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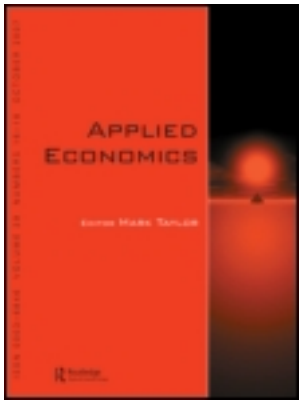

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The integration of direct real estate and stock markets in Asia

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The integration of direct real estate and stock markets in Asia

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Currently, there exists relatively little research investigating the long-term association between stock and direct real estate markets. Using appropriate transaction-based property indices, this study focuses on the relationship between stock and direct real estate markets in nine Asian countries from the period 1980 to 2012 through both linear and nonlinear cointegration techniques. We find empirical evidence of linear cointegration of stock and property markets in Taiwan, fractional cointegration in Singapore and Hong Kong and no evidence of cointegration in China, Japan, Thailand, Malaysia, Indonesia and South Korea. It is concluded that segmentation of property markets from stock markets does not appear to be linked to the differences in the maturity of national financial markets and that the differing degrees of integration across Asia may instead be reflective of a range of factors impacting upon the underlying economic structures in each country.

Keywords: cointegration; Asia; stocks; direct real estate

JEL Classification: C22; G11

I. Introduction

The financial characteristics of direct real estate and stocks have intrigued homebuyers and investors. Stocks are one of the most convenient investment vehicles with high liquidity and low transaction cost, whereas real estate is a 'bulky' asset with low liquidity and high transaction cost. Their distinctive asset characteristics have made the two assets potential risk diversifiers for each other in portfolio management.

Although unfavourable characteristics of real estate as an asset, such as large lot size, high transaction cost, illiquidity and information asymmetry may cause segmentation between stock and property markets, common macroeconomic factors (e.g. interest rates, economic growth, employment, inflation and financial crisis) may drive the two asset categories to converge. Consequently, whether direct real estate displays strong diversification gains remains ambiguous.

In Asia, real estate is particularly important because of traditional values and high population density. Holding property investment is, therefore, a common practice. As our preliminary evidence shows in this area, direct real estate may sometimes share systematic risk with stock markets. For example, the 2007–2009 subprime mortgage crisis that began in the United States negatively influenced the stock rather than property markets in the nine Asian economies surveyed, as shown in Appendix Figs A1 and A2. However, the Asian financial crisis from the period 1997 to 1999 had a negative impact on the majority of both stock and real estate markets in Asia. These simple graphical illustrations indicate that stock and real estate markets in Asia may, sometimes, move in the same direction, which may reflect the regional socioeconomic environments.

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Though the integration between stock and direct real estate markets has been studied, the majority of the empirical findings are based on the results of valuation or appraisal-based property return series. However, because of the measurement issues of these indices, quantitative results based on the appraisal-based return series may misleadingly present that direct real estate has insignificant relationships with other asset categories (Knight *et al*., 2005; Hoesli and Lizieri, 2007). Therefore, an ideal empirical analysis of direct real estate markets should depend on transaction-based rather than appraisal-based property indices.

To the best of our knowledge, few studies have applied a transaction-based direct real estate index to explore the integration issue. With the application of transaction-based property indices, this study concentrates on exploring the cointegration between stock and direct real estate markets in nine Asian economies: China, Japan, Taiwan, Singapore, Hong Kong, South Korea, Thailand, Malaysia and Indonesia.

Identifying such an integration relationship provides insights for portfolio management and government policy. If real estate markets are found to be segmented from stock markets, this would allow investors to have a better diversified portfolio and lower systematic risk. The joint effect of such portfolio strategies can affect their overall wealth, consumption behaviours, aggregate demand and employment in one country. In response to such a potential chain reaction, local governments seek to propose effective tax and growth strategies (Apergis and Lambrindis, 2011).

Thus, the primary objective of this study was to assess whether any significant cointegration or segmentation does exist between stock and direct real estate markets in Asia, with the application of transaction-based indices and, if so, to ascertain what implications it may have for policymakers and practitioners. Furthermore, the factors that drive the integration between stock and property markets have remained a puzzle in literature. Consequently, we intend to establish a theory that allows us to explain the segmentation or integration between stock and direct real estate markets.

We first explore a possible cointegration relationship by the Johansen's maximum eigenvalue and trace tests for cointegration (Johansen, 1988, 1991). Considering that our sample period covers both the Asian Financial Crisis and Global Financial Crisis and the existence of a structural break may disguise the true nature of integration, we also apply a Gregory and Hansen cointegration test (Gregory and Hansen, 1996). For robustness, the nonlinear integration method developed by Okunev and Wilson (1997) is then applied to examine the fractional integration relationship between the stock and real estate markets in the absence of linear cointegration.

Our empirical evidence shows that property and stock markets are linearly cointegrated in Taiwan, fractionally cointegrated in Singapore and Hong Kong and not cointegrated in China, Japan, Thailand, Malaysia, Indonesia and South Korea. The corollary of this finding is that the integration between stock and property markets is found in densely populated and heavily urbanized economies (Taiwan, Singapore and Hong Kong) and also that portfolio risk reduction can be achieved through holding domestically diversified instruments of stocks and property in China, Japan, Thailand, Malaysia, Indonesia and South Korea.

The outline of this article is as follows: Section II presents the relevant literature and theoretical concepts; the research methodology and data set used is described in Sections III and IV, respectively; Section V explains how the results have been obtained and discusses their significance and Section VI presents a conclusion on the basis of these results.

II. Literature Review and Theoretical Framework

The long-run association between stock and direct real estate markets lies mainly within the framework of integration and segmentation. Understanding market integration/segmentation across one economy is important, since disturbances in one market's fundamentals can drive capital movements of the relevant market. If stock and direct real estate markets are well integrated, then it implies that the two assets are good substitutes in investment allocations, such substitution having a significant influence on price fluctuations in the related market. Conversely, if two markets are segmented, then this has significant implications for investment strategy where two assets can be included in a portfolio as means of risk reduction (Wilson *et al*., 1996; Liow and Yang, 2005; Gerlach *et al*., 2006; Lin and Lin, 2011).

