PANOECONOMICUS, 2013, 6, pp. 743-757
Received: 28 January 2012; Accepted: 24 April 2013.

UDC 330.322.4:339.13
DOI: 10.2298/PAN1306743F
Original scientific paper

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Are the Global REIT Markets Efficient by a New Approach?

Summary: This study uses a panel KSS test by Nuri Ucar and Tolga Omay (2009), with a Fourier function based on the sequential panel selection method (SPSM) procedure proposed by Georgios Chortareas and George Kapetanios (2009) to test the efficiency of REIT markets in 16 countries from 28 March 2008 to 27 June 2011. A Fourier approximation often captures the behavior of an unknown break, and testing for a unit root increases its power to do so. Moreover, SPSM can determine the mix of I(0) and I(1) series in a panel setting to clarify how many and which are random walk processes. Our empirical results demonstrate that REIT markets are efficient in all sampled countries except the UK. Our results imply that investors in countries with efficient REIT markets can adopt more passive portfolio strategies.

Key words: REIT, Efficiency, Sequential panel selection method, Panel KSS test with a Fourier function, Portfolio strategy.

JEL: C23, C52, D53, G11, G14, L85.

Eugene F. Fama (1991) proposed that securities markets generally are efficient because prices instantaneously reflect new information, eliminating opportunities for arbitrage. Real estate investment trust (REIT) markets are recent developments among securities markets. However, compared with the analysis of efficiency for other securities markets, fewer studies have investigated whether price changes for REITs follow a unit root process, and their findings are inconclusive (Yuming Li and Ko Wang 1995; Vinod Chandrashekaran 1999; Michael Cooper, David H. Downs, and Gary A. Patterson 2000; Simon Stevenson 2002; Benjamas Jirasakuldech, Robert D. Campbell, and John R. Knight 2006). The market efficiency of REITs has become an important issue, given their growth in recent years. Besides the extended line of successful products in the United States and Australia, REITs have become important investment vehicles in Europe and Asia (European Public Real Estate Association 2004). Collectively, these markets almost equal the total of all REITs worldwide (Table 1). This paper analyzes whether changes in REIT prices follow a random walk or mean reversion. We are the first to employ a panel KSS test with a Fourier function by the SPSM procedure to document efficiency among REIT indices. Our study fills several gaps in the literature.

1. Literature Review

Some studies have reported inefficiencies in REIT markets, implying mean reversion. Chandrashekaran (1999) and Stevenson (2002) documented short-term performance persistence in REIT returns. Cooper, Downs, and Patterson (2000) found that REIT returns are more predictable than returns of small stocks, large stocks, and bonds. Edward Nelling and Joseph Gyourko (1998) and James L. Kuhle and Jaime R. Alvayay (2000) verified that REIT returns are predictable, suggesting evidence of a rational bubble model, and other evidence suggests speculative bubbles in real estate markets (Jim Clayton 1997; Kicki Bjorklund and Bo Soderberg 1999; Maurice J. Roche and Kieran McQuinn 2001). Yuming Fu and Lilian K. Ng (2001) showed obvious, prolonged price adjustment to news in real estate markets, suggesting evidence of long memory and slow reversion to the mean. Other studies demonstrate that REIT markets are efficient. Li and Wang (1995) found that REIT returns are no more predictable than returns of other stocks. Jirasakuldech, Campbell, and Knight (2006) showed that REIT markets are not prone to rational bubbles. Jarl Kallberg, Crocker H. Liu, and Paolo Pasquariello (2008) indicate that market prices adjust to reflect the underlying real market behavior and that abnormal REIT returns eventually disappear.

A unit root test measures the efficiency of the security price series, and many scholars have employed it to examine whether security market prices are a random walk (Kausik Chaudhuri and Yangru Wu 2003; Juha Junttila 2003). Jirasakuldech, Campbell, and Knight (2006) used it and found no evidence of rational bubbles in the REIT market. However, some studies propose that conventional unit root tests have less power than near-unit root but stationary alternatives and also fail to consider cross-regional information, resulting in less efficient estimations (Mark P. Taylor and Lucio Sarno 1998; Gangadharrao S. Maddala and Shaowen Wu 1999; Andrew Levin, Chien-Fu Lin, and Chia-Shang J. Chu 2002; Kyung S. Im, Hashem M. Pesaran, and Yongcheol Shin 2003). John H. Cochrane (1988) showed that the test power of conventional unit root tests is insufficient for small samples. Ronald Balvers, Yangru Wu, and Erik Gilliland (2000) proposed that empirical results for data with a brief time series usually cannot reject the random walk hypothesis, as a lengthy progression is needed for documenting mean reversion.

