiwan	0.020**	0.000***
Thailand	0.544	0.000***
South Korea	0.654	0.000***
Panel C: Crisis	**Level**	**First Difference**
Japan	0.554	0.000***
Singapore	0.750	0.000***
Hong Kong	0.616	0.000***
Malaysia	0.299	0.000***
Taiwan	0.807	0.000***
Thailand	0.484	0.000***
South Korea	0.269	0.000***
Panel D: Post-crisis	**Level**	**First Difference**
Japan	0.989	0.000***
Singapore	0.080*	0.000***
Hong Kong	0.638	0.000***
Malaysia	0.821	0.000***
Taiwan	0.195	0.000***
Thailand	0.745	0.000***
South Korea	0.996	0.000***

Source: Authors.

the overall study period (one cointegrating vector), crisis period (one cointegrating vector) and post-crisis period (two cointegrating vectors). This implies the reduction of diversification benefit among the REITs markets during these periods. In addition, the higher number of cointegrating vectors indicates that the linkage between markets was stronger after the crisis. The results differ to the finding of Kim (2009), who found that a cointegrating relationship did exist during the pre-crisis period, which is probably due to the dataset difference.

Exclusion test

The cointegrating vector between markets implies the diversification benefit has reduced. However, the existence of cointegrating vectors in a system of variables does not require the subset of the variables to be cointegrated (Allen & MacDonald, 1995). Despite this, the exclusion test was conducted to examine whether all of the

Table 3. Johansen Cointegration Test.

	Ho: r = 0	Ho : r ≤ 1	Ho : r ≤ 2	Ho : r ≤ 3	Ho : r ≤ 4	Ho : r ≤ 5
Overall Study Period	0.028**	0.448	0.920	0.974	0.993	0.987
Pre-crisis Period	0.646	0.818	0.809	0.605	0.399	0.329
Crisis Period	0.020**	0.143	0.507	0.930	0.950	0.911
Post-Crisis Period	0.000***	0.018**	0.057*	0.136	0.357	0.384

Each entry in the table denotes the p-value; *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.
Source: Authors.

cointegrated markets were sharing the cointegrating relationship, in order to observe whether the diversification benefit does still exist among the cointegrated markets.

As shown in Table 4, the results of the exclusion test indicate that only Hong Kong and Taiwan were participating in the cointegrating vector in the overall study period, which may be due to their adjacent geographical location. During the crisis period, Japan, Hong Kong and Singapore were not participating in the cointegrating vector. On the other hand, even though there were four REIT markets (Japan, Hong Kong, Taiwan and South Korea) that participated in the cointegrating vector during the post-crisis period, the diversification opportunity still existed.

In summary, the domestic REIT investor can achieve better diversification benefits by including certain international REIT markets in their portfolio. Table 5 indicates the possible combination of the markets that can potentially improve the diversification benefits of the portfolio. For instance, Japan can combine with any or the other markets to achieve diversification benefits in the overall study period (Panel A). However, if Hong Kong REITs were added to Japan REITs, there was no more diversification benefit by further adding Taiwan REITs to the portfolio as it was cointegrated with Hong Kong REITs. Last, the markets that enter the cointegrating vector were different throughout the time period, suggested that the linkage among markets varies with time. Investors therefore need to review their portfolio periodically in order to maximize their portfolio return.

Granger Causality Test

To test for the short-run linkage, the Granger Causality Test was conducted on the VAR model in first difference for the pre-crisis period, while the VECM model was

Table 4. Exclusion test.

Markets	Overall Study Period	Crisis Period	Post Crisis Period
Japan	0.801	0.696	0.011**
Singapore	0.231	0.443	0.154
Hong Kong	0.000***	0.576	0.013**
Malaysia	0.331	0.023**	0.069*
Taiwan	0.000***	0.009***	0.008***
Thailand	0.261	0.128	0.489
South Korea	0.963	0.031**	0.037**

Each entry in the table denotes the p-value; *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.
Source: Authors.

applied for the remaining periods. The causality relationship among the Asian REIT markets is displayed in Table 6. Overall, the number of causality effects observed for each of the sub-periods were nine (overall study period), six (pre-crisis), seven (crisis) and three (post-crisis), respectively, with it appearing that the number of causality relationships was decreasing over the time.

For the overall study period, the significance of the error correction term indicates that only the Hong Kong REIT market bears the long-term adjustment process. In the short run, Singapore was the most influential market affecting both developed markets (Hong Kong, Japan) and emerging markets (Malaysia, Taiwan and Thailand). On the other hand, Malaysia appears to be endogenous as it was influenced by Singapore, Hong Kong and South Korea.

Before the crisis, Malaysia and Taiwan were the exogenous markets as none of the markets Granger caused them. On the other hand, causality relationships were found among the neighboring countries where Hong Kong and Malaysia cause Taiwan and Singapore, respectively.

In the crisis period, the significance of the error correction term for Malaysia and Taiwan indicates that both of them bear the long-term adjustment process. In short run, Malaysia and Hong Kong appear to be the exogenous markets as neither received any causality impact from the other markets. On the other hand, Thailand appears to be the most influential market as it affects Japan, Taiwan and South Korea.

Table 5. Possible combination of markets.

