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Are stock and real estate markets integrated? An empirical study of six Asian economies

Tsoyu Calvin Lin [a,*], Zong-Han Lin [b]

[a] *Department of Land Economics, National ChengChi University, Taiwan. Address: 64, Sec. 2, ZhiNan Rd., WenShan District, Taipei, Taiwan*
[b] *Department of Finance, ChaoYang University of Technology, Taiwan*

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ABSTRACT

Rising asset prices spurred by Asia's emerging economy have drawn much attention recently. This study examines one source of growth patterns in asset prices by analyzing the integration relationship between stock markets and real estate markets in Asia. Six economies are selected for empirical analysis: China, Hong Kong, Japan, Singapore, South Korea, and Taiwan. Results show that stock markets are integrated with real estate markets in Japan, and partially integrated with real estate markets in China, Hong Kong, and Taiwan. This implies that these two investment vehicles are substitutable in China, Hong Kong, Japan, and Taiwan, and provide diversification potential for investment portfolios in South Korea and Singapore. Examining the timing of market changes, we found the real estate market leading the stock market in some countries, and the stock market leading the real estate market in others. We conclude that stock and real estate markets show a variety of inter-relationships depending on economic and political policy environments.

1. Introduction

Real estate and stocks are important assets for most investors. The liquidity and the relationship of these two assets have often attracted the attention of both homebuyers and investors. Stock is the most convenient form of investment for many. It offers relatively high liquidity and transparency of transaction information compared with other investment vehicles. For most households, however, real estate is probably the most important and expensive asset to obtain. In Asia real estate is especially preferred, due to traditional values and to the region's high population density.

* Corresponding author. Tel.: +886 2 29393091x51142.
E-mail address: tsoyulin@nccu.edu.tw (T.C. Lin).

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Stock and real estate values are also influenced strongly by economic conditions (e.g., economic growth, inflation, interest rates, employment, financial crisis, and so on). For example, the 2008 subprime mortgage crisis that began in the U.S. had a significant negative impact on both stock and real estate prices in the six markets surveyed, as shown in Figs. 1 and 2. However, the differential effects of these conditions on these assets have repeatedly drawn the attention of investors, households, and scholars. On the one hand, if there is an integrated relationship between markets for these two assets, this implies that they are substitutable or interchangeable. Investors may be able to predict one market through observing the other's performance. On the other hand, the stock market may also react independently of real estate market due to various market conditions or government

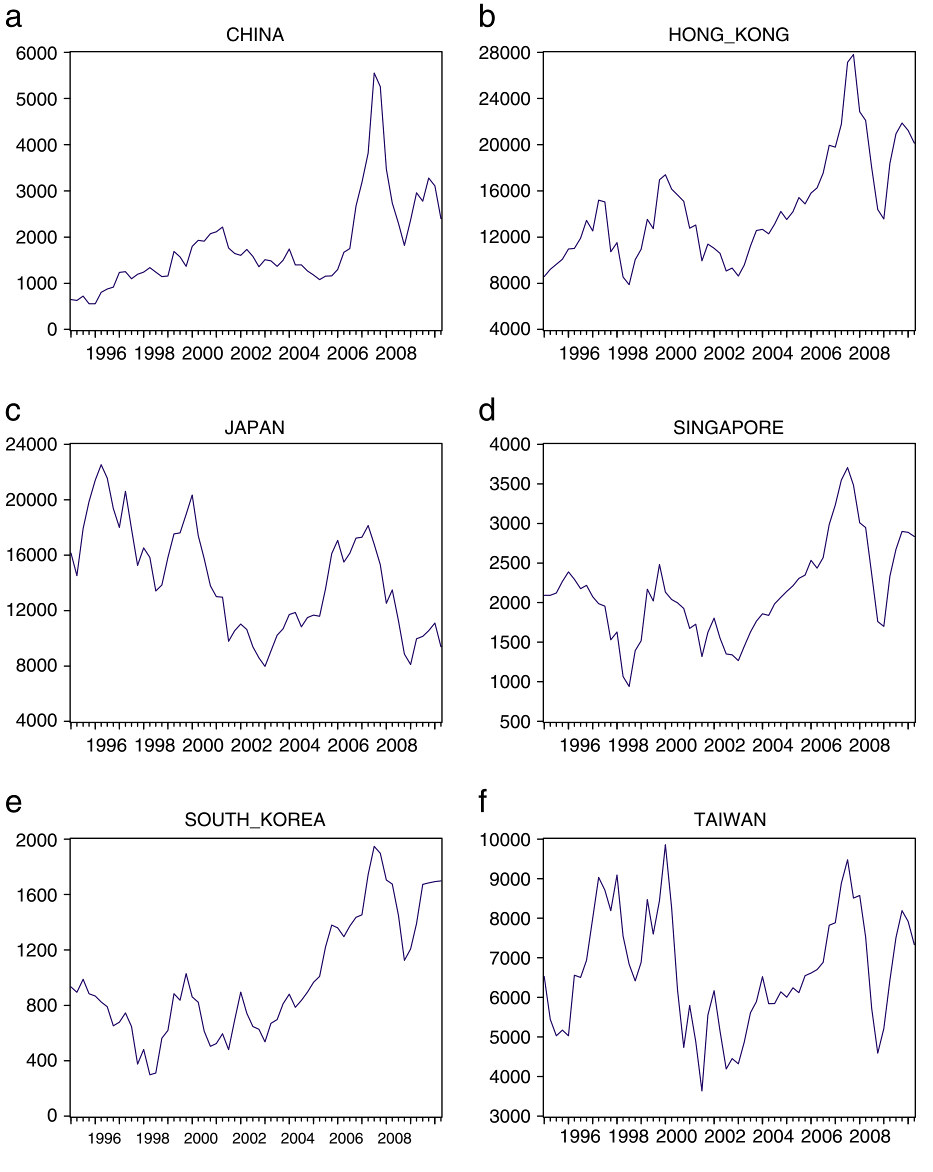

Fig. 1. The movements of Asian stock markets.

