2. NONLINEAR ADJUSTMENT TO THE LONG-RUN EQUILIBRIUM BETWEEN THE REIT AND THE STOCK MARKETS IN JAPAN AND SINGAPORE

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Abstract

This paper uses a powerful Autoregressive Distributed Lag (ADL) test for the threshold cointegration proposed by Li and Lee (2010) to examine the cointegration equilibrium between Investing in real estate investment trusts (REITs) and the stock markets in Japan and Singapore and between the J-REIT and S-REIT markets. The empirical results indicate that there is a long-run equilibrium between REITs and the stock markets in Japan and Singapore but no equilibrium between the J-REIT and S-REIT markets. The results of the Granger causality test, based on the Threshold Error-Correction Model (TECM), indicate that there is a wealth effect and a credit price effect in Japan, a wealth effect in Singapore, and a feedback effect between the J-REIT and S-REIT markets. Our results offer important implications for investors seeking to gain from arbitrage or to diversify in these two Asian countries, which have the largest market capitalisations of REITs in Asia.

Keywords: Real Estate; Stock ; ADL test; Threshold cointegration, Threshold Error-Correction Model
JEL Classification: C22; G11; L85; D53; C58; F14

1. Introduction

Investing in real estate investment trusts (REITs) requires a lower investment amount and offers higher liquidity and a more stable rate of return compared to investing in physical real estate and real estate stock. Because of these advantages, shares in securitised real estate have become the preferred form of real estate investment,

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especially in recent years. In addition to preferring an investment in stocks with high liquidity and profitability, many investors incorporate securitised real estate assets into their investment portfolios for the purpose of diversifying risk. Many studies focus on the diversification benefits between REITs and other markets, such as stocks, bonds, and real estate. These studies propose that changes in the REIT prices are closely related to changes in the stock markets (Mengden, 1988; Giliberto, 1990; Ennis and Burik, 1991; Liu and Mei, 1992; Myer and Webb, 1993; Su, Huang and Pai, 2010). This study considers the viewpoint of investors who invest in the stock and the REIT markets, or in various REIT markets, to analyse the changes in prices in both markets and the influence of the asset allocation of investors.

The REIT markets in Asia have flourished since the first REIT was listed in Japan in 2001.[4] The aggressive acquisitions made by Japan's and Singapore's REITs between 2002 and 2006 have accounted for over a third of the market capitalisation for J-REITs and S-REITs (hereafter, J-REITs denotes Japan's REITs, S-REITs denotes Singapore's REITs).[5] That is, Japan and Singapore are the two largest REIT markets in Asia. Global funds have continued to flow into Asian markets in recent years as the economic growth of the developed markets in Europe and America has slowed. The US has implemented a monetary policy of quantitative easing, and certain European countries have experienced a credit crisis. Therefore, this study separately explores the relationship between price changes in the real estate securitisation market and those in the corresponding stock markets in Japan and Singapore and their influence on the asset allocation of investors, which includes a comparison of the REIT and the stock indices in the US and Australia. In analysing the international diversification of real estate shares, Eichholtz (1996) found that the correlation among the real estate markets of different countries is lower than that among the stock or the bond markets in these countries. Because the risk diversified effect of investing in the real estate markets in different countries might not be inferior to the effect of investing in the stock and real estate markets, this study also considers the investors' views on investing in J-REITs and S-REITs concurrently to analyse the relationship between price changes in the two real estate markets and their influence on the investing strategies.

The perspectives of the early studies in exploring the existence of this integration or segmentation between the real estate market and the stock market assumed that they exhibit linear behaviours (Liu et al., 1990; Myer and Webb, 1993).[6] These prior studies ignored the possibility that the fitted model describing the relationship between the real estate and the stock market could be non-linear, perhaps because there is increasing recognition of the non-linear characteristics in many of the macroeconomic and financial

[4] *According to the Asian Public Real Estate Association, the market capitalisation for Asian REITs is estimated to reach US$ 200 billion within the next decade.*

[5] *This obvious growth can be attributed to a boom in the number of REIT IPOs and aggressive acquisitions by most of the newly listed REITs.*