To overcome this difficulty, researchers have used panel data to increase power in testing for a unit root (Balvers, Wu, and Gilliland 2000; Jeffrey Gropp 2004; Ranjpour Reza and Karimi T. Zahra 2008). Levin, Lin, and Chu (2002) and Im, Pesaran, and Shin (2003) used panel data with the asymptotic finite-sample properties of ADF tests, which significantly improved power even in small panels. However, the all-or-nothing nature of the Levin, Lin, and Chu (2002) tests has not been refined (Taylor and Sarno 1998; Janice B. Breuer, Robert McNown, and Myles Wallace 2001). Tests by Taylor and Sarno (1998), Maddala and Wu (1999) and Im, Pesaran, and Shin (2003) permitted autoregressive parameters to differ across panel members under the stationary alternative when the null hypothesis is rejected. Reza and Zahra (2008) using different panel unit root tests, examined whether economic convergence and catching-up have been characteristics of economic growth in ten new members of the European Union. However, these panel tests do not delineate which series are stationary, as they are not joint tests of the null hypothesis. Sune Karlsson and Mickael Lothgren (2000) and Breuer, McNown, and Wallace (2001) insisted that researchers do not conclude each series in the panel to be stationary when the null hypothesis is rejected. The sequential panel selection method (SPSM) proposed by Chortareas and Kapetanios (2009) can determine the mix of I(0) and I(1) series in a panel setting so as to group a whole panel into stationary and nonstationary series. Moreover, Guochen Pan, Sen-Sung Chen, and Tsangyao Chang (2012) applied the SPSM to examine whether the growth rate of total insurance premium is independent from their size for 35 insurance companies in China. Pierre Perron (1989) proposed that when the stationary alternative is true and the structural break is ignored, the power to reject a unit root decreases if a structural break occurs, making it easier to accept the null hypothesis of a unit root. When using dummy variables to approximate breaks, some limitations arise. Among these limits, the exact number and location of the breaks must be known, the tests account only for one to two breaks, and use of dummies means sharp and sudden changes in the trend or level term. Stephen Leybourne, Paul Newbold, and Dimitrios Vougas (1998) deemed that breaks should be approximated as smooth and gradual processes. Philip H. Franses and Timothy J. Vogelsang (1998) and Charles Harvey (2001) use the HEGY seasonal unit root testing with an unknown breakpoint to be estimated from the data, and Ozlem Tasseven (2008) extends the HEGY testing procedure by allowing for seasonal mean shifts with double exogenous break points. Furthermore, Bong-Soo Lee (1998), Ralf Becker, Walter Enders, and Stan Hurn (2004) and Razvan Pascalau (2010) indicated that a Fourier approximation often captures the behavior of an unknown break, even if it is not periodic. Their testing framework requires only the specification of the proper frequency in the estimating equations, and the tests are confirmed to have good size and power regardless of the time or shape of the break since the number of estimated parameters is reduced. Moreover, although many studies have shown nonlinear adjustment of REIT indexes empirically (John Okunev, Patrick Wilson, and Ralf Zurbruegg 2000; Kim H. Liow and Haishan Yang 2005; Yen-Hsien Lee and Chien-Liang Chiu 2010; Kuang-Liang Chang 2011), evidence of nonlinear adjustment need not imply a nonlinear random walk (nonstationarity). Perron (1989) proposed that conventional unit root tests, such as the augmented Dickey-Fuller (ADF) test, tend not to reject the null hypothesis of the unit root when examining nonlinear data. Hence, efficiency tests on a nonlinear framework with the panel unit root must be applied. Ucar and Omay (2009) combine the nonlinear framework in Kapetanios, Shin, and Andy Snell (2003) with the panel unit root testing procedure of Im, Pesaran, and Shin (2003) to produce a nonlinear panel unit root test.