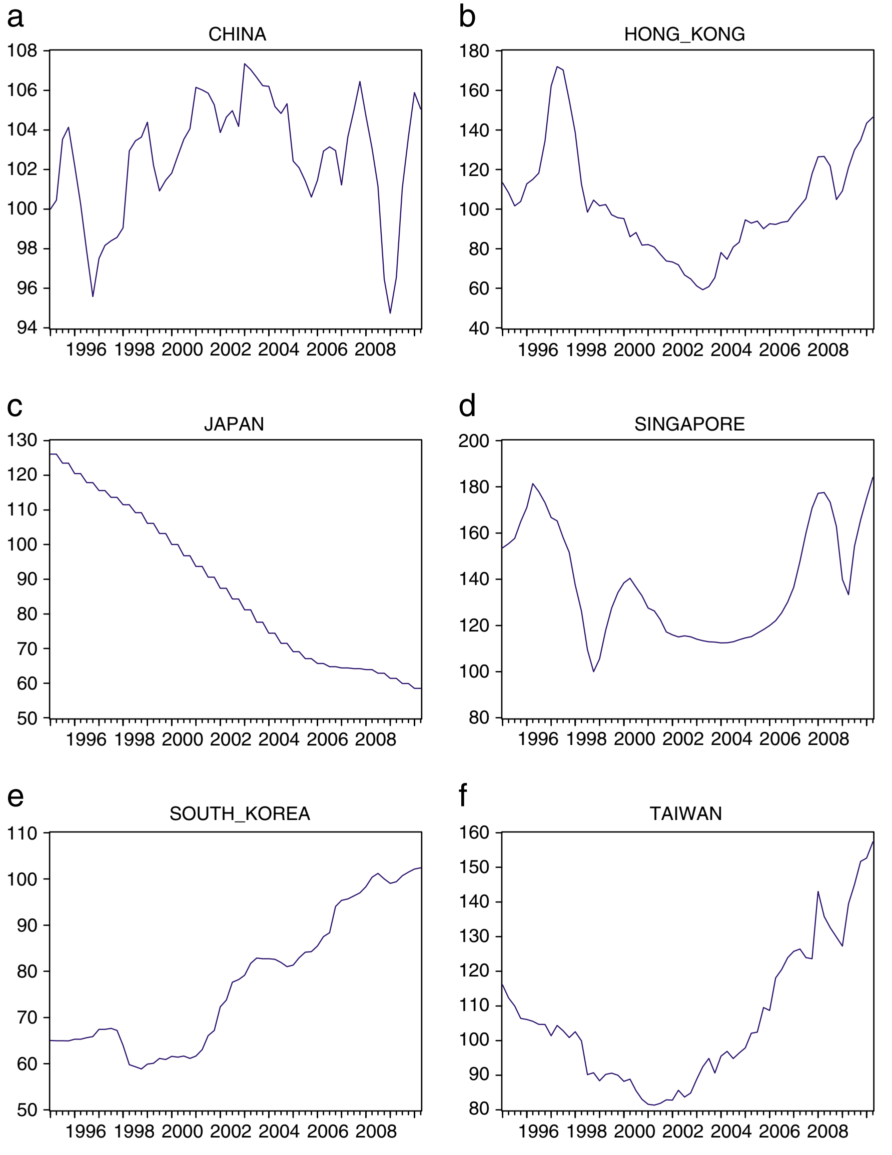

Fig. 2. The movements of Asian real estate markets.

intervention, including distortions in supply or demand, taxation, supply or price control, data quality, or other transaction costs. If these two markets are segmented, investors can diversify their portfolios by holding both types of assets simultaneously.

Numerous studies have explored the relationship between the stock market and the real estate market in the U.S., but results have been inconsistent, perhaps due to differences in sampling areas, sampling periods, data quality, or economic environments (Ambrose, Ancel and Griffiths, 1992; Chaudhry, Myer, and Webb, 1999; Fraser, Leishman, and Tarbert, 2002; Liow and Yang, 2005; Ling and Naranjo, 1999; Liu et al., 1990; Okunev and Wilson, 1997; Wilson, Okunev, and Ta, 1996; Wilson and Okunev, 1999). Now that the emerging Asian stock and real estate markets have attracted worldwide attention, trends in the region are extensive enough to merit the same attention previously reserved for the developed economy of the U.S. This study is a preliminary examination of the relationship between Asian stock markets and real estate markets. It examines six Asian economies and the relationship between their stock and real estate markets. This is a timely subject for several reasons. First, stock and real estate markets in Asia are growing with Asian economies, especially compared with markets in most of the developed countries like the United States and most of Europe. Therefore, the relationship between these two markets is worth examining. Second, most research on stock and real estate markets in the past focused on western countries. Studies or comparative research on the Asian region are rare. This study fills this gap. Finally, with the development of the economy in the Asian regions, the growth of stock markets and real estate markets has attracted significant interest from global investors. Therefore, we attempt to discover any relationships and examine what similarities the Asian region shares with other countries.

Data for this study comes from six Asian economies: China, Hong Kong, Japan, Singapore, South Korea, and Taiwan. The cointegration test proposed by Johansen (1988) and Johansen and Juselius (1990) is used to examine the relationship between stock markets and real estate markets in these economies from March 1995 to June 2010. If the null hypothesis of no cointegration is rejected, it indicates that these two markets can reach equilibrium in the long run, and implies that the stock market is integrated with the real estate market in these economies. Therefore, we can conclude that these two assets are good substitutes in investment allocation. Conversely, if the null hypothesis of no cointegration is accepted, segmentation between the stock market and the real estate market exists, and these two assets can be held in a portfolio for diversification purpose. If these markets show no cointegration, it is still possible that that there is nonlinear (or fractional) cointegration relationship between the two markets. We therefore employ the model proposed by Okunev and Wilson (1997) to examine possible fractional integration relationships. Finally, we study possible causal relationships between stock markets and real estate markets.

This paper is organized as follows: Section 2 discusses and reviews theories and literature related to this study. Section 3 describes the data and methodology used. Section 4 presents the empirical results obtained. Section 5 presents the study's conclusions.

2. Literature review

In portfolio management, it is important to understand the relationship among assets for efficient allocation since investors are concerned with maximizing the value of the portfolio. According to the "life cycle savings hypothesis", consumers will distribute increases in anticipated wealth over time based upon the marginal propensity to consume the wealth, whether from stocks, real estate, or any other source (Case, Quigley, and Shiller, 2001). Arnott and von Germeten (1983) asserted that the systematic asset allocation process involves the transformation of information into an asset deployment strategy to add value to the portfolio. One investment tool may yield superior results, but it will not do so consistently, or at least not consistently enough to satisfy investors.