[6] *Liu, Hartzell, Greig and Grissom (1990) analyse whether the commercial real estate market is integrated with or segmented from the stock market. Their result shows that there is segmentation between the two markets, perhaps due to indirect barriers such as the cost, amount and quality of information on real estate. However, Myer and Webb (1993) propose that the returns of equity REITs are very similar to the returns of common stocks, thus assuming a certain degree of integration between the two markets.*

time-series variables. The related literature of the post period in 1990, based on their use of non-linear models, show that there has been evidence of cointegration between real estate and stock prices (Ling and Naranjo, 1999; Tuluca et al., 2000; Glascock, 2000; Liow and Yang, 2005; Su, 2011; Su et al., 2011). By using a fractional test, Okunev and Wilson (1997) demonstrate that the relationship between the stock and real estate markets can be characterised by a non-linear model. Wilson and Okunev (1999) use fractional cointegration to examine the long-term equilibrium between the property and stock markets in the US, the UK and Australia. Their results show that, except for some co-memory effects in the Australian markets, there is no evidence for integration between the two markets in the US or the UK markets. Ling and Naranjo (1999) use the APT multi-factors model to confirm that the REIT markets tend to be increasingly integrated with the stock market as time increases. Glascock et al. (2000) use the cointegration and VAR model to find that the REIT market is more cointegrated with the stock market and less cointegrated with the respective securitised real estate and direct real estate indices in the US samples. Moreover, Su (2011) uses the non-parametric rank test to investigate whether there is a non-linear long-run equilibrium between the real estate and stock markets in Western European countries. His result provides strong evidence for a long-run equilibrium accompanied by non-linear adjustments. Su et al. (2011) also use the threshold auto-regressive (TAR) model to determine whether there is a long-run equilibrium between the real estate and stock markets in European countries. Their results show that, under a specific threshold value, the dynamics towards a long-run relationship follow non-linear adjustments.

Because there is significant nonlinear evidence of the relationship between the REIT market and the stock market as presented by the above literature, there is no reason to assume that the long-run adjustment process of the two markets toward equilibrium is always symmetric. Enders and Granger (1998) and Enders and Siklos (2001) proposed that if two series exhibit an asymmetric effect, the results of the traditional cointegration tests exhibit low power. Hutson and Stevenson (2008) found that the equity indices exhibited positive asymmetry after the technology stock crash, while the REIT indices' superior post-crash performance was accompanied by negative asymmetry, which means that the stock and the REIT index adjustments are asymmetric. Liow and Yang (2005) proposed that the cointegration relationship between REITs and the corresponding stock indices is influenced by macroeconomic factors, the property market, and the capital market. Hence, cointegration could only occur in partial regimes when certain factors related to the REIT or stock indices are considered, which implies that the process of error corrections can be asymmetric. Therefore, we use the Autoregressive Distributed Lag (ADL) test by Li and Lee (2010) for threshold (asymmetric) cointegration to distinguish the relationship between the REIT and the stock indices under different regimes. The major advantage of this approach is that it allows us to simultaneously investigate nonlinearity and cointegration. This study is the first of its kind to utilise the ADL test for threshold cointegration to test the long-run equilibrium between the REIT and stock indices in Japan and Singapore and between the J-REIT and S-REIT indices. Our aim is to fill the existing gap in the literature.

The previous studies propose that the wealth effect of the stock market affecting the real estate market and the credit price effect of the real estate market affecting the stock market exist in the interpretation of the relationship between the two markets, and the studies have not reached a common conclusion. Liu et al. (1990) empirically found that some indirect barriers existed between the American stock and real estate markets, which led to segmentation between the markets, resulting in minimal linking-up between the two market indices. Quan and Titman (1999) examined the correlation between the REIT indices and the stock price indices in 17 countries and found a correlation between the two indices to some extent. Green (2002) uses the Granger causality tests and finds that the wealth effect existed in the regions with higher housing prices. Companies then transfer funds to expand their investment, which will result in the continuous increase in both prices. Benjamin et al. (2004) propose that investors adjust their portfolios to increase investments in the real estate market when they have unexpected gains in the stock market and they usually sell stocks and invest in real estate to rebalance their portfolios when there is a rise in the stock returns. Oppenheimer and Grissom (1998) and Larson (2005) found that the stock market indices have a “leading effect” on REIT prices, and a rapid reversal in the stock market will cause the REITs to show the same reaction. However, Okunev, Wilson and Zurbruegg (2000) compare the relationship between the American S&P 500 stock price index and its E-REIT index with the linear and nonlinear Granger causality test. The nonlinear results indicated that REIT prices strongly influence stock prices. The result of Chen (2001) shows that when the price of real estate rises, a firm with significant real estate holdings produces large unrealised capital gains. Therefore, the firm’s revenue from its investment in the real estate market will lead to the rise of its stock price due to the increase in its asset value. In addition, Okunev et al. (2002) studied the relationship between the Australian real estate and stock markets and found that an unstable nonlinear relationship and bidirectional Granger causality exists between real estate prices and stock prices.