The majority of the literature tends to support the hypothesis that segmentation between stock and direct real estate markets does exist (Liu *et al*., 1990; Wilson *et al*., 1996; Ling and Naranjo, 1999; Quan and Titman, 1999; Lu *et al*., 2007).[1] However, because of the lack of frequent transactions of individual properties, such findings typically rely on appraisal-based returns.[2] As pointed

[1] Although Quan and Titman (1999) present mixed results on the integration between stock and real estate markets at an international level, it is noteworthy that four of the countries (US, Australia, Canada and Hong Kong) with the most reliable data all have insignificant relations between stock and real estate prices.

[2] The quantitative analysis of Liu *et al*. (1990) as well as Ling and Naranjo (1999) is based on the appraisal-based property indices, whereas the analysis of Quan and Titman (1999) is based on transaction-based property indices for some countries and appraisal-based property indices for other countries, depending on the availability of data sources. In terms of Wilson *et al*. (1996) and Lu *et al*. (2007), they do not consider the issue of choosing transaction-based over appraisal-based property indices in their empirical analysis.

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out by Knight *et al*. (2005) and Hoesli and Lizieri (2007), the low volatility, high serial correlation in direct real estate returns and their low or negative covariance with other assets result from the measurement issues of appraisal indices. Therefore, quantitative analysis based on appraisal-based returns may be unable to present the true integration between stock and direct real estate markets.

By contrast, when real estate stocks are taken into consideration, there seems to be a close link between stock and real estate markets (Gyourko and Keim, 1992; Mei and Lee, 1994; Li and Wang, 1995; Oppenheimer and Grissom, 1998; Ling and Naranjo, 1999; Ambrose *et al*., 2007). Nevertheless, real estate securities are not representative of underlying direct real estate markets since they also reflect the performance of real estate companies (Bradley *et al*., 1998; Friday *et al*., 1999; Capozza and Seguin, 2000; Knight *et al*., 2005; Hoesli and Lizieri, 2007).

Generally speaking, appraisal-based property and securitized real estate indices have their drawbacks in terms of reflecting the underlying property returns and thus may fail to present the true integration relationship. To complement previous studies, this study applies a favourable transaction-based real estate index to investigate the true integration between stock and direct real estate markets. The financial markets chosen for our empirical analysis are in Asia, since rising asset prices stimulated by Asia's dynamic economy have received worldwide attention, yet the studies of the integration in the past have focussed on Western countries rather than Asian states.

Lin and Lin (2011), writing in response to the increasing level of international interest in Far Eastern economic growth, have made a significant contribution to the understanding of the subject by investigating the cointegration between direct real estate and stock markets in six Asian economies (China, Japan, Taiwan, Singapore, South Korea and Hong Kong). Although the study of Lin and Lin (2011) rigorously examines the integration issue, there are nonetheless certain improvements, which can be made to aspects of their methodology and data set.

First, the property index used in their study may not be optimal as they are from multiple sources and hence may not be directly comparable. For example, they employ housing indices to represent the whole Chinese property market, whereas they use land value indices as a proxy for the Japanese property market. Second, the authors do not address some of the well-known problems of performance measurement of direct real estate indices, such as appraisal smoothing and thin market evidence during crisis periods, in their empirical analysis. Third, their analysis ends in June 2010 and so does not allow a longer-term analysis of the effects of the Global Financial Crisis. Fourth, the model of nonlinear cointegration developed by Okunev and Wilson (1997) appears to be incorrectly specified in their research.[3]

A further recent study that examines the relationship between direct real estate and stock markets during periods of financial crisis is conducted by Guo *et al*. (2011). The authors find evidence of contagion among several asset classes using a Markov regime-switching VAR framework. Of direct relevance to the present article is their finding that the real estate market impacts significantly upon the stock market, but this impact appears to be stronger in times of economic and financial stability and diminishes in crisis periods following market shocks. Perhaps surprisingly, the authors do not confirm any impact of the credit default market on the real estate market.

Focussing on the US market, Yang *et al*. (2012) find evidence of asymmetric volatilities in the daily index returns of S&P500, US corporate bonds, and their real estate equivalents (REITs and CMBS) from the period 1999 to 2008. As expected, the authors find that REITs are not a good hedge against stock market risk, particularly during downturns. Their multivariate asymmetric generalized dynamic conditional correlation GARCH model provides further evidence that the financial crisis caused a major structural break in the correlations of these markets.

Chan *et al*. (2011) investigate the behaviour of asset markets in the United States (stocks, bonds, oil, gold and real estate assets) and identify a 'tranquil' regime characterized by a movement towards riskier asset classes, notably from gold to stocks, and a 'crisis' regime with evidence of contagion between several asset classes. The most relevant finding of this study for the topic at hand is significant contagion between stock and direct real estate markets during market downturns. Finally, focussing on six Asian securitized real estate markets, Lin (2013) finds that the negative volatility spillover from stock to REIT markets is more pronounced during the Global Financial Crisis.

III. Methodology

Considering these issues, we complement the study of Lin and Lin (2011) described in the previous section by using improved methodology and a potentially more accurate, more extensive and more up-to-date data set. The countries chosen for our empirical analysis are

[3] Specifically, Equation 7 in the study of Lin and Lin (2011) appears to be incorrectly specified. See Equation 7 of the present article for our equivalent specification.

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expanded to nine Asian economies. In contrast to Lin and Lin (2011), we ensure that our index used for property market is consistent across countries. Second, avoiding the apparent specification error in Lin and Lin (2011), the nonlinear integration by Okunev and Wilson (1997) is correctly specified in our study. Third, the quarterly property index we can obtain is from January 1980 to September 2012, which is two times larger than that of Lin and Lin (2011). Fourth, considering that our sample period covers both the Asian Financial Crisis and Global Financial Crisis, we also apply a general Gregory and Hansen cointegration test, which allows a trend and regime shift (Gregory and Hansen, 1996). Finally, different from all of the previous integration studies, this study significantly contributes to the literature by applying non-controversial transaction-based property indices to correctly ascertain the integration relationship between stock and direct real estate markets across countries.