In a study investigating the relationship between commercial real estate and stock markets, Liu et al. (1990) defined "integration" and "segmentation" as follows: "Integration" exists if the only risk priced for both stock and real estate is the systematic risk relative to the overall market. No additional premium is associated with any of the market. Investors therefore earn the same risk-adjusted return on stock and real estate. "Segmentation" arises if the only risk priced for real estate is systematic risk relative to the real estate market. Investors thus do not necessarily earn the same expected return on real estate and stocks. Once the integration relationship is found between two investment vehicles, the two assets are substitutable (Liow and Yang, 2005). On the contrary, if two investment vehicles are segmented, then these two assets may be held together for the purpose of portfolio diversification.

Factors causing the integration or segmentation of assets are also worth exploring. Explanations for the integration relationship can be illustrated by some economic rationales (e.g., the "substitution effect", the "flight to quality", the "wealth effect", business cycle factors, and so on). The "substitution effect" occurs when the price of one investment vehicle is too high to make a profit and the investor searches for alternative assets. The alternatives may or may not be as efficient as the original vehicle, but the investor believes they will provide more profit than the original asset. In a similar vein, the "flight to quality" phenomenon stimulates investors to switch investment vehicles or move funds to pursue high return or risk aversion (Kim, Moshirian, and Wu, 2006; Bernanke, Gertler, and Gilchrist, 1996). The "wealth effect" implies the causal effect of exogenous changes in wealth upon consumption behavior (Case, Quigley, and Shiller, 2001). As investors sense an increase in wealth, investments in various assets might simultaneously increase. Quan and Titman (1999) found that the correlation between the returns of stock and real estate will increase if "business cycle" variables simultaneously affect corporate profits and rents. Moreover, stock and real estate prices will also move together if expectations (either rational or irrational) of future profits and rents move together. These results suggest that a large fraction of the observed positive correlation is due to economic fundamentals that affect both stock and real estate prices.

Although the cointegration relationship between stocks and real estate has been widely discussed, the evidence is still inconclusive. Liu et al. (1990) argued that if real estate is segmented from other assets, its returns should show different characteristics from those of other assets. Otherwise, asset returns should show similar behavior. Their results showed that the stock market is segmented from the real estate market when "appraisal-based" return analysis is used. However, they also obtained a contradictory result, that the stock market and the real estate market are integrated, if equity REIT returns are employed for testing. Ambrose, Ancel, and Griffiths (1992), Wilson, Okunev, and Ta (1996), Okunev and Wilson (1997), Chaudhry, Myer, and Webb (1999), and Fraser, Leishman, and Tarbert (2002) conducted similar studies but drew differing conclusions.

Ambrose, Ancel, and Griffiths (1992) used rescaled range analysis, developed in the fractal geometry, to re-examine the segmentation relationship between the stock and real estate markets. Contrary to Liu et al. (1990), they found that segmentation does not exist between these two markets.

Okunev and Wilson (1997) provided yet another perspective on the relationship between stock and real estate markets. They argued that the integration between these two markets may not be linear. Thus, they proposed a nonlinear integration framework to test the relationship between the two markets. The nonlinear test supported their view that the markets are fractionally integrated. This result is quite different from previous studies.

Comparing results from the United States, Wilson, Okunev, and Ta (1996) collected Australian data to explore whether real estate and equity markets are integrated. They employed a multi-index framework of the arbitrage pricing model (APM) to test for a co-integration relationship between real estate and equity markets. Their results suggested that the cointegration relationship between these two markets is weak in Australia.

The quality and characteristics of data may also lead to different results when testing for cointegration. Ling and Naranjo (1999) employed the multifactor model to explore the integration relationship between the US commercial real estate market (both exchange-traded and non-exchange-traded) and the stock market. They found that the market for traded real estate companies, including REITs, is integrated with the stock market. However, they also found that, consistent with the results of Liu et al. (1990), the "appraisal-based" real estate returns failed to integrate with the stock market returns, which may indicate that it is not an accurate proxy for commercial real estate returns.

Wilson and Okunev (1999) applied the technique of fractional co-integration to explore the relationship between stock and real estate markets in the United States, United Kingdom, and Australia from 1971 to 1993. They found that there was no long-run relationship between the stock and real estate markets in these countries. They further argued that the stock crash of 1987 might have incurred the structural change, and they chose that as a breaking point of the structural change and re-examined the issue. They found that there was a cointegration relationship between the stock and real estate markets in the United States from 1971 to 1987 and in the United Kingdom from 1988 to 1993. Quan and Titman (1999) examined stock and real estate markets in seventeen countries and found that the relationship between real estate and stock returns is not statistically significant, except in Japan.

In relation to the study of integration or segmentation between the two markets, the causality relationship is another interesting issue that could assist us in understanding the extent to which they are causally related. He and Webb (2000) examined the causal relationship between the residential and commercial real estate markets, including office, retail, and industrial properties, in Hong Kong. They found that there is unidirectional causality running from residential property prices/rentals to commercial properties. Similarly, Okunev, Wilson, and Zurbruegg (2000) applied both linear and nonlinear causality approaches to investigate the dynamic relationship between real estate and the S&P 500 index in the United States from 1972 to 1988. They found that the linear causality results were spurious, but that there was a strong unidirectional relationship running from the stock market to the real estate market.

Due to rapid economic growth in Asia, many scholars have attempted to analyze asset markets in the region. For example, Phylaktis (1997) examined the extent of integration in the Pacific-Basin region by analyzing the co-movements of real interest rates. He found that there is integration of capital markets in Singapore, Hong Kong, and Taiwan. Masih and Masih (1999) examined the dynamic linkages among Asian emerging stock markets. They found evidence of co-integration among these markets. These results implied that investors could take advantage of market inefficiency to engage in arbitrage activities.

Liow and Li (2006) investigated whether real estate company stock prices deviate from their net asset values (NAVs) which represent the underlying value of real estate assets in Asian-Pacific securitized real estate markets. They took the difference between stock prices and NAVs and divided it by NAV to measure the extent of discounts or premiums of real estate stocks (NAVDISC). They suggest that if there is a stable NAVDISC for real estate companies in the long run, there should be a long-run co-integration relationship between stock prices and NAVs.

As this review shows, studies of market cointegration have given diverse and inconsistent results. This is partly attributable to the different time periods examined, quality of data, or differing economic or political environments. Since the causal relationship is concerned with cointegration, specific insight may be provided by examining the causal relationship between stock and real estate markets. Along with the development of the Asian economies and the appreciation of asset prices, the long run and causal relationship between the stock and real estate markets in this region have thus captured our attention for further empirical analysis.