Markets	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Panel A: Overall Study Period							
Japan	–	✓	✓	✓	✓	✓	✓
Singapore	✓	–	✓	✓	✓	✓	✓
Hong Kong	✓	✓	–	✓	x	✓	✓
Malaysia	✓	✓	✓	–	✓	✓	✓
Taiwan	✓	x	✓	✓	–	✓	✓
Thailand	✓	✓	✓	✓	✓	–	✓
South Korea	✓	✓	✓	✓	✓	✓	–
Panel B: Crisis Period							
Markets	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Japan	–	✓	✓	✓	✓	✓	✓
Singapore	✓	–	✓	✓	✓	✓	✓
Hong Kong	✓	✓	–	✓	✓	✓	✓
Malaysia	✓	✓	✓	–	x	✓	x
Taiwan	✓	✓	✓	x	–	✓	x
Thailand	✓	✓	✓	✓	✓	–	✓
South Korea	✓	✓	✓	x	x	✓	–
Panel C: Post-crisis Period							
Markets	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
Japan	–	✓	x	✓	x	✓	x
Singapore	✓	–	✓	✓	✓	✓	✓
Hong Kong	x	✓	–	✓	x	✓	x
Malaysia	✓	✓	✓	–	✓	✓	✓
Taiwan	x	✓	x	✓	–	✓	x
Thailand	✓	✓	✓	✓	✓	–	✓
South Korea	x	✓	x	✓	x	✓	–

✓ diversification opportunity exists; x no diversification opportunity; - not appropriate
Source: Authors.

Table 6. Granger Causality Test.

Panel A: Overall Study Period

Country	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
ECT	0.961	0.141	0.035**	0.102	0.001***	0.171	0.633
Japan	–	0.000***	0.342	0.810	0.651	0.925	0.318
Singapore	0.000***	–	0.001***	0.010**	0.010**	0.004***	0.326
Hong Kong	0.835	0.293	–	0.358	0.750	0.631	0.775
Malaysia	0.466	0.743	0.896	–	0.120	0.232	0.291
Taiwan	0.325	0.934	0.846	0.528	–	0.114	0.409
Thailand	0.120	0.470	0.073*	0.314	0.052*	–	0.003***
South Korea	0.076*	0.175	0.080*	0.042**	0.722	0.001***	–

Panel B: Pre-Crisis Period

Country	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
ECT	–	–	–	–	–	–	–
Japan	–	0.549	0.653	0.062*	0.106	0.738	0.144
Singapore	0.004***	–	0.519	0.757	0.666	0.139	0.003***
Hong Kong	0.650	0.290	–	0.412	0.032**	0.282	0.142
Malaysia	0.754	0.019**	0.012**	–	0.137	0.299	0.052*
Taiwan	0.569	0.235	0.195	0.844	–	0.130	0.693
Thailand	0.880	0.254	0.124	0.342	0.016**	–	0.849
South Korea	0.019**	0.103	0.634	0.364	0.891	0.383	–

Panel C: Crisis Period

Country	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
ECT	0.816	0.553	0.775	0.011**	0.006***	0.774	0.198
Japan	–	0.013**	0.868	0.687	0.488	0.853	0.384
Singapore	0.004***	–	0.110	0.201	0.329	0.014**	0.307
Hong Kong	0.731	0.044**	–	0.180	0.787	0.953	0.647
Malaysia	0.985	0.459	0.672	–	0.492	0.864	0.539
Taiwan	0.360	0.705	0.889	0.994	–	0.196	0.107
Thailand	0.008***	0.154	0.091*	0.761	0.006***	–	0.041**
South Korea	0.910	0.610	0.187	0.123	0.362	0.011**	–

Panel D: Post-crisis Period

Country	Japan	Singapore	Hong Kong	Malaysia	Taiwan	Thailand	South Korea
ECT	0.206	0.174	0.040**	0.798	0.000***	0.032**	0.042**
Japan	–	0.085*	0.051*	0.542	0.085*	0.241	0.750
Singapore	0.075*	–	0.015**	0.149	0.125	0.208	0.002***
Hong Kong	0.905	0.017**	–	0.823	0.771	0.633	0.949
Malaysia	0.767	0.813	0.803	–	0.113	0.104	0.440
Taiwan	0.894	0.685	0.587	0.711	–	0.767	0.329
Thailand	0.141	0.476	0.119	0.907	0.783	–	0.123
South Korea	0.063*	0.866	0.383	0.963	0.333	0.211	–

Each entry in the table denotes the p-value of the market on the top caused by the markets at the left hand side. ECT – Error Correction Term; ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level

Source: Authors.

In the post-crisis period, there were four significant error correction terms observed (Hong Kong, Taiwan, Thailand, South Korea). The developed markets become the dominant markets as none of the market is caused by emerging markets for short run. Malaysia remained as the exogenous market, together with Japan, Taiwan and Thailand. On the other hand, a two way causality relationship was also observed between Singapore and Hong Kong.

Conclusion

This study investigates the linkages among the Asian REIT markets across different time frames. The results show that the Asian REIT markets were cointegrated in the overall study period, crisis period and post-crisis period. This finding is similar to Liow (2008) and Yunus and Swanson (2007) who also found evidence of linkages among listed property company's markets. Further analysis reveals that certain markets were excludable from the cointegrating vector for each of the sub-periods, which implies that investors can achieve long-run diversification opportunities by incorporating international REITs into their domestic REIT portfolio.

Finally, the Asian REIT markets were linked to each other in the short run. The number of short-run causality relationships that were decreasing over time implies that there were more diversification opportunities in the short run. Overall, Singapore dominated the short-term effects for the overall study period. In addition, a short-run causality relationship exists between the neighbouring countries. In the post-crisis period, the developed markets played the influencing roles within the region.

Overall, the linkage among the Asian REIT markets may be due to national economic linkages (Liow, 2008), geographic location and from developing to the emerging markets. This paper suggests that an international diversification opportunity exists among the Asian REIT markets. However, investors should continually review the composition and performance of their portfolios in order to achieve the greatest possible returns, given the time varying long-run linkages among the Asian REIT markets.

Limitation

It should be noted that the very small number of REITs when each market was formed can cause the index return to be driven by changes in REIT composition over time rather than by the global financial crisis.

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