Unit root test

The study begins by examining the stationarity of the time series data via the Augmented Dickey–Fuller (ADF) (Dickey and Fuller, 1981) and the Phillips–Perron (PP) (Phillips and Perron, 1988) methods. The specification of these methods is as follows:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \sum_{i=1}^{q} \lambda_i \Delta Y_{t-i} + \delta t + \varepsilon_t \tag{1}$$

where Y_t is the natural logarithm of time series indices, δt is the time trend, q is the number of lags and ε_t is the error term. The selection of optimal lag length is determined by Bayesian information criterion (BIC). Different from ADF testing, the PP test makes a nonparametric correction to the t-test statistic, which is robust with respect to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test equation. The null hypothesis of the ADF and PP approaches is that the index is nonstationary. If the null hypothesis is rejected, then the index is concluded to be stationary.

Johansen cointegration testing

If nonstationary variables are integrated of the same order, it indicates that these nonstationary variables may share a common trend in the long run. The Johansen cointegration test (Johansen, 1988,1991) is next employed to examine the cointegration between stock and direct real estate markets, which is specified as follows:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{q-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \tag{2}$$

where Y is a $(G \times 1)$ vector of $I(1)$ variables, α and β are $(G \times r)$ parameter matrices with rank $(r < G)$, $\Gamma_1, \cdots, \Gamma_{q-1}$ are $(G \times G)$ matrices of parameters, and ε_t is a $(G \times 1)$ vector of normally distributed errors that is serially uncorrelated but has a contemporaneous covariance matrix. Finally, the optimal lag length in the model is determined by BIC.

The Johansen cointegration test is based on two likelihood ratio tests (the trace and maximum eigenvalue statistics) to determine the number of cointegration vectors:

$$\text{Trace Statistic} = -T \sum_{i=r+1}^{G} \ln(1 - \hat{\lambda}_i) \tag{3}$$

$$\text{Maximum Eigenvalue Statistic} = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{4}$$

where T is the number of observations, $\hat{\lambda}_i$ are the estimated eigenvalues and r is the number of cointegrations. The null hypothesis of the trace test is that the number of cointegration vectors is less than or equal to r, whereas the null hypothesis of the maximum eigenvalue test is that there are r cointegration vectors. For both tests, the alternative hypothesis is that there are $f > r$ cointegrating vectors.

Gregory–Hansen cointegration testing

The aforementioned integration method assumes that the cointegration vector is time-invariant under the alternative hypothesis. However, as our time-series data of property and stock markets both cover the Asian Financial Crisis and Global Financial Crisis, it is more robust to ascertain the possibility that the series are cointegrated, in the sense that a linear combination of the nonstationary variables is stationary, yet that this linear combination has shifted at one unknown point.[4] Thus, we apply a more general cointegration model that permits a trend shift and regime shift by Gregory and Hansen (1996):

$$y_{1t} = u_1 + u_2\varphi_{t\tau} + \beta_1 t + \beta_2 t\varphi_{t\tau} + \alpha_1^T y_{2t} + \alpha_2^T y_{2t}\varphi_{t\tau} + e_t, \quad t = 1, \ldots, n \tag{5}$$

where y_{1t} and y_{2t} is our two series for stock and property index respectively, u_1, α_1, β_1 are the intercept, slope

[4] As shown in Appendix Figs A1 and A2, one can observe break points in the series across countries during the Asian Financial Crisis and Global Financial Crisis. Although not shown in this study, a preliminary unit root testing procedure by Zivot and Andrews (1992) also confirms our argument.

coefficients and trend coefficient, respectively, before the regime shift; u_2, α_2, β_2 are the corresponding changes after the break. The dummy variable $\varphi_{t\tau}$ is used to model the structural change:

$$\varphi_{t\tau} = \begin{cases} 0, & \text{if } t \leq [n\tau] \\ 1, & \text{if } t > [n\tau] \end{cases}$$

where $\tau \in (0, 1)$ is a relative timing of the change point with the break point changing over the previous interval. The test is an extension and modifications of the test statistics: Z_α, Z_t (derived from Phillips (1987)) and ADF.

Nonlinear cointegration technique

According to the previous cointegration tests, if one market is not cointegrated with the other, then these two markets are segmented. Nevertheless, Okunev and Wilson (1997) contend that this conclusion is based on the assumption that the series in both markets are linearly related; it is likely that the two series have a nonlinear relationship. Therefore, Okunev and Wilson (1997) develop a nonlinear model to measure the degree of market cointegration as the following function:

$$R(t) = S(t)^{\beta} e^{\{\alpha(t)-k\}} \tag{6}$$

where $R(t)$ and $S(t)$ represent the real estate and equity indices at time t, respectively. The β coefficient denotes the exponent of the relationship. This nonlinear model can be summarized as the following equation:[5]

$$\log \frac{R(t+1)}{R(t)} = \gamma_0 + \gamma_1 \log \frac{S(t+1)}{S(t)} + \gamma_2 \log S(t) + \gamma_3 \log R(t) + e(t) \tag{7}$$

where the constant term is denoted by γ_0, and the coefficient of γ_1 allows us to test whether the market relationship is fractionally cointegrated ($0 < \gamma_1 < 1.$). The coefficient of γ_2 represents the change in the mean reversion characteristics of the property towards stock index. The coefficient of γ_3 signifies the speed of adjustment of mean reversion towards the stock market.

IV. Data and Descriptive Statistics

The proxy variable for the property market used in this study is the quarterly transaction-based housing price index published by Oxford Economics from the period January 1980 to September 2012 for all of the nine Asian economies in this study.[6] The transaction-based property value index is preferred since it more closely reflects the true returns of property markets over the appraisal-based property index (Geltner, 1991, 1993; Fisher *et al*., 1994; Chaplin, 1997; Cho *et al*., 2003; Booth and Marcato, 2004; Marcato *et al*., 2007a, b; Lizieri *et al*., 2012).

The stock market indices employed are the Shanghai Stock Exchange Composite Index (China), the Tokyo Nikkei 225 Index (Japan), the Taiwan Stock Exchange Weighted Index (Taiwan), the South Korea Seoul Composite Index (South Korea), the Hong Kong Hang Seng Index (Hong Kong), the Singapore Straits Time Index (Singapore), the Stock Exchange of Thailand Index (Thailand), the FTSE Bursa Malaysia Kuala Lumpur Composite Index (Malaysia) and the Jakarta Stock Exchange Composite Index (Indonesia).[7]

Table 1 shows descriptive statistics of stock and real estate returns in the nine Asian economies. Several interesting findings can be noted. First, the SD is a measure of volatility. The return of the stock market is found to be more volatile than that of the real estate market in all of the nine Asian economies. This suggests that stocks are a riskier investment vehicle than real estate.