3. Data and methodology

3.1. Data

The reasons to choose the economies used in this study are straightforward. First, Japan is the most developed country in Asia, and the movement of its stock and real estate markets often gathers the world's attention. Secondly, the economic growth of the so-called "Four Dragons" (e.g., Hong Kong, Singapore, South Korea, and Taiwan) has greatly expanded their stock markets and real estate markets since the 1980s. Finally, the rapid growth of China's economy over the past decade has raised asset prices sharply. This growth gives us more data sets we can use to explore the long-run relationship between stock markets and real estate markets.

The quarterly indices of the stock and real estate markets from March 1995 to June 2010 were collected from two sources. The real estate data from China were collected from National Housing Indices, published by the National Statistical Bureau. Data from South Korea were collected from the national average of the land value index published by the Ministry of Construction, and housing price indices were obtained from the Korea Housing Bank. Real estate data from Japan uses the publicly posted land value indices, and data from Hong Kong and Singapore were collected from the University of Hong Kong Real Estate Index and FTSE (Financial Times Securities Exchange) Real Estate Index, respectively. The data from Taiwan were collected from the Institute for Physical Planning and Information (IPPI) of Taiwan. The IPPI also compiles data on international residential prices and rent indices from China, Hong Kong, South Korea, Singapore, Japan, and the United States. Stock market indices, including the Shanghai Stock Exchange Composite Index (SSEC), Hong Kong's Hang Seng Index (HHI), Tokyo's Nikkei 225, the South Korea Seoul Composite Index (KOSPI), the Singapore Straits Time Index (STI), and the Taiwan Weighted Stock Index (TWSI), were taken from the Taiwan Economic Journal (TEJ) database.

The data collected covers the subprime mortgage crisis of 2008. The subprime crisis had a negative impact on all six markets (as shown in Figs. 1 and 2). Due to the limited data after the crisis in 2008, however, we do not attempt to explore the relationship between these two assets by breaking the whole period into two intervals. Such analysis may be conducted when more data accumulates in the future.

4. Methodology

4.1. Unit root test

The study began by first examining the stationarity of the time series data. A series is non-stationary if it has a unit root process. A non-stationary series may become a stationary one by differentiating it "t" times.

Then the series is integrated to the order of "t". To ensure that the series are integrated to the same degree, the Augmented Dickey Fuller (ADF) and Phillips–Perron (PP) approaches were employed for a unit root test. For robustness, we also adopted the Kwiatkowski, Phillips, Schmidt, and Shin (1992, KPSS) approach. For each approach, we tested unit root with intercept or intercept and trend based on the time trend of the series. The model specifications of these approaches are expressed as follows:

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \beta_t + \sum_{i=1}^{p} \lambda_i \Delta Y_{t-i} + \varepsilon_t, \quad (2)$$

where Y_t is the natural logarithm of the stock index or real estate index, α is drift, β_t is the time trend, p is the lag term, and ε_t is the error term. The null hypothesis of either ADF or PP method is that the series has a unit root process. If the null hypothesis is rejected, then the series is not stationary. Contrary to ADF or PP, the null hypothesis of KPSS method is stationary. Therefore, the series has a unit root process if the null hypothesis is rejected.

4.2. Cointegration

We then employed the Johansen (1988) and Johansen and Juselius (1990) cointegration approaches to examine the market integration. The related model specification is listed as follows:

$$\Delta Y_t = A_0 + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \Pi Y_{t-p} + \varepsilon_t \quad (3)$$

where ΔY_t is the first-difference time series vector, A_0 is the constant vector; $\Pi = -(I - A_1 - A_2 - \cdots A_p)$, $\Gamma_i = -(I - A_1 - A_2 - \cdots A_i)$, and ε_t is the column vector Gaussian noise with zero mean and finite variance.

Johansen (1988) and Johansen and Juselius (1990) proposed two likelihood ratio techniques to determine the number of co-integration vectors. These techniques are trace test and maximum eigen value test, which are expressed as follows:

$$\text{Trace Statistic} = -T \sum_{i=\gamma+1}^{N} ln(1-\lambda_i) \quad (4)$$

$$\text{Maximum Eigenvalue Test} = -T ln(1-\lambda_{r+1}), \quad (5)$$

where $-T$ is the number of observations, λ_i is the ith largest eigen value, and r is the number of cointegrations. The null hypothesis of trace test is that there are at most r cointegration vectors. That is, the number of co-integration vectors is less than or equal to r. The null hypothesis for maximum eigen value test is that there are r cointegration vectors. For both tests, the alternative hypothesis is that there are $g > r$ co-integration vectors.

To determine the optimal lag length of the Johansen test, we began with eight lags of each equation as an unrestricted model and estimated the variance/covariance matrix of residuals. Then we used shorter lag lengths as a restricted model again to estimate the variance/covariance matrix of residuals. Following Sims (1980), the optimal lag lengths are determined by the following formula:

$$(T-c)(log|\Sigma_r| - log|\Sigma_u|), \quad (6)$$

where Σ_u and Σ_r are the variance/covariance matrices of the unrestricted and restricted models, respectively. T is the number of observations, and c is the number of parameters estimated in the unrestricted model. Thus, the optimal lag length is 1 in four of six economies, including China, Hong Kong, Singapore, and South Korea. However, for Japan and Taiwan, the optimal lag lengths are 2.

4.3. Nonlinear cointegration test

According to previous studies, if one market is not cointegrated with the other, then these two markets are segmented. However, Okunev and Wilson (1997) argue that this conclusion is based on the assumption that the series in both markets are linearly related. It is possible that the nonlinearity relationship of the series resulted in rejection of the cointegration test. Therefore, in addition to segmentation and integration, Okunev and Wilson (1997) proposed that the degree of market integration might be fractional if there is no cointegration relationship between the two markets. They developed a nonlinear model to measure the degree of market integration. The nonlinear cointegration model is expressed as:

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

where R(t) presents the value of the real estate market index at time t, and S(t) stands for the value of the stock market index. The coefficient of γ_1 allows us to test whether the market relationship is segmented ($\gamma_1=0$), fractionally cointegrated ($0<\gamma_1<1$), or linear ($\gamma_1=1$). The coefficient of γ_2 measures the change in the mean reversion characteristics of the real estate market index towards the stock market index. The coefficient of γ_3 represents the speed of adjustment of mean reversion towards the stock market.

According to Okunev and Wilson (1997), if there is no cointegration relationship between two markets, then the nonlinear cointegration test can still be performed. Therefore, if the cointegration relationship between the stock and real estate markets is not observed, nonlinear cointegration test can be conducted to examine the fractional integration. If there is fractional integration, then the coefficient of γ_1 will be significantly different from zero and one.