Because Fourier approximation often captures the unknown break, this study uses a panel KSS test with a Fourier function by the SPSM procedure to search for random walks among REIT indices in 16 countries. In addition, previous studies assume that countries' REIT indexes are cross-sectionally independent, whereas our study recognizes that they may be contemporaneously correlated and that independence cannot be assumed. We approximate the bootstrap distribution of the tests to control for cross-sectional dependence among REIT indices. If changes in a country's REIT index are a random walk, investors cannot use historical price movements to predict future returns, so they can adopt more passive portfolio strategies such as diversifying investment among a few efficient REIT markets. However, if prices revert to the mean, investors potentially can predict future returns of the index, and they can adopt more active portfolio strategies.

Section 2 presents data used in our study. Section 3 describes the SPSM test proposed by Chortareas and Kapetanios (2009). Section 4 presents our empirical results. Section 5 discusses economic and policy implications of our empirical findings. Section 6 concludes.

2. Data Scope

Our empirical data cover 16 countries: the U.S., Canada, Australia, New Zealand, Belgium, Bulgaria, France, the Netherlands, Turkey, the United Kingdom, Taiwan, Hong Kong, Japan, Singapore, South Korea, and China. Data exclude countries in Africa with the least REIT capitalization. Among these, the U.S. market has the largest capitalization, and Australian is second largest (Table 2). France has Europe’s largest REIT market and is in order contrast to the remaining countries, including the United Kingdom, the Netherlands, Belgium, Turkey, and Bulgaria. REITs in Germany, Greece, and Italy were established after mid-2007. Because changes in REIT indices in Germany, Greece, and Italy are small because of short establishing times or less liquidity, we omit data for these three countries. Japan and Singapore have Asia’s largest REIT markets and are in order contrast to the remaining countries, including Hong Kong, Taiwan, South Korea, and China. We also delete data for India, Malaysia, Thailand, and the Philippines because of infrequent changes in REIT indices or their brief existence.

This study uses daily data from 28 March 2008 to 27 June 2011. All REIT indices are taken from Datastream, and each was transformed into a natural logarithm before analysis. Table 5 provides summary statistics. Our empirical results show that the average return of Australian REITs is significantly higher than those among other nations, perhaps because of its capitalization and because Australia has the highest ratio of securitized real estate among sampled countries. Turkish REITs are the most volatile in our sample (standard deviation = 0.162), and New Zealand REITs are the least volatile (standard deviation = 0.096). Average return and standard deviation for New Zealand REITs are the lowest, suggesting that investors in New Zealand face a trade-off between REITs’ risk and average return. Results of our Jarque-Bera test indicate that, except for South Korea, the REIT return datasets are approximately non-normal for all other 15 sample countries.

3. Methodology: Sequential Panel Selection Method and Panel KSS Unit Root Test with a Fourier Function

Numerous studies have shown empirical evidence for nonlinear adjustment of REIT indexes, but their findings need not imply a nonlinear random walk (nonstationarity). Therefore, efficiency (nonstationarity) tests based on a nonlinear framework must be applied. The KSS test proposed by Kapetanios, Yongcheol, and Snell (2003) seeks to detect the appearance of nonstationarity against a nonlinear but stationary exponential smooth transition autoregressive (ESTAR) process. The model is expressed as follows:

$$\Delta X_t = \gamma X_{t-1}\{1-\exp(-\theta X_{t-1}^2)\} + \nu_t . \tag{1}$$

where X_t is the data series of interest, ν_t is an i.i.d. error with zero mean and constant variance, and $\theta \geq 0$ is the transition parameter of the ESTAR model and governs the speed of transition. In the null hypothesis, X_t follows a linear unit root process, whereas X_t follows a nonlinear stationary ESTAR process in the alternative hypothesis. Given that γ cannot be identified in the null hypothesis, Ritva Luukkonen, Pentti Saikkonen, and Timo Teräsvirta (1988) and Kapetanios, Yongcheol, and Snell (2003) used a first-order Taylor series to estimate $\{1-\exp(-\theta X_{t-1}^2)\}$ approximately. In regard to the null hypothesis $\theta = 0$, Equation (1) can be rewritten as the auxiliary regression:

$$\begin{gathered} \Delta X_t = \xi + \delta X_{t-1}^3 + \sum_{j=1}^{k} \theta_j \Delta X_{t-j} + \nu_t \\ t = 1,2,....,T . \end{gathered} \tag{2}$$