Furthermore, the mean and SDs of stock and real estate returns support the theoretical risk–return relationship in asset prices. The principle of risk–return trade-off is that potential return rises with an increase in risk. Although the stock markets are more volatile than the real estate markets, it can also be clearly observed that the domestic stock return is higher than the real estate return in the majority of Asian economies.

V. Empirical Results

Unit root test

The empirical analysis in this research begins by examining the stationarity of the time series data as shown in

[5] For further details on this model, please refer to Okunev and Wilson (1997).
[6] Our data is collected from Datastream. We have contacted Datastream for the measurement issues of real estate indices, and they have expressed that the housing index published by Oxford Economics is transaction-based.
[7] All of the stock indices are from the period January 1980 to September 2012, except that of China, Singapore, Thailand and Indonesia, because indices in these markets were formally established after January 1980. The sample period obtained for those stock indices is from December 1990, December1987, September 1987 and June 1983 to September 2012 for China, Singapore, Thailand and Indonesia, respectively.

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Table 1. Descriptive statistics of stock and real estate markets in Asia

	Mean (%)	SD (%)	Max. (%)	Min. (%)
Panel A: Stocks				
China	3.23	22.49	113.9	−52.83
Japan	0.22	11.01	21.01	−42.01
Taiwan	2.04	21.45	99.48	−75.61
Thailand	1.06	18.64	54.94	−54.08
Malaysia	1.49	15.48	47.81	−52.01
Indonesia	3.20	17.48	81.88	−47.91
Singapore	1.32	13.01	39.35	−42.35
Hong Kong	2.48	15.16	43.74	−53.80
South Korea	2.23	15.40	59.47	−54.21
Panel B: Property				
China	1.44	3.31	20.39	−3.11
Japan	0.41	6.61	29.58	−19.31
Taiwan	0.63	5.16	14.57	−12.00
Thailand	0.87	6.42	19.94	−23.26
Malaysia	0.97	1.45	3.94	−2.92
Indonesia	2.09	3.04	19.51	−2.45
Singapore	1.76	5.78	24.03	−15.15
Hong Kong	1.78	5.89	17.46	−18.55
South Korea	1.07	2.24	7.50	−7.29

Note: We use the logarithm approach to calculate the returns of stock and real estate markets in Asia.

Table 2. Unit root test on stationarity of stock and property index

	ADF		PP	
	Level	First	Level	First
Panel A: Stocks				
China	1.00	−9.07***	0.89	−9.15***
Japan	0.15	−10.86***	0.14	−10.85***
Taiwan	0.84	−12.19***	0.95	−12.22***
Thailand	0.44	−10.96***	0.47	−10.94***
Malaysia	0.95	−12.08***	1.05	−12.11***
Indonesia	1.87	−9.99***	1.78	−10.05***
Singapore	0.90	−9.06***	0.86	−9.05***
Hong Kong	1.65	−12.45***	1.75	−12.46***
South Korea	1.42	−11.14***	1.42	−11.15***
Panel B: Property				
China	1.74	−1.86**	4.59	−13.48***
Japan	0.60	−5.79***	0.60	−13.15***
Taiwan	1.21	−4.53***	1.79	−11.25***
Thailand	2.74	−4.89***	2.65	−19.51***
Malaysia	3.29	−3.62***	8.03	−10.01***
Indonesia	3.53	−2.04**	4.44	−5.59***
Singapore	1.36	−5.00***	1.74	−4.65***
Hong Kong	1.36	−5.10***	1.91	−5.22***
South Korea	2.24	−5.48***	2.74	−5.54***

Note: *** and ** indicate significance at the 0.01 and 0.05 levels, respectively.

Table 2. The null hypothesis of nonstationary index at the level series cannot be rejected in the ADF (Dickey and Fuller, 1981) and the PP (Phillips and Perron, 1988) methods, but the null hypothesis of nonstationary index at the first difference series is rejected. The results of these unit root tests consistently show that all indices are $I(1)$processes, indicating they are difference stationary and conventional Johansen rank tests can be performed.[8]

Johansen cointegration testing

Table 3 exhibits the results of Johansen cointegration tests (Johansen, 1988, 1991).[9] Based on the trace and the maximum eigenvalue statistics of Johansen cointegration testing, the null hypothesis of no cointegrating vector is not rejected in Taiwan, Malaysia, Indonesia, Singapore, Hong Kong and South Korea, but is rejected in China, Japan and Thailand at the significant level of 1%. This suggests that there is a long-run equilibrium between direct real estate and stock markets in China, Japan and Thailand.

Gregory–Hansen cointegration testing

As previously discussed, since our sample period covers both the Asian Financial Crisis and Global Financial Crisis, it is more robust to apply the cointegration method allowing structural shifts. Otherwise, the existence of structural breaks may disguise the true integration between assets within the portfolio (Gerlach *et al.*, 2006). In Table 4 of the Gregory–Hansen cointegration test, which permits a trend shift and regime shift,[10] our result shows that Taiwan is the only country where stock is significantly integrated with the property market, irrespective of the specification of test statistics. Furthermore, given the presence of structural breaks, the integration of stock and property markets in China, Japan and Thailand found in the Johansen cointegration testing is not observed in the robust Gregory–Hansen cointegration testing.

Nonlinear cointegration technique

The results of the aforementioned cointegration tests are based on the linear assumption. Although the property market is not linearly cointegrated with the equity market in China, Japan, Thailand, Malaysia, Indonesia, Singapore, Hong Kong and South Korea, it is possible

[8] The lag length in the ADF test is selected by BIC. The spectral estimation method and bandwidth used in the PP test is the Bartlett Kernel and Newey–West, respectively.
[9] The lag length made for the Johansen cointegration test is selected by BIC. The modelling specification such as assuming no deterministic trend in data, allowing linear deterministic trend, or allowing quadratic deterministic trend, is also selected by BIC.
[10] The lag length made for the Gregory–Hansen cointegration test is selected by BIC.