4.4. Granger causality

We performed the Granger (1969) causality test to examine the causal relationship between the stock and real estate markets based on the bi-variate VAR model. The specifications of the causality test are as follows:

$$\Delta y_{1t} = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i}\Delta y_{1t-i} + \sum_{i=1}^{k} \alpha_{2i}\Delta y_{2t-i} + \varepsilon_{1t}$$

$$\Delta y_{2t} = \beta_0 + \sum_{i=1}^{k} \beta_{1i}\Delta y_{1t-i} + \sum_{i=1}^{k} \beta_{2i}\Delta y_{2t-i} + \varepsilon_{2t} \quad (8)$$

where γ_{1t} and γ_{2t} denote the natural logarithm of stock index and the natural logarithm of real estate index, and γ_{1t} and ε_{2t} are assumed to be Gaussian white noise with zero mean and a finite covariance matrix. If the null hypothesis of the coefficients of $\alpha_{2i}=0$ is rejected, it suggests that γ_{2t} Granger-causes γ_{1t}. Conversely, if the null hypothesis of the coefficients of $\beta_{1i}=0$ is rejected, it implies that γ_{1t} Granger-causes γ_{2t}. However, if both coefficients of α_{2i} and β_{1i} are significantly different from zero, there exists feedback relationship between γ_{1t} and γ_{2t}.

5. Empirical Results

5.1. Descriptive statistics

Table 1 shows descriptive statistics for stock returns and real estate returns in our six Asian markets. Panel A presents stock market returns during the sample period. Except for Japan, all of the average stock markets returns are positive, ranging from 0.19% to 2.15% for each year. We found that the average return for China is 2.15%, outperforming other markets during the sample period due to China's rapid growth. Stock market returns in South Korea were the most volatile (with a standard deviation of 18.65%). Investors could gain about 59.47%, but also could lose 54.21% in South Korea. Due to the acute impact of the Asian financial crisis in 1997, both the highest and lowest returns are observed in South Korea. Other stock markets in Asia appear relatively stable compared to South Korea.

Panel B shows Asian real estate market returns. In contrast to stock markets, Asian real estate markets performed quite poorly. Average returns in real estate markets ranged from −2.56% to 0.74%. The highest average return was in China, at 0.08%, indicating the effects of a series of reforms and growth on the real estate market. In addition to lower returns, real estate markets in these economies generally

Table 1
Descriptive statistics of Asian stock markets and Asian real estate markets (1995Q1–2010Q2).

	Mean (%)	Median (%)	Maximum (%)	Minimum (%)	Std. dev	Skewness	Kurtosis
Panel A: Asian stock markets							
China	2.15	0.98	42.31	−41.55	17.38	0.1995	0.1174
Hong Kong	1.40	2.59	30.29	−33.90	13.24	−0.4029	0.5974
Japan	−0.89	1.22	21.02	−28.28	11.27	−0.2456	−0.5584
South Korea	0.98	1.25	59.47	−54.21	18.65	−0.0881	1.9872
Singapore	0.50	1.27	39.35	−42.36	14.26	−0.0701	1.6965
Taiwan	0.19	1.00	42.29	−29.47	14.59	−0.0188	0.1644
Panel B: Asian real estate markets							
China	0.08	0.18	4.59	−4.75	1.68	0.1010	0.7889
Hong Kong	0.42	0.53	18.73	−20.94	7.38	−0.0991	0.8773
Japan	−2.56	−2.47	−0.31	−4.53	1.07	0.3270	−0.2375
South Korea	0.74	0.60	7.36	−6.82	2.05	−0.0321	4.9919
Singapore	0.30	0.35	14.63	−15.16	5.40	−0.3500	1.2468
Taiwan	0.50	0.29	14.58	−10.28	3.76	0.8167	3.1555

Note: We use the logarithm approach to calculate the returns of Asian stock and real estate markets, and then report the descriptive statistics including mean, median, maximum, minimum, standard deviation, skewness, and kurtosis.

shows less variation than stock markets did during the 1995 to 2010 period. Of these six real estate markets, Hong Kong had the largest quarterly standard deviation (7.38%), perhaps due to its handover to China in 1997, whereas Japan had the smallest variation (1.07%) as a result of the long-term slump in real estate. The standard deviations for real estate market returns were all within 5%, except for Hong Kong and Singapore.

5.2. Unit root test

This study used the Augmented Dickey Fuller (ADF) test, the Phillips–Perron (PP) test, and the Kwiatkowski, Phillips, Schmidt, and Shin (1992, KPSS) test to examine whether the sample stock and real estate series were stationary. As mentioned, we tested the unit root with either intercept or intercept and trend. If a series showed a time trend either in Fig. 1 (stock movements) or Fig. 2 (real estate movements), we then tested the series with the trend; otherwise we adopted the method with intercept. Stock indices show a time trend everywhere except in Taiwan. Real estate indices show a time trend in Japan, South Korea, and Taiwan. Therefore, these series with a trend were tested. To eliminate series auto-correlation, the optimal lags were selected according to the minimum AIC criteria.

Panel A in Table 2 shows the results of the unit root test for Asian stock markets. We found that the null hypotheses of both ADF and PP tests were not rejected, but the null hypothesis of the KPSS test was rejected, indicating that all the stock market indices in our sample are non-stationary series.

Panel B shows results for Asian real estate markets. As in panel A, the results of the ADF, PP, and KPSS tests indicate that all the real estate indices are non-stationary. However, although stock and real estate markets indices are stationary before the first difference, it is worth noting that they are all integrated to the same degree. Table 3 exhibits the unit root test for the first difference. All series, both stock market indices and real estate indices, are I (1) series indicating that they are stationary after the first difference. Therefore, the Johansen co-integration test could be further conducted.

5.3. Cointegration test

Table 4 illustrates the results of the Johansen cointegration test, where Panel A reports the trace statistics of the cointegration test. We find that the null hypothesis $r=0$ is not rejected in China, Hong Kong, South Korea, Singapore, and Taiwan, but is rejected in Japan. This indicates that there is a cointegration relationship for the stock and real estate markets, and that these two markets will reach equilibrium in the long run in Japan. Other economies, such as China, Hong Kong, South Korea, Singapore, and Taiwan do not show a cointegration relationship since the null hypothesis $r=0$ is not rejected,

Table 2
The unit root test for Asian stock markets and real estate market (level, 1995Q1–2010Q2).