In this framework, the null and alternative hypotheses are expressed as $\delta = 0$ (nonstationarity) against $\delta < 0$ (nonlinear ESTAR stationarity). Ucar and Omay (2009) expanded a nonlinear panel data unit root test based on Regression (3). The regression is as follows:

$$\Delta X_{i,t} = \gamma_i X_{i,t-1}\{1-\exp(-\theta_i X_{i,t-1}^2)\} + \nu_{i,t} . \tag{3}$$

They also applied first-order Taylor series approximation to the PESTAR (1) model around $\theta_i = 0$ for all *i* and obtained the auxiliary regression:

$$\Delta X_{i,t} = \xi_i + \delta_i X_{i,t-1}^3 + \sum_{j=1}^{k} \theta_{i,j} \Delta X_{i,t-j} + \nu_{i,t} \tag{4}$$

where $\delta_i = \theta_i \gamma_i$. Their hypotheses for unit root testing based on Regression (4) are as follows:

$H_0 : \delta_i = 0$, for all *i* (linear nonstationarity)

$H_0 : \delta_i < 0$, for some *i* (nonlinear stationarity).

Recalling that a Fourier approximation often captures unknown breaks, the system of a nonlinear panel data with a Fourier function that we estimate here is as follows:

$$\Delta X_{i,t} = \xi_i + \delta_i X^3{}_{i,t-1} + \sum_{j=1}^{k} \theta_{i,j} \Delta X_{i,t-j} + a_i \sin\left(\frac{2\pi kt}{T}\right) + b_j \cos\left(\frac{2\pi kt}{T}\right) + \varepsilon_{i,t} \tag{5}$$

where $t = 1,2,....,T$.

The rationale for selecting $[\sin(2\pi kt/T), \cos(2\pi kt/T)]$ is that a Fourier expression can approximate absolutely integrable functions to any accuracy, where k represents the frequency selected for the approximation and $[a_i, b_j]'$ measures the amplitude and displacement of the frequency component. If there is a structural break, at least one frequency component must be present. Since their Monte Carlo experiments, Enders and Junsoo Lee (2009) suggest that no more than one or two frequencies should be used because the loss of power associated with a larger number of frequencies occurs. Because there is no information about the shape of breaks in the data, we first perform a grid search to find the fitted frequency. Finally, based on the SPSM procedure, we can separate the entire panel into groups evidencing a random walk and groups displaying mean reversion. The SPSM procedure is detailed in Chortareas and Kapetanios (2009).

4. Empirical Results

First, we used several univariate unit root tests to test the null of a unit root in REIT indices for the 16 sampled countries. Then, we employed first- and second-generation panel unit root tests. Three univariate unit root tests - Augmented David A. Dickey and Wayne A. Fuller (1981), Peter C. B. Phillips and Perron (1988), and Denis Kwiatkowski et al. (1992) - in Table 6 consistently concluded that all examined indices follow unit roots. This result shows that the power of these univariate unit root tests is low when a few indices may follow mean reversion, implying that REIT indices in all 16 countries were efficient during the period. Other explanations for the poor power of these tests might be that REIT index processes are nonlinear or researchers used a finite sample. Moreover, panel-based unit tests are found to increase the power of the order of the integration analysis by allowing combinations of cross-sectional and temporal dimensions.