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Table 3. Johansen cointegration test between stock and property markets

	Null hypothesis	Eigenvalue	Trace statistic	Max-Eigen statistic
China	H_0:$r = 0$	0.16	16.51***	14.58***
	H_0:$r \leq 1$	0.02	1.93	1.93
Japan	H_0:$r = 0$	0.14	19.78***	19.66***
	H_0:$r \leq 1$	0.0008	0.11	0.11
Taiwan	H_0:$r = 0$	0.06	9.47	8.15
	H_0:$r \leq 1$	0.01	1.32	1.32
Thailand	H_0:$r = 0$	0.13	16.54***	14.60***
	H_0:$r \leq 1$	0.01	1.93	1.93
Malaysia	H_0:$r = 0$	0.07	16.35	10.16
	H_0:$r \leq 1$	0.04	6.18	6.18
Indonesia	H_0:$r = 0$	0.04	5.87	4.90
	H_0:$r \leq 1$	0.008	0.97	0.97
Singapore	H_0:$r = 0$	0.07	7.34	7.33
	H_0:$r \leq 1$	0.00006	0.006	0.006
Hong Kong	H_0:$r = 0$	0.02	5.18	3.67
	H_0:$r \leq 1$	0.01	1.51	1.51
South Korea	H_0:$r = 0$	0.05	11.37	7.73
	H_0:$r \leq 1$	0.02	3.63	3.63

Notes: r denotes the number of cointegrating vectors in the null hypothesis. ***and ** indicate significance at the 0.01 and 0.05 levels, respectively.

Table 4. Gregory–Hansen cointegration test between stock and property markets

	Test statistic		
	ADF	Z_t	Z_α
China	−4.01	−3.99	−27.34
Japan	–4.06	–4.12	–28.19
Taiwan	−6.29***	−6.32***	−61.53**
Thailand	–5.74**	–5.71**	–50.26
Malaysia	−4.58	−4.43	−35.24
Indonesia	–4.54	–4.79	–36.00
Singapore	−5.19	−5.21	−40.83
Hong Kong	−4.93	−4.63	−38.40
South Korea	–3.80	–3.90	–27.05

Note: *** and ** indicate significance at the 0.01 and 0.05 levels, respectively.

that there is nonlinear (partial) cointegration. The results from the fractional cointegration test[11] developed by Okunev and Wilson (1997) are shown in Table 5. We find that the coefficients of γ_1 in Singapore and Hong Kong are statistically significant between zero and one, suggesting that direct real estate and stock markets are fractionally cointegrated in Singapore and Hong Kong. In comparison, the coefficients of γ_1 in China, Japan, Thailand, Indonesia, Malaysia and South Korea are not statistically significant between zero and one, showing that the property market is segmented from the stock market in these six countries.

Discussion of results

Lin and Lin (2011) find the significant evidence of cointegration between stock and property markets in Japan, partial integration in China, Hong Kong and Taiwan, and no evidence of integration in South Korea and Singapore. However, when a more appropriate data and methodology is used, our result differs from Lin and Lin (2011).

To summarize, our quantitative evidence shows that stock and direct real estate markets are linearly cointegrated in Taiwan and partially cointegrated in Singapore and Hong Kong. By contrast, segmentation is observed in China, Japan, Thailand, Indonesia, Malaysia and South Korea. This implies that stocks and property investments are good substitutes for investment allocation in Taiwan, Singapore and Hong Kong, whereas these two assets should be included in a portfolio as means of risk reduction in China, Japan, Thailand, Indonesia, Malaysia and South Korea.

The integrated real estate markets in Taiwan, Singapore and Hong Kong also indicate that such markets may respond to the same economic stimuli as the stock markets, thereby offering little gain from diversifying across these markets. In contrast, the segmented real estate market in China, Japan, Thailand, Indonesia, Malaysia and South Korea suggests that stock and property investments in these countries may respond to different economic stimuli, and practitioners are therefore recommended to include direct real estate and stocks together in investment portfolios for increased risk reduction.

Further implication of results

Similar to the approach of previous literature (Liu *et al*., 1990; Wilson *et al*., 1996; Ling and Naranjo, 1999; Lu *et al*., 2007; Lin and Lin, 2011), yet using a transaction-based property index, we ascertain the integration of stock and direct real estate markets and present its associated long-run implication. Although exploring integration issues is important, we believe that finding the factors that drive the integration is enduringly significant.

Stock and direct real estate markets should supposedly be linked in their economic fundamentals, but the unfavourable characteristics of real estate as an asset – large lot size, high transaction cost, illiquidity and information asymmetry – may cause the segmentation between stock

[11] There are several nonlinear cointegration methods in literature. The one developed by Okunev and Wilson (1997) is particularly used in this study for two reasons. First, this technique is only designed for the partial integration between stock and real estate markets. Second, using this method, we can compare our results with previous literature such as Lin and Lin (2011).

Table 5. The nonlinear cointegration test between stock and property markets

	γ_0	γ_1	γ_2	γ_3
China	0.119** (0.047)	0.005 (0.017)	0.012 (0.009)	−0.044** (0.019)
Japan	−0.099 (0.135)	0.051 (0.052)	0.048*** (0.015)	−0.078*** (0.025)
Thailand	0.225 (0.142)	−0.046 (0.029)	0.014 (0.012)	−0.063** (0.027)
Malaysia	−0.002 (0.017)	−0.0002 (0.008)	0.007 (0.004)	−0.008 (0.007)
Indonesia	0.043*** (0.015)	−0.030 (0.016)	−0.004 (0.004)	0.0008 (0.006)
Singapore	−0.676*** (0.088)	0.126*** (0.027)	0.165*** (0.016)	−0.118*** (0.013)
Hong Kong	−0.027 (0.044)	0.086*** (0.033)	0.030** (0.013)	−0.044** (0.019)
South Korea	0.133*** (0.026)	0.007 (0.012)	0.020*** (0.005)	−0.062*** (0.012)

Notes: *** and ** indicate significance at the 0.01 and 0.05 levels, respectively. SEs are in parentheses next to corresponding parameter estimates. See Equation 7 for details.