	ADF	PP	KPSS
Panel A: Asia stock market index			
China	−3.00	−2.53	0.19 **
Hong Kong	−2.55	−2.77	0.16 **
Japan	−2.41	−2.18	0.15 **
Singapore	−3.08	−2.56	0.15 **
South Korea	−2.71	−2.8	0.17 **
Taiwan	−1.87	−2.51	0.25 ***
Panel B: Real estate market index			
China	−2.28	−2.66	0.16 **
Hong Kong	−1.01	−1.01	0.21 **
Japan	−2.37	−1.24	1.13 ***
Singapore	−1.57	−1.36	0.21 **
South Korea	−2.55	−2.02	0.16 **
Taiwan	−1.29	−1.19	0.25 ***

Note: We employ Augmented Dickey Fuller (ADF), Phillips–Perron (PP), and Kwiatkoeski, Phillips, Schmidt, and Shin (KPSS) approaches to examine whether the stock market indices and real estate market indices are stationary. We perform the unit root test with intercept or intercept and trend among these methods based on whether the series have time trend. The optimal lags of each series in both stock market and real estate market are determined by AIC criteria.

indicating that the stock market is segmented from the real estate market in these economies. Panel B in Table 4 shows the maximum eigen value statistics for the co-integration test. These results are the same as the trace test in panel A. The stock market is integrated with the real estate market in Japan, but segmented from the real estate market in other economies.

5.4. Nonlinear cointegration test

In Table 4, we found that five of the six economies (all except for Japan) do not show a cointegration relationship between stock and real estate markets. This result indicates that most of them do not have a linear cointegration relationship. We then examined whether there exists a nonlinear cointegration relationship, using the Okunev and Wilson (1997) test. The results are shown in Table 5. We found that the coefficients of γ_1 in China, Hong Kong, and Taiwan are significantly different from zero and one, indicating

Table 3
The unit root test for Asian stock markets and real estate market (first difference, 1995Q1–2010Q2).

	ADF	PP	KPSS
Pane A: Asia stock market index			
China	−4.34 ***	−6.19 ***	0.05
Hong Kong	−7.02 ***	−7.03 ***	0.04
Japan	−6.29 ***	−6.33 ***	0.07
Singapore	−6.84 ***	−6.83 ***	0.04
South Korea	−5.03 ***	−7.7 ***	0.04
Taiwan	−5.35 ***	−6.67 ***	0.04
Panel B: Real estate market index			
China	−5.74 ***	−4.98 ***	0.04
Hong Kong	−4.16 ***	−5.01 ***	0.08
Japan	−20.23 ***	−13.56 ***	0.12
Singapore	−4.54 ***	−3.55 ***	0.04
South Korea	−4.85 ***	−4.74 ***	0.10
Taiwan	−8.92 ***	−9.27 ***	0.08

Note: We employ Augmented Dickey Fuller (ADF), Phillips–Perron (PP), and Kwiatkoeski, Phillips, Schmidt, and Shin (KPSS) approaches to examine whether the stock market indices and real estate market indices are stationary. We perform the unit root test with intercept or intercept and trend among these methods based on whether the series have time trend. The optimal lags of each series in both stock market and real estate market are determined by AIC criteria.

Table 4
Johansen co-integration test in Asian stock markets and real estate markets (1995Q1–2010Q2).

	H0: no co-integration	Eigen value	Trace Statistic/max-eigen statistic
Panel A: Trace test			
China	$r=0$	0.1954	18.3479 *
	$r\leq1$	0.0846	5.3004
Hong Kong	$r=0$	0.1260	10.1680
	$r\leq1$	0.0342	2.0868
Japan	$r=0$	0.2605	18.1342 **
	$r\leq1$	0.0056	0.3285
South Korea	$r=0$	0.1339	11.2979
	$r\leq1$	0.0435	2.6706
Singapore	$r=0$	0.1611	14.6712
	$r\leq1$	0.0665	4.1305
Taiwan	$r=0$	0.1776	11.8921
	$r\leq1$	0.0060	0.3537
Panel B: Maximum eigen value test			
China	$r=0$	0.1954	13.0475
	$r\leq1$	0.0846	5.3004
Hong Kong	$r=0$	0.1260	8.0812
	$r\leq1$	0.0342	2.0868
Japan	$r=0$	0.2605	17.8056 **
	$r\leq1$	0.0056	0.3285
South Korea	$r=0$	0.1339	8.6272
	$r\leq1$	0.0435	2.6706
Singapore	$r=0$	0.1611	10.5407
	$r\leq1$	0.0665	4.1305
Taiwan	$r=0$	0.1776	11.5384
	$r\leq1$	0.0060	0.3537

Note: We employ Johansen approach to test whether there is cointegration relationship between stock and real estate markets. Two likelihood ratio techniques including trace statistics and max eigen value statistics are employed to determine the number of cointegration vectors. The optimal lags length of Johansen test are determined by the statistics proposed by Sims (1980).

that the stock market and real estate market are fractionally integrated in China, Hong Kong, and Taiwan. However, the coefficients of γ_1 in South Korea and Singapore range from zero to one, showing that the stock market is segmented from the real estate market in these two countries.

To summarize the results in Tables 4 and 5, we can conclude that the stock market is integrated with the real estate market in Japan, and fractionally integrated with the real estate market in China, Hong Kong,

Table 5
The nonlinear cointegration test in Asian stock markets and real estate markets (1995Q1–2010Q2).

	γ_0	γ_1	γ_2	γ_3
China	−0.3778 **	0.0274 **	0.003	0.1831 **
	(−2.65)	(2.26)	(0.69)	(2.53)
Hong_Kong	−0.3445 ***	0.2089 ***	0.0694 **	0.029
	(−2.95)	(3.27)	(2.27)	(0.83)
South_Korea	−0.029	0.0111	0.0095	0.0023
	(−1.08)	(0.74)	(0.94)	(0.10)
Singapore	−0.3431 ***	0.0067	0.1454 ***	−0.0642
	(−4.87)	(0.15)	(5.65)	(−1.50)
Taiwan	−0.0536	0.0846 **	−0.0215	0.0682 **
	(−0.65)	(2.59)	(−0.95)	(2.53)

*Presents significance at 10%; ** presents significant at 5%; *** presents significance at 1%.
Note: We perform the nonlinear cointegration model proposed by Okunev and Wilson (1997) to examine whether stock and real estate markets are segmented, integrated, or fractional integrated. The Okunev and Wilson's model is specified as: $log\frac{R(t+1)}{R(t)} = \gamma_0 + \gamma_1 log\frac{S(t+1)}{S(t)} + \gamma_2 S(t) + \gamma_3 logR(t) + e(t)$, where the coefficient of γ_1 presents a nonlinear relationship between stock market and real estate market, γ_2 presents the change in the mean reversion characteristics of the real estate index toward the stock index, and γ_3 is the speed of adjustment of mean reversion towards stock market.

and Taiwan. This implies that the movement of the prices in one asset might be influenced by the other, and thus both of these assets are substitutable for investment purposes. However, the stock market and the real estate market were not integrated in South Korea and Singapore. This suggests a diversification strategy for investment portfolios in these two countries.