Tables 7 and 8 present the results for the first- and second-generation panel-based unit root tests. Three first-generation panel-based unit root tests of Maddala and Wu (1999), Levin, Lin, and Chu (2002) and Kapetanios, Shin, and Snell (2003) show similar results, indicating that REIT indices are stationary in our sampled countries. The first-generation panel-based unit root tests do not combine possible cross-sectional dependencies with the panel-based unit root test procedure, and failure to consider contemporaneous correlations among data will bias the panel-based unit root test toward rejecting the joint unit root hypothesis (Paul G. J. O’Connell 1998). The four second-generation panel-based unit root tests of In Choi (2001), Jushan Bai and Serena Ng (2004), Hyungsik R. Moon and Benoit Perron (2004) and Pesaran (2007) consider cross-sectional dependencies to offer a superior test of the indices’ efficiency. Table 8 presents the results. The Bai and Ng (2004) and Kapetanios, Shin, and Snell (2003) tests show that REIT indices follow a random walk, but results from the other two tests indicate mean reversion in all sampled countries. Second-generation panel-based unit root tests cannot confirm that REIT indices in our sampled countries are efficient.

Panel-based unit root tests also cannot determine the mix of I(0) and I(1) series in a panel setting and offer limited usefulness detecting a random walk among

REIT indices because they do not incorporate structural breaks in the model. However, the SPSM procedure can clarify how many and which series in the panel are stationary or nonstationary processes. Table 9 shows the results of panel KSS unit root test with a Fourier function on the indices where the panel KSS statistics are produced with the bootstrap p-values, individual minimum KSS statistics, and stationary series identified each time. The residual sum of squares (RSS) indicates that the best frequency is 2 for most of the series. Except for sequence 1, 3, 4, 8, 11, 13, and 15, we found that the best frequency is 4, 3, and 1. When we first used the panel KSS unit root test on the whole panel in Table 9, the null hypothesis of a unit root for the REIT index was rejected, producing a value of -1.871 with a p-value of 0.075. Following the SPSM procedure, our results show that only the UK is stationary with the minimum KSS value of -3.608. We removed UK data and reimplemented the panel KSS unit root test on the remaining sets of series. We found that the procedure stopped just at sequence 1, after the UK REIT index was removed from the panel while continuing the procedure until the panel KSS unit root test failed to reject the unit root null hypothesis at the 10% significance level. Therefore, by using the panel KSS unit root test with a Fourier function, the SPSM procedure provides strong evidence of a random walk among REIT indices in our sampled countries. We conclude that REIT markets are efficient in surveyed countries outside the UK.

Regulative limits may create the UK REIT market's inefficiency. UK REITs must raise funds through listings on recognized stock exchanges and reside for tax purposes in the UK, which impairs their growth and liquidity. Nonresident investors should be subject to UK income tax withholding on REIT payments, which is problematic in the context of the UK's double tax, as distributions of property income will be treated as dividends for treaty purposes. Also, companies that have held REIT status fewer than 10 years are subject to corporation tax during that accounting period. Although REITs in the UK may hold foreign real estate, the 10% portfolio limit is enforced, and they pay tax in the country where the real estate is located. The limitation on gearing will restrict the scope for sheltering this with interest expense, a drawback compared with other REITs with established cross-border investment structures. Finally, each UK resident member of a group must distribute 95% of the profits of its tax-exempt business, which should give greater flexibility in apportioning tax-exempt investment business and taxable development business. However, our overall results insist that REIT markets in our sampled countries are efficient and display nonlinear random walks.

5. Economic and Investing Implications

Past studies are inconclusive about whether REIT markets are efficient. Scholars like Sanjoy Basu (1977) have proposed that capital markets are inefficient because of trading costs and taxes; trading costs of REITs in most countries are low, and many avoid double taxation. Although previous studies have found inefficiencies in REIT markets (Cooper, Downs, and Patterson 2000; Kuhle and Alvayay 2000; Roche and McQuinn 2001; Stevenson 2002), the efficiency hypothesis holds up rather well in the real markets (see Fama 1998). Fama (1991) indicated that the deviations from the extreme version of the efficiency hypothesis are within trading cost and information.

Also, Fama (1998) asserted that the probabilities of investors' underreaction and overreaction are each 50%, the entire market is still efficient when they are placed together. Therefore, we expect the REIT markets to be efficient in our sampled countries, and our results confirm that expectation. Our results reinforce those of Brent W. Ambrose, Esther Ancel, and Mark D. Griffiths (1992), Crocker H. Liu and Jianping Mei (1992) and Jirasakuldech, Campbell, and Knight (2006) which support the efficiency of REIT markets for most countries.