Enders and Granger (1998) use the Threshold Error-Correction Model (TECM) to obtain the asymmetric-adjustment long-term equilibrium and short-run lead-lag relationship between the two variables under different threshold regimes. Therefore, we follow Enders and Granger (1998) to examine the possible asymmetric lead-lag relationship between J-REITs or S-REITs and the corresponding stock indices or between the J-REIT and the S-REIT indices. The remainder of this paper is organised as follows. Section 2 describes the data used in our study. Section 3 introduces the methodology. Section 4 presents the reports and analyses the empirical findings, and lastly, Section 5 offers conclusions.

2. Data and Analysis of Descriptive Statistics

2.1 Data Range

The data range of our study consists of the REIT and stock markets in Japan and Singapore. The REIT indices consist of the REIT indices in Japan and Singapore, and the corresponding stock indices consist of the Nikkei 225 stock index and the Singapore Straits Times Index. Daily data are employed in our empirical study. The study considers the separate beginnings of the J-REIT and S-REIT indices as the beginning of the REIT and stock indices in Japan and Singapore, respectively, as the introduction of the REIT indices in the two countries is slightly different. Thus, the data regarding the REIT stock price indices in Japan range from September 16, 2003 to May 31, 2011, and those for Singapore range from June 30, 2003 to May 31, 2011. All of the REITs and stock indices employed in this study are taken from Datastream. Each of the REIT and stock indices was transformed into natural logarithms before the empirical analysis.

2.2 A Descriptive Statistical Analysis

The descriptive statistics in Table 1 indicate that the average return and standard deviation for REITs are slightly higher than those for stocks in Japan, which means that investors investing in Japan could face a slight trade-off between the REITs and stocks. However, in Singapore, the results in Table 1 indicate that the average return for stocks is slightly higher than that for REITs; combined with a lower standard deviation for stocks than that for REITs, this implies that an investment in stocks can gain more than an investment in REITs in Singapore. Table 1 also indicates that the average return for S-REITs is higher than that for J-REITs and is accompanied by lower fluctuations in prices for S-REITs than those for J-REITs, which could result from the fact that there are more geographically diversified benefits from S-REITs than from J-REITs. In terms of the skewness coefficient, the REIT returns in Japan and the stock returns in Japan and Singapore are left-skewed, while the REIT returns in Singapore are right-skewed. Regarding the kurtosis coefficient, both the REITs and the stock returns in the two countries are leptokurtic, which indicates a high probability of the occurrence of extreme values in REIT and stock prices. The same table shows that the Jarque-Bera test results of the REIT and stock returns in these areas are significantly different from zero, which indicates that the REIT and stock returns in these areas do not conform to the normal distribution.

3. Methodology

3.1 Threshold Cointegration

This study uses the ADL test by Li and Lee (2010) for the threshold cointegration technique to test the relationship between the REITs and the corresponding stock indices with asymmetric adjustments in Japan and Singapore and between the J-REIT and the S-REIT indices. Following Li and Lee (2010), we also relax the assumption of a pre-specified cointegrating vector and consider estimating the cointegrating vector. Therefore, the threshold ADL model is appropriate, and threshold cointegration tests are suggested. First, the estimated cointegrating vector is given by the following regression:[7]

$$P_t^h = \alpha_0 + \alpha_1 P_t^s + u_t \tag{3-1}$$

Then, we estimate the following cointegration regression based on the possible influence of J-REITs on S-REITs.[8]

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[7] *Where P_t^s and P_t^h represent the logarithm of the REIT and stock price levels, respectively, and u_t is the stochastic disturbance term.*

[8] *Where P_t^{h1} and P_t^{h2} represent the logarithm of the J-REIT and S-REIT price levels, respectively, and u_t is the stochastic disturbance term.*

$$P_t^{h2} = \alpha'_0 + \alpha'_1 P_t^{h1} + u_t \qquad (3\text{-}2)$$

Two indicators, *Indicator A* with $I_t^a = I(u_{t-1} < u_{t-1}^*(\tau))$ and *Indicator B* with $I_t^b = I(\Delta u_{t-1} < \Delta u_{t-1}^*(\tau))$, are considered. Specifically, the threshold ADL regression model of the REIT and the corresponding stock indices are described as follows:

$$\Delta P_t^h = \beta_0 + \beta_1 P_{t-1}^h I_t + \beta_2 P_{t-1}^h (1 - I_t) + \beta_3 P_{t-1}^s I_t + \beta_4 P_{t-1}^s (1 - I_t) + \\ + \beta_5 \Delta P_t^s + \beta_6 \Delta P_{t-1}^h + \beta_7 \Delta P_{t-1}^s + \varepsilon_t \qquad (4\text{-}1)$$