5.5. Causality test and implication

5.5.1. Granger causality test

We further conducted the Granger causality test over the sample period to examine whether a causality relationship exists between the stock and real estate markets. The results of the causality tests are illustrated in Table 6. In this table, no evidence is found to reject the null hypothesis that stock indices are unrelated to real estate indices in all six countries. Therefore, we did not find that the stock market led the real estate market in all economies. However, the null hypothesis that the real estate index is not related to the stock index was rejected for Singapore and Taiwan, indicating that the real estate market leads the stock market in Singapore and Taiwan. In other words, the fluctuation of the real estate market may drive stock market price movement in these two countries.

5.5.2. Implications of results

5.5.2.1. China. China's economic growth is a successful model for other communist countries. Since the decision to implement a "planned market economy" three decades ago, China's economy has continued to grow despite Asia's financial downturn in the late 1990s. To curb speculation, the Chinese government adopted macro-economic controls in the early 2000s, causing a four-year decline. Since financial renewal and two-digit growth in 2005, the stock market in China has continued to climb new heights, as shown in Fig. 1 (a).

Rapid economic growth in China led to significant appreciation of urban real estate markets in areas such as Beijing, Shanghai, and other coastal cities. However, real estate in inland areas experienced slower growth during the sample period, widening the gap between coast and inland.

Analysis found no causality relationship between stock and real estate markets in China from March 1995 to June 2010. There may be several reasons for this. First, real estate markets in China include many regions and cities. The real estate index employed in this study may not reflect the trend of one specific region or city. An alternative approach to overcome this shortcoming is to use the index of different regions or cities for further concise conclusions. Second, China's population of over 1.2 billion are all looking for

Table 6
Granger causality test in Asian stock markets index and real estate markets (1995Q1–2010Q2).

	Null hypothesis	F-statistic
China	H_0:Stock Index does not Granger cause Real Estate Index	0.7171
	H_0:Real Estate Index does not Granger cause Stock Index	0.1677
Hong Kong	H_0:Stock Index does not Granger cause Real Estate Index	0.2636
	H_0:Real Estate Index does not Granger cause Stock Index	0.4632
Japan	H_0:Stock Index does not Granger cause Real Estate Index	0.7066
	H_0:Real Estate Index does not Granger cause Stock Index	0.0484
Singapore	H_0:Stock Index does not Granger cause Real Estate Index	0.1905
	H_0:Real Estate Index does not Granger cause Stock Index	6.6519 ***
South Korea	H_0:Stock Index does not Granger cause Real Estate Index	0.4080
	H_0:Real Estate Index does not Granger cause Stock Index	2.2053
Taiwan	H_0:Stock Index does not Granger cause Real Estate Index	1.8199
	H_0:Real Estate Index does not Granger cause Stock Index	13.6009 ***

*** Presents significance at 1%.

Note: We perform the Granger causality test based on the bi-variate VAR model to examine the causal relationship between stock and real estate markets. The specifications of causality test are $\Delta y_{1t} = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i}\Delta y_{1t-i} + \sum_{i=1}^{k} \alpha_{2i}\Delta y_{2t-i} + \varepsilon_{1t}$ and $\Delta y_{2t} = \beta_0 + \sum_{i=1}^{k} \beta_{1i}\Delta y_{1t-i} + \sum_{i=1}^{k} \beta_{2i}\Delta y_{2t-i} + \varepsilon_{2t}$. If the null hypothesis of coefficients of $\alpha_{2i} = 0$ reject, it suggests that y_{2t} Granger-causes y_{1t}. If the null hypothesis of coefficients of $\beta_{1i} = 0$ is reject, it implies that y_{1t} Granger-causes y_{2t}. If both coefficients of α_{2i} and β_{1i} are different from zero with significance, there exists feedback relationship between y_{1t} and y_{2t}.

homes after the end of the public ownership system prevailing during the early Communist era. Real state market trends and their relationship with other markets before there is equilibrium between supply and demand is difficult to determine. Third, both the stock market and especially the housing market, are profoundly influenced by Chinese government intervention (taxation, credit control, construction permits and so on). These factors may contribute to the lack of causality relationship between the stock and real estate markets in China.

5.5.2.2. Hong Kong. Hong Kong is considered one of the most liberal markets in the world. The Hong Kong government has cultivated a market economy for almost a century. However, its economy is easily influenced by the political environment of the region, especially the relationship between China and the United States, and between China and Taiwan.

Hong Kong's capital fled the stock market prior to 1997 due to the uncertainty involved in Hong Kong's return to China and in the aftermath of the Asian financial crisis. The Hang Seng Stock Index plunged to a historic low. After China guaranteed the free development of the economy, Hong Kong regained market momentum. Then in 2003, the SARS (Severe Acute Respiratory Syndrome) epidemic ravaged Hong Kong's stock market. Not until Hong Kong was opened to mainland Chinese tourism and the signing of the “Closer Economic Partnership Arrangement” (CEPA) did stock market momentum in Hong Kong revive, as shown in Fig. 1 (b).

The decline of Hong Kong's real estate market over the last 15 years is also related to the larger economic and political circumstances. Both markets plunged in 1997 due to Hong Kong's return to China. The stock market fluctuated then rebounded in 2003 after the end of global deflation and SARS. The real estate market also recovered in 2003, as shown in Fig. 2 (b).

Granger causality analysis shows no causality relationship between the stock and real estate market trends in Hong Kong from March 1995 to June 2010 (see Table 6). This is reasonable since Hong Kong's stock market is more international and closely related with the overall economy of Hong Kong. In contrast, Hong Kong's real estate market was much more intensely influenced by the political transition in 1997. Emigration and loss of confidence in real estate did not reverse as quickly as recovery in the stock market.