A major implication of our study is that investors generally cannot use price changes in the REIT indexes of our sampled countries to predict future returns. For 15 of 16 sampled countries, price movements do not determine whether a REIT index is overvalued or undervalued. Hence, REIT investors in efficient markets can adopt more passive portfolio strategies, such as diversifying investment, among these efficient REIT markets. Inefficiency arises in the UK, where price movements of the REIT index can be used to predict future returns. Investors there can consider frequent-adjusting portfolio strategies. Knowing the market's efficiency enables investors to select a type of portfolio strategy in the REIT markets.

6. Conclusions

In recent years, many investors have gravitated to REITs; however, previous studies offer inconsistent conclusions about the efficiency of REIT markets. This paper used the SPSM approach proposed by Chortareas and Kapetanios (2009), capable of determining the mix of I(0) and I(1) series in a panel setting, to examine the efficiency of REIT markets in 16 countries from 28 March 2008 to 27 June 2011. The panel KSS test with a Fourier function based on the SPSM procedure presents a clear picture about the random walk of country-specific REIT markets.

Our results signify that REIT markets in 15 of 16 global countries are efficient, the exception being the UK, where regulative limits may impose inefficiency. This study implies that price changes in the world's REIT indices generally cannot be used to predict their future returns. Hence, investors in efficient REIT markets can adopt more passive portfolio strategies such as diversifying investment.

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Table 1 Number and Market Capitalization of REIT Traded on World Markets

	Number of REITs	Value of REITs (€ bn)	Value of global REIT market
Africa	5	2.6	0.7
Americas	208	223.9	57.4
Asia	98	45.9	11.9
Australia	68	45.3	11.6
Europe	123	72	18.4
Total	**502**	**389.7**	**100.0**

Source: European Public Real Estate Association (EPRA) Global REIT Survey 2010.

Table 2 Number and Market Capitalization of REIT Traded on European Countries

	Year established	Number of REITs	Value of REITs (€ bn)	Percentage of the European REIT market (%)	Percentage of worldwide REIT market (%)
Belgium	1995	14	4	5.56	1
Bulgaria	2004	19	0.1	0.14	0
France	2003	44	37.6	52.22	9.6
Netherlands	2003	7	6.9	9.58	1.8
Turkey	1995	15	1.3	1.81	0.3
UK	2007	19	21.1	29.31	5.4

Source: EPRA Global REIT Survey 2010.

Table 3 Number and Market Capitalization of REIT Traded on Asia

	Year established	Number of REITs	Value of REITs (€ bn)	Percentage of the Asia REIT market (%)	Percentage of worldwide REIT market (%)
Taiwan	2005	8	1.2	2.61	0.3
Hong Kong	2003	7	6.6	14.38	1.7
Japan	2001	36	21.2	46.19	5.4
Singapore	2001	21	14.5	31.59	3.7
South Korea	2001	6	0.2	0.44	0.1
China	2006	6	4.4	9.57	1.1

Source: EPRA Global REIT Survey 2010.

Table 4 Number and Market Capitalization of REIT Traded on American and Australian

	Year established	Number of REITs	Value of REITs (€ bn)	Percentage of the American REIT market (%)	Percentage of worldwide REIT market (%)
USA	1960	173	206.9	92.41	53.1
Canada	1994	35	17	7.59	4.3
Australia	1985	60	43.7	96.47	11.2
New Zealand	1960	8	1.6	3.53	0.4

Source: EPRA Global REIT Survey 2010.