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and property markets. In this study, we find mixed results of the integration/segmentation between stock and property markets in Asia.

The different degrees of integration across Asia are said to reflect fundamental differences in the structure of the regional economies (Lin and Lin, 2011). However, what exactly the fundamental differences in the structure of the regional economies are still remains uncertain. In our study, we explore the integration for nine Asian economies (China, Japan, Taiwan, Singapore, Hong Kong, South Korea, Thailand, Malaysia and Indonesia) and we find integration of stock and property markets in Taiwan, Singapore and Hong Kong.

According to the 2010 World Population Prospects, Taiwan, Singapore and Hong Kong are the top three most densely populated areas in our surveyed nine Asian economies.[12] Compared with stock markets, real estate markets tend to be more illiquid with higher transaction costs and information asymmetry. It is also known to be sluggish in terms of reacting to economic stimuli. Since there is higher demand and supply (specifically, frequent transactions) in the densely populated real estate markets, property in these markets will be more liquid with fewer transaction costs and information asymmetry. This means that the unique characteristics of real estate markets such as liquidity, transactions costs and information asymmetry, which cause its segmentation from stock markets, may be less pronounced in the densely populated areas. Therefore, similar to stock markets, densely populated real estate markets will adjust simultaneously to the impact of common macroeconomic factors. This may explain why we observe the integration in Taiwan, Singapore and Hong Kong.

Moreover, we also argue that whether stock and real estate markets are integrated or not is irrelevant to the underlying maturity of national financial markets. Based on the 2009 classification of International Finance Corporation, Japan, Taiwan, Hong Kong, Singapore and South Korea are classified as the developed markets, whereas China, Indonesia, Thailand and Malaysia are classified as emerging markets. This result suggests that integration/segmentation of property markets and stock markets does not seem to be related to the differences in the underlying development of national financial markets.

Further research is suggested to explore why the long-run association between stocks and direct real estate is significant in some countries, but not in others, and also to explore the socioeconomic variables that drive the convergence or divergence between the two asset categories.

VI. Conclusion

Because of the measurement issue of property indices, previous studies based on appraisal-based property indices may not ideally explore the cointegration between stock and direct real estate markets. This empirical work attempts to disclose the true cointegration in nine Asian countries from the period 1980 to 2012, via transaction-based property indices. The Johansen cointegration technique and Gregory–Hansen cointegration testing, given the presence of a structural break, is applied to investigate this relationship. For robustness, the nonlinear integration method developed by Okunev and Wilson (1997) is thereafter employed to investigate the fractional integration relationship between the stock and real estate markets in the absence of linear cointegration.

The quantitative results demonstrate that the stock market is linearly cointegrated with the direct real estate

[12] We select the medium variant in World Population Prospects for calculating population density. The population density (population per sq. km) in 2010 for China, Japan, Singapore, Hong Kong, South Korea, Thailand, Malaysia and Indonesia is 113, 224, 9773, 6580, 410, 79, 129 and 166, respectively. Unfortunately, Taiwan is not included in World Population Prospects. So, we use the estimated population density from National Statistics in Taiwan, and the estimated value for 2010 is 640 per sq. km.

market in Taiwan and fractionally integrated in Singapore and Hong Kong. By contrast, segmentation is observed in China, Japan, Thailand, Malaysia, Indonesia and South Korea. The former result implies that the stock and direct real estate markets will reach a long-run equilibrium, and these two assets may be substitutable for investment allocation, whereas the latter finding indicates that including the two assets provides risk diversification benefits.

As shown in this empirical study, although the degree of integration differs across the nine Asian countries studied, the integration between stock and property markets is observed in the most densely populated areas of our surveyed economies (Taiwan, Singapore and Hong Kong). Densely populated real estate markets imply that real estate markets in Taiwan, Singapore and Hong Kong will have frequent transactions, and as such, their real estate market will be more transparent and liquid as well as less sluggish with fewer information and translation costs. Therefore, under the impact of common economic stimuli, real estate markets in these areas tend to comove with stock markets, and this explains why the significant integration tends to be observed in the densely populated areas.

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References

Ambrose, B. W., Lee, D. W. and Peek, J. (2007) Comovement after joining an index: spillovers of nonfundamental effects, *Real Estate Economics*, **35**, 57–90.

Apergis, N. and Lambrinidis, L. (2011) More evidence on the relationship between the stock and the real estate market, *Briefings Notes in Economics*, **85**, 1–15.

Booth, P. and Marcato, G. (2004) The measurement and modelling of commercial real estate performance, *British Actuarial Journal*, **10**, 5–61.

Bradley, M., Capozza, D. R. and Seguin, P. J. (1998) Dividend policy and cash-flow uncertainty, *Real Estate Economics*, **28**, 555–80.

Capozza, D. R. and Seguin, P. J. (2000) Debt, agency, and management contracts in REITs: the external advisor puzzle, *Journal of Real Estate Finance and Economics*, **20**, 91–116.

Chan, K. F., Treepongkaruna, S., Brooks, R. *et al*. (2011) Asset market linkages: evidence from financial, commodity and real estate assets, *Journal of Banking & Finance*, **35**, 1415–26.

Chaplin, R. (1997) Unsmoothing valuation-based indices using multiple regimes, *Journal of Property Research*, **14**, 189–210.

Cho, H., Kawaguchi, Y. and Shilling, D. J. (2003) Unsmoothing commercial property returns: a revision to Fisher-Geltner-Webb's unsmoothing methodology, *Journal of Real Estate Finance and Economics*, **27**, 393–405.

Dickey, D. A. and Fuller, W. A. (1981) Likelihood ratio statistics for autoregressive time series with unit root, *Econometrica*, **49**, 1057–72.

Fisher, J. D., Geltner, D. M. and Webb, R. B. (1994) Value indices of commercial real estate: a comparison of index construction methods, *Journal of Real Estate Finance and Economics*, **9**, 137–64.

Friday, S. H., Sirmans, S. G. and Conover, M. C. (1999) Ownership structure and the value of the firm: the case of REITs, *Journal of Real Estate Research*, **17**, 71–90.

Geltner, D. (1991) Smoothing in appraisal-based returns, *Journal of Real Estate Finance and Economics*, **4**, 327–45.