5.5.2.3. Japan. Japan is the most developed economy in Asia; it therefore has a special role as a regional leader. Rapid economic growth from the 1970s to the 1980s in Japan caused the Japanese Yen to appreciate significantly. This appreciation rose sharply in the late 1980s, from an exchange rate of 242 yen to one US dollar in 1985, to 128 yen to the dollar in 1988. Export industries were severely injured by appreciation. To stimulate investment in the hope of continuing economic growth, the government reduced interest rates from 5% to 2.5% in 1986, causing a boom in the stock and real estate markets.

To control the resulting rises in asset prices and inflation, Japan raised interest rates in 1990, this time resulting in long-term economic recession. In order to stimulate investment and the economy, the Japanese government reduced the interest rates again and fell into a “liquidity trap”.

The stock and real estate markets in Japan were significantly affected by changes in interest rates and the overall economy. The Granger test showed no causality relationship between the stock and real estate markets from March 1995 to June 2010 in Japan. From Figs. 1(c) and 2(c), it is obvious that stock markets in Japan fluctuate with the overall economy. Yet the real estate market remained sluggish during the sample period. This may be due to the fact that maximum loan-to-value (LTV) ratio for real estate financing in Japan could reach 120% in the 1980s. The over-leveraging eventually led to a long-term recession in its real estate market. This may be one reason no causality relationship was found between the stock and real estate markets in Japan.

5.5.2.4. Singapore. Asset markets in Singapore were severely affected by the Asian financial crisis in 1997 and the government introduced several measures to stimulate economic growth. Limits on foreign investment were greatly reduced, and international companies were encouraged to go public in Singapore. These measures gradually attracted international investors, and stock and real estate markets revived. In 2000, the overall economy, including the asset markets, was again hit by falls in stock market values of information technology industry (“dot com”). Stock and real estate markets did not pick up until 2003, after the end of worldwide deflation [see Fig. 1 (d) and 2 (d)].

Results of the causality test show a uni-directional leading effect from the real estate to the stock market in Singapore (see Table 6). This may be attributed to the fact that the land and housing in Singapore is mostly (around 80%) owned and controlled by the government. The revival of the real estate market may serve as a signal for other investment vehicles and confidence in Singapore.

5.5.2.5. South Korea. South Korea is one of the "Four Dragons" of Asia. Its economy was severely affected by the Asian financial crisis in 1997, with stock and real estate markets plunging to historic lows. The collapse of the global information technology industry in 2000 and rising default levels on credit card debt further affected the overall economy and asset markets in South Korea. Markets recovered afterwards with the global economy. The government launched a series of financial reforms with the assistance of the International Monetary Fund (IMF), but it was only in 2001 that the economy regained momentum and the stock and real estate markets began to recover. Trends in the stock and real estate markets in South Korea are shown in Figs. 1 (e) and 2 (e).

The causality results are reported in Table 6. No causality relationship between the stock and real estate markets was found. This may be explained by the fact that the stock and real estate markets in South Korea attract sharply differing investors. As a result, neither the stock market nor the real estate market can serve as the leading indicator for the other.

5.5.2.6. Taiwan. Taiwan experienced a peak in economic growth in the 1980s. This led to a surge in the stock and real estate markets. The stock markets increased from a weighted index of 2000 in 1986 to 12,000 in 1991. During the same period, the real estate market appreciated threefold.

In 1997, the stock market in Taiwan was affected by the Asian financial crisis, but rebounded within a year. When the U.S. information technology industry bubble burst in the late 1990s, however, Taiwan's electronics industry was hit hard. The bubble's collapse coincided with a major earthquake in 1999, and as a result stock markets in Taiwan dropped by approximately 3000 points. The SARS epidemic in 2003 prolonged the slump in Taiwan's economy. In 2004, the stock market in Taiwan finally regained momentum with the end of the worldwide deflation and global economic recovery [see Fig. 1(e)].

The real estate market in Taiwan has tended to move in a pattern similar to the stock market for the past decade, as shown in Fig. 2(e). Various policies, including thousands of billions of NT dollars in low-rate mortgages to encourage real estate investment, were announced after the Asian financial crisis, but the real estate market did not pick up until after the SARS epidemic of 2003.

Causality test results for Taiwan found a uni-directional leading effect from the real estate to the stock market, as shown in Table 6. There may be several reasons for this. First, there has been a housing shortage of approximately 7% (70,000 units) in Taipei city for the past decade. The traditional preference for real estate investment is driven by the housing shortage, high population density, and the employment opportunity. Second, metropolitan Taipei accounts for over 1/3 of the population in Taiwan, and the value of the real estate in Taipei represent a significant proportion of the entire country. The combination of these factors encouraged the escalation of housing prices in Taipei, leading to an annual average 10% appreciation for the past decade. It is therefore not surprising that real estate plays a leading role for other investment vehicles in Taiwan.

All results in Table 6 for Taiwan show a uni-directional relationship between the stock and real estate markets. In summary, the null hypothesis, that the real estate index is not influenced by the stock market index, is rejected in Singapore and Taiwan over the sample period. This indicates that the real estate index may be used to forecast stock index in these two countries. In other words, the real estate market led the stock market and had a significant impact on the stock market in both countries, indicating people's preference for real assets and the homeownership.

6. Conclusions

The swift development of Asia's economy has caused a significant appreciation of the stock and real estate markets in the Asian region and gained the attention of global investors. Therefore, we examined the integration relationship between the stock and real estate markets in China, Hong Kong, Japan, Singapore, South Korea, and Taiwan. The Johansen co-integration test was applied for examining this relationship in this study. For robustness, we also applied Okunev and Wilson's (1997) method to examine the fractional integration relationship between the stock and real estate markets in the absence of cointegration.

We found that the stock market is integrated with the real estate market in Japan, but is fractionally integrated with the real estate markets in China, Hong Kong, and Taiwan. However, the stock market and real estate market is segmented in South Korea and Singapore. The former results indicate that the stock market and real estate market will reach equilibrium in the long run, and these two assets may be substitutable for investment strategy. The latter implies that it provides a diversification function for portfolio allocation.

As for the causality relationship, we found that the real estate market significantly led the stock market in Singapore and Taiwan over the entire sample period. This finding indicates that real estate index may be used to forecast stock index in these two countries. Therefore, policy makers may pay attention to the development of the real estate market to prevent volatility in the stock market. In sum, we conclude that stock and real estate markets may show various inter-relationships under different economic and political policy environments according to the empirical results from these Asian economies in this study.

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