Table 5 Summary Statistics

	Mean	Max.	Mini.	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Hong Kong	2.103	2.257	1.870	0.093	-0.295	2.272	31.030***
Singapore	2.250	2.446	1.950	0.112	-0.782	2.796	87.746***
Japan	2.998	3.200	2.848	0.075	0.985	3.506	146.108***
China	0.887	1.090	0.544	0.117	-1.303	3.693	256.599***
Taiwan	2.001	2.063	1.847	0.040	-0.934	3.964	155.932***
South Korea	2.090	2.276	1.903	0.080	0.051	2.930	0.534
Turkey	1.701	1.953	1.305	0.162	-0.536	2.205	62.811***
Belgium	2.133	2.250	2.042	0.039	0.801	3.706	108.218***
Bulgaria	1.697	1.991	1.576	0.123	1.433	3.651	304.770***
Netherlands	2.202	2.341	1.993	0.066	-0.415	2.798	25.808***
United Kingdom	2.282	2.552	2.001	0.106	0.579	3.180	48.528***
Canada	2.244	2.371	2.012	0.095	-0.735	2.364	90.486***
New Zealand	0.834	0.889	0.793	0.021	0.116	2.126	28.878***
Australia	3.654	3.781	3.493	0.059	-0.675	2.953	64.461***
America	2.053	2.225	1.736	0.111	-0.639	2.516	65.967***
France	2.317	2.427	2.082	0.082	-0.725	2.369	88.361***

Note: The sample period is weekly from 1985M1 to 2008M9. *** indicates 1% significance level.

Source: Authors' calculations.

Table 6 Univariate Unit Root Tests

	Level			1st difference		
	ADF	PP	KPSS	ADF	PP	KPSS
Hong Kong	-2.013(0)	-1.971(5)	0.474(23) ***	-31.108(0) ***	-31.103(5) ***	0.106(6)
Singapore	-1.937(0)	-1.938(4)	0.457(23) ***	-19.298(1) ***	-31.191(6) ***	0.202(4)
Japan	-2.357(6)	-2.059(24)	0.530(23) ***	-14.348(5) ***	-27.009(29) ***	0.068(26)
China	-1.859(0)	-1.996(9)	0.264(23) ***	-27.062(0) ***	-27.217(7) ***	0.132(9) *
Taiwan	-2.538(2)	-2.431(9)	0.312(23) ***	-15.427(1) ***	-27.308(8) ***	0.077(9)
South Korea	-1.865(0)	-1.867(2)	0.451(23) ***	-28.758(0) ***	-28.757(3) ***	0.118(2)
Turkey	-1.944(0)	-2.035(5)	0.246(23) ***	0.246(0) ***	-27.325(2) ***	0.100(4)
Belgium	-2.820(0)	-2.657(18)	0.566(23) ***	-28.344(0) ***	-28.697(22) ***	0.044(21)
Bulgaria	-1.219(1)	-1.239(8)	0.621(23) ***	-32.037(0) ***	-31.889(9) ***	0.153(8) **
Netherlands	-2.403(1)	-2.328(22)	0.458(23) ***	-26.608(0) ***	-26.504(26) ***	0.094(24)
United Kingdom	-1.883(0)	-1.907(5)	0.586(23) ***	-28.842(0) ***	-28.844(6) ***	0.055(6)
Canada	-1.846(1)	-1.723(11)	0.517(23) ***	-26.160(0) ***	-26.164(14) ***	0.142(11) *
New Zealand	-2.066(2)	-2.425(7)	0.209(23) ***	-24.672(1) ***	-35.165(8) ***	0.047(4)
Australia	-1.890(0)	-1.875(3)	0.398(23) ***	-29.500(0) ***	-29.503(3) ***	0.130(2) *
America	-1.986(1)	-1.970(23)	0.572(23) ***	-37.291(0) ***	-38.535(21) ***	0.087(29)
France	-2.273(0)	-2.249(16)	0.440(23) ***	-28.118(0) ***	-28.117(18) ***	0.099(17)

Note: *, **, and *** indicate 10%, 5%, and 1% significance levels, respectively. Numbers in parenthesis indicate the lag order selected based on the recursive t-statistic, as suggested by Perron (1989). Bracketed numbers indicate the truncation for the Bartlett Kernel.

Source: Authors' calculations.