Geltner, D. (1993) Estimating market values from appraised values without assuming an efficient market, *Journal of Real Estate Research*, **8**, 325–45.

Gerlach, R., Wilson, P. and Zurbruegg, R. (2006) Structural breaks and diversification: the impact of the 1997 Asian financial crisis on the integration of Asia-Pacific real estate markets, *Journal of International Money and Finance*, **25**, 974–91.

Gregory, A. W. and Hansen, B. E. (1996) Tests for cointegration in models with regime and trend shifts, *Oxford Bulletin of Economics and Statistics*, **58**, 555–60.

Guo, F., Chen, C. R. and Huang, Y. S. (2011) Markets contagion during financial crisis: A regime-switching approach, *International Review of Economics and Finance*, **20**, 95–109.

Gyourko, J. and Keim, D. B. (1992) What does the stock market tell us about real estate returns?, *Real Estate Economics*, **20**, 457–85.

Hoesli, M. and Lizieri, C. (2007) Real estate in the investment portfolio, A report prepared for the investment strategy council of the royal ministry of finance: Norway, May.

Johansen, S. (1988) Statistical analysis of co-integration vectors, *Journal of Economic Dynamics and Control*, **12**, 231–54.

Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models, *Econometrica*, **59**, 1551–80.

Knight, J., Lizieri, C. and Satchell, S. (2005) Diversification when it hurts? The joint distributions of real estate and equity markets, *Journal of Property Research*, **22**, 309–23.

Li, Y. and Wang, K. (1995) The predictability of REIT returns and market segmentation, *Journal of Real Estate Research*, **10**, 471–82.

Lin, P. (2013) Examining volatility spillover in Asian REIT markets, *Applied Financial Economics*, **23**, 1701–5.

Lin, T. C. and Lin, Z. H. (2011) Are stock and real estate markets integrated? An empirical study of six Asian economies, *Pacific-Basin Finance Journal*, **19**, 571–85.

Ling, D. C. and Naranjo, A. (1999) The integration of commercial real estate markets and stock markets, *Real Estate Economics*, **27**, 483–515.

Liow, K. H. and Yang, H. (2005) Long-term co-memories and short-run adjustment: securitized real estate and stock markets, *Journal of Real Estate Finance and Economics*, **31**, 283–300.

Liu, C. H., Hartzell, D. J., Greig, W. *et al*. (1990) The integration of the real estate market and the stock market: some preliminary evidence, *Journal of Real Estate Finance and Economics*, **3**, 261–82.

Lizieri, C., Satchell, S. and Wongwachara, W. (2012) Unsmoothing real estate returns: a regime-switching approach, *Real Estate Economics*, **40**, 775–807.

Lu, Y. C., Chang, T. and Wei, Y. C. (2007) An empirical note on testing the cointegration relationship between the real estate and stock markets in Taiwan, *Economics Bulletin*, **3**, 1–11.

Marcato, G. and Key, T. (2007a) Index smoothing and the volatility of commercial property, Technical report, Investment Property Forum, London.

Marcato, G. and Key, T. (2007b) Smoothing and implication for asset allocation choices, *Journal of Portfolio Management*, **33**, 85–99.

Mei, J. and Lee, A. (1994) Is there a real estate risk premium?, *Journal of Real Estate Finance and Economics*, **9**, 113–26.

Okunev, J. and Wilson, P. (1997) Using nonlinear tests to examine integration between real estate and stock markets, *Real Estate Economics*, **25**, 487–503.

Oppenheimer, P. and Grissom, T. V. (1998) Frequency space correlation between REITs and capital market indices, *Journal Real Estate Research*, **16**, 291–309.

Phillips, P. C. B. (1987) Time series regression with a unit root, *Econometrica*, **55**, 277–301.

Phillips, P. C. B. and Perron, P. (1988) Testing for a unit root in time series regression, *Biometrika*, **75**, 335–46.

Quan, D. and Titman, S. (1999) Do real estate prices and stock prices move together?, An international analysis, *Real Estate Economics*, **27**, 183–207.

Wilson, P., Okunev, J. and Ta, G. (1996) Are real estate and securities markets integrated?, *Journal of Property Valuation and Investment*, **14**, 7–24.

Yang, J., Zhou, Y. and Leung, W. K. (2012) Asymmetric correlation and volatility dynamics among stock, bond, and securitized real estate markets, *The Journal of Real Estate Finance and Economics*, **45**, 491–521.

Zivot, E. and Andrews, D. K. W. (1992) Further evidence on the great crash, the oil price shock, and the unit root hypothesis, *Journal of Business and Economic Statistics*, **10**, 251–70.