Table 7 First-Generation Panel Unit Root Test

Maddala and Wu (1999)		**Levin, Lin, and Chu (2002)**			
P_{MW}	Z_{MW}	t_{ρ}^{*}	t_{ρ}^{*B}	t_{ρ}^{*C}	$\hat{\rho}$
44.571**	1.881**	-3.405***	-2.965***	-2.907***	-0.004***

Im, Pesaran, and Shin (2003)				
t_bar_{NT}	$W_{t,bar}$	$Z_{t,bar}$	$t\_bar_{NT}^{DF}$	$Z_{t,bar}^{DF}$
-1.855	-1.503*	-1.637*	-1.769	-1.103

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. P_{MW} and ZMW denote the Fisher's test statistic and the standardized statistic. t_{p}^{*}, t_{p}^{*B}, t_{p}^{*C}, and t_{ρ}^{*} denote the adjusted t-statistics computed with a Bartlett kernel function and a common lag truncation parameter given by $\bar{K} = 3.21T^{1/3}$, a Bartlett kernel function and individual bandwidth parameters, a quadratic spectral kernel function and individual bandwidth parameters, and a Bartlett kernel function and a common lag truncation parameter. $\hat{\rho}$ is the pooled least squares estimator. $t\_bar_{NT}^{DF}$ and t_bar_{NT} denote the mean of Dickey Fuller and Augmented Dickey Fuller individual statistics. $Z_{t,bar}^{DF}$ and $Z_{t,bar}$ are the standardized $t\_bar_{NT}^{DF}$ statistic and the standardized t_bar_{NT} statistic based on moments of the Dickey Fuller distribution. $W_{t,bar}$ denotes the standardized t_bar_{NT} statistic based on simulated approximated moments.

Source: Authors' estimations.

Table 8 Second-Generation Panel Unit Root Test

Bai and Ng (2004)		**Choi (2001)**		
$Z_{\hat{e}}^{c}$	$P_{\hat{e}}^{c}$	P_{m}	Z	L^{*}
-0.230	28.216	8.878***	-5.930***	-6.541***

Pesaran (2007)		**Moon and Perron (2004)**			
$CIPS$	$CIPS^{*}$	t_{a}^{*}	t_{b}^{*}	t_{a}^{*B}	t_{b}^{*B}
-1.994	-1.994	-4.590***	-2.992***	-4.792***	-3.048***

Notes: *** indicates significance at the 1% level. $P_{\hat{e}}^{c}$ and $Z_{\hat{e}}^{c}$ are a Fisher's type statistic based on p-values of individual ADF tests and a standardized Choi's type statistic. The P_{m}, Z and L^{*} test are a modified Fisher's inverse chi-squared test, an inverse normal test and a modified logit test. $CIPS$ and $CIPS^{*}$ are the mean of individual cross-sectionally augmented ADF statistics and the mean of truncated individual CADF statistics. t_{a}^{*} and t_{b}^{*} (t_{a}^{*B} and t_{b}^{*B}) are unit root test statistics based on defactored panel data (are computed with a Bartlett kernel function despite a quadratic spectral kernel function).

Source: Authors' estimations.

Table 9 Results of KSS with Fourier Test on Efficiency of REIT Indices

Sequence	OU Statistic	Min. KSS	Fourier(*K*)	Series
1	-1.871 (0.0752)	-3.608	4	United Kingdom
2	-1.755 (0.161)	-3.458	2	Belgium
3	-1.634 (0.320)	-2.806	4	Japan
4	-1.544 (0.479)	-2.339	3	New Zealand
5	-1.477 (0.559)	-2.201	2	China
6	-1.412 (0.627)	-2.072	2	Turkey
7	-1.346 (0.656)	-2.068	2	Netherlands
8	-1.265 (0.701)	-1.904	3	South Korea
9	-1.186 (0.796)	-1.683	2	Bulgaria
10	-1.115 (0.875)	-1.680	2	Australia
11	-1.020 (0.899)	-1.627	3	France
12	-0.899 (0.908)	-1.621	2	America
13	-0.719 (0.909)	-1.233	2	Singapore
14	-0.547 (0.889)	-1.142	2	Taiwan
15	-0.249 (0.946)	-0.771	1	Canada
16	0.273 (0.906)	0.273	2	Hong Kong

Notes: Entries in parenthesis stand for the asymptotic p-value. Asymptotic p-values are computed by means of bootstrap simulations using 10,000 replications.

Source: Authors' estimations.

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