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Appendix

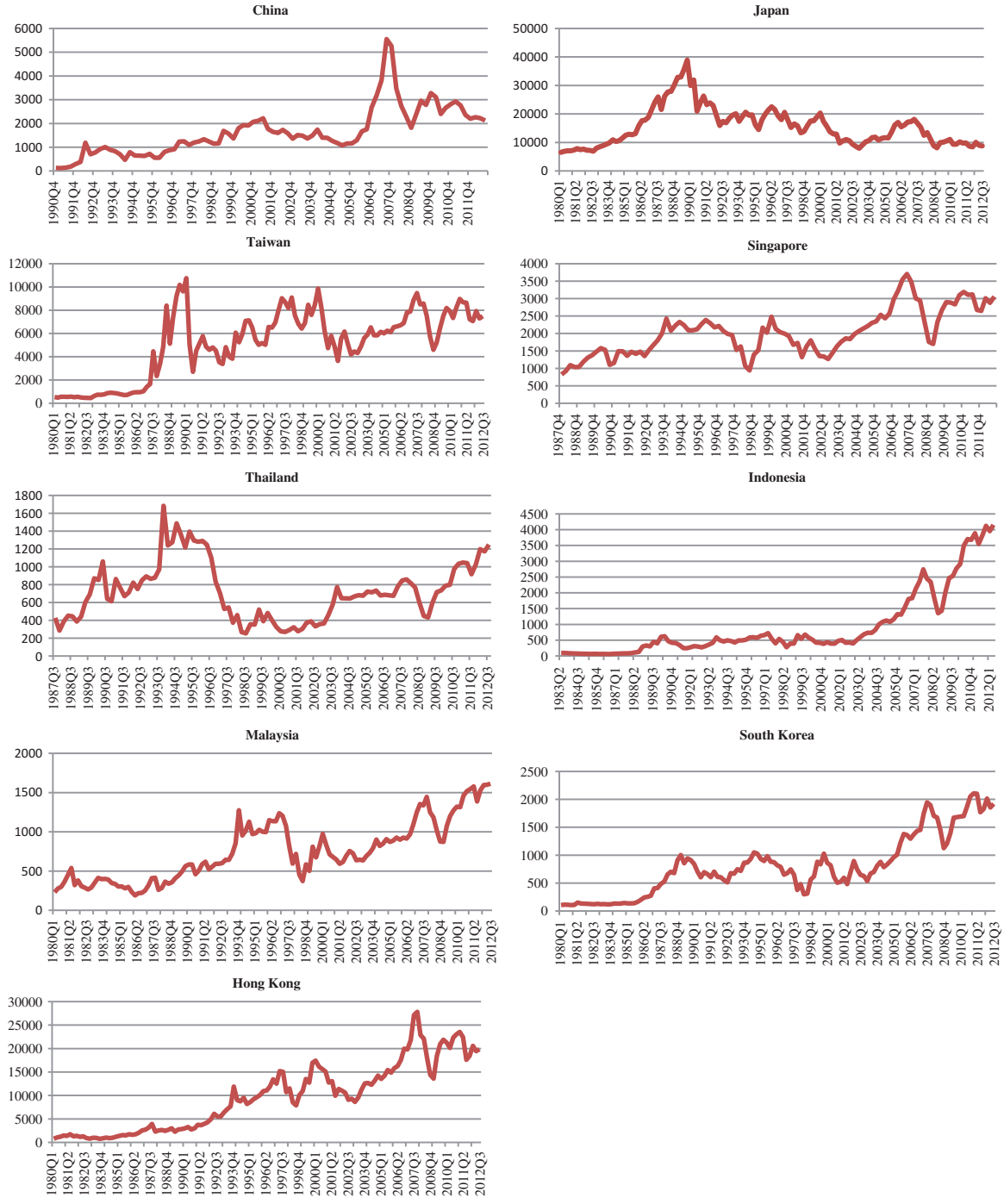

Fig. A1. The movements of stock markets in Asia

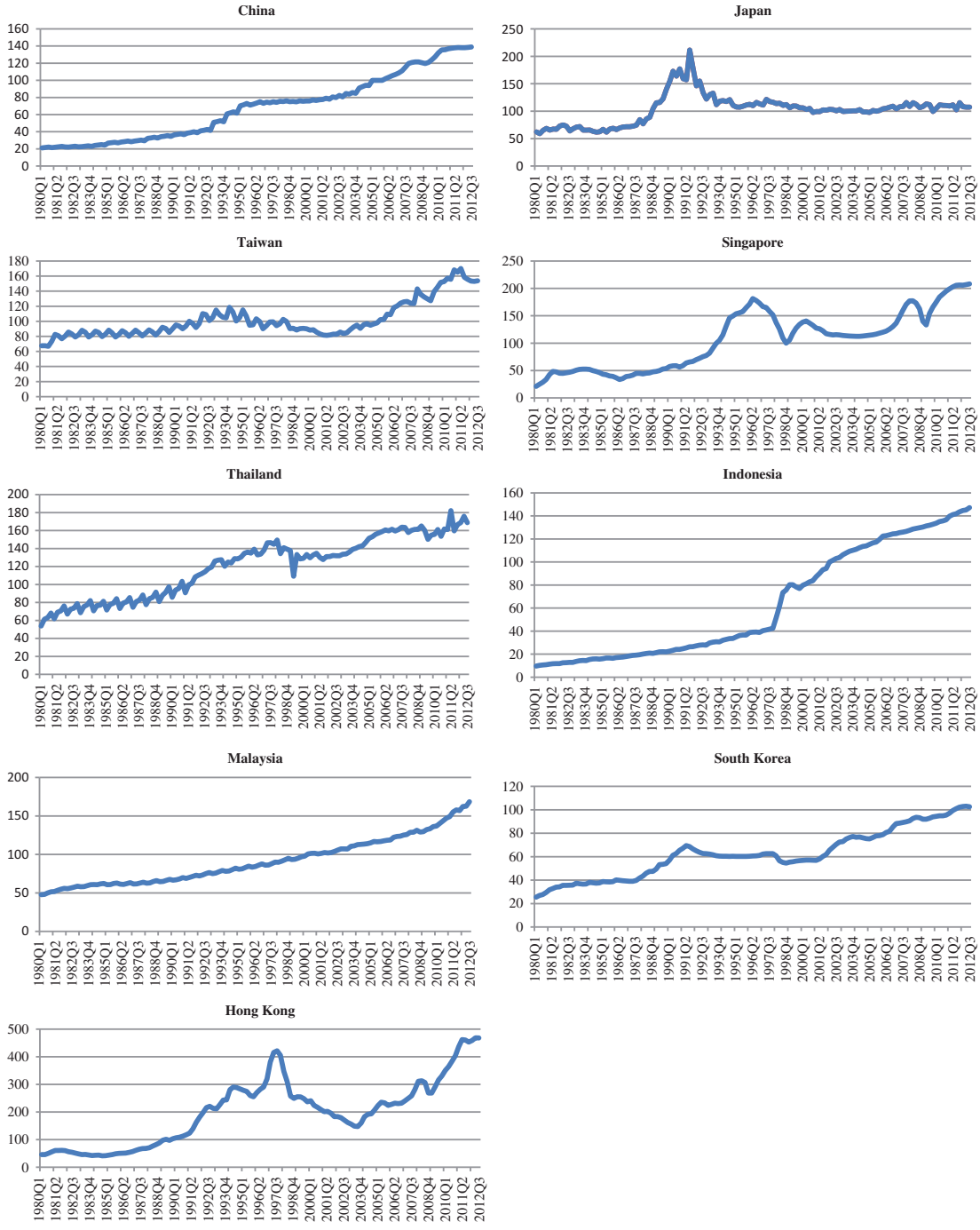

Fig. A2. The movements of direct real estate markets in Asia

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