Because J-REITs tend to invest only in real estate in Japan and S-REITs are more geographically diversified across different countries, the threshold ADL regression model of the J-REIT and S-REIT indices is described as follows:

$$\Delta P_t^{h2} = \beta'_0 + \beta'_1 P_{t-1}^{h2} I_t + \beta'_2 P_{t-1}^{h2} (1 - I_t) + \beta'_3 P_{t-1}^{h1} I_t + \beta'_4 P_{t-1}^{h1} (1 - I_t) + \\ + \beta'_5 \Delta P_t^{h1} + \beta'_6 \Delta P_{t-1}^{h2} + \beta'_7 \Delta P_{t-1}^{h1} + \varepsilon_t \qquad (4\text{-}2)$$

where I_t can be replaced with I_t^b if *Indicator B* is adopted. The adjustment speeds toward the long-run equilibrium, as measured by β_i (*i* = 1, 2, 3, 4), are allowed to vary in the threshold model. Thus, the conventional ADL model is a special case of the threshold ADL model when $\beta_1 = \beta_2$ and $\beta_3 = \beta_4$.[9] The lag-selection is guided by the partial autocorrelation function (PACF) of ΔP_t^h or ΔP_t^{h2}. Li and Lee (2010) proposed two tests for threshold cointegration. The first test is the BO-type test (Boswijk, 1994), which suggests testing the coefficients of P_{t-1}^h and P_{t-1}^s, or P_{t-1}^{h2} and P_{t-1}^{h1}, in the testing regression. In contrast, the second test, the BDM-type test of Banerjee et al. (1998), suggests separately adding the lead of P_{t-1}^h or P_{t-1}^{h2} to the regression so that the asymptotic results are valid in the absence of strict exogeneity. Based on their Monte Carlo experiment, Li and Lee (2010) indicate that the BO test performs better than any of the other tests in terms of size and power. As such, we use the BO threshold cointegration test for our empirical research. The threshold BO test is based on testing the following null hypothesis:

$$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0 \qquad \text{BO test} \qquad (5)$$

If the null hypothesis is rejected, it indicates that difference exists in the adjustment speeds of the REIT indices or the corresponding stock indices (J-REIT indices or S-REIT indices) on the different regimes of threshold value, implying that there are asymmetric adjustments of these indices. Because there is generally no prescribed rule as to whether to use *Indicator A* or *Indicator B* in our model, the recommendation is to

[9] *Here, only one lag of* ΔP_t^s *and* ΔP_t^h *or* ΔP_t^{h1} *and* ΔP_t^{h2} *is included in the regression following the parsimony principle.*

select the adjustment mechanism by using a model selection criterion, such as the Akaike Information Criteria (AIC) or the Schwartz Criteria (SC).

3.2 Threshold Granger-Causality Tests

The transmissions between the REIT indices and the stock indices, or between the J-REIT and the S-REIT indices, are tested using the threshold error-correction model (TECM). The TECM can be separately expressed as (6-1) and (6-2):

$$\Delta P_{it} = \alpha + \gamma_1 Z_{t-1}^{+} + \gamma_2 Z_{t-1}^{-} + \sum_{i=1}^{k_1} \delta_i \Delta P_{t-i}^{s} + \sum_{i=1}^{k_2} \theta_i \Delta P_{t-i}^{h} + v_t \ , \tag{6-1}$$

$$\Delta P_{it}^{'} = \alpha^{'} + \gamma_1^{'} Z_{t-1}^{+} + \gamma_2^{'} Z_{t-1}^{-} + \sum_{i=1}^{k_1} \delta_i^{'} \Delta P_{t-i}^{h1} + \sum_{i=1}^{k_2} \theta_i^{'} \Delta P_{t-i}^{h2} + v_t^{'} \tag{6-2}$$

where $\Delta P_{it} =$(REIT and stock returns), and $\Delta P_{it}^{'} =$ (S-REIT and J-REIT returns). When indicator A of the threshold ADL regression model is chosen, $Z_{t-1}^{+} = I_t \hat{u}_{t-1}$ and $Z_{t-1}^{-} = (1 - I_t)\hat{u}_{t-1}$ are obtained such that $I_t = 1$ if $u_{t-1} \geq \tau$ and $I_t = 0$ if $u_{t-1} < \tau$. On the contrary, when indicator B of the threshold ADL regression model is chosen, $Z_{t-1}^{+} = I_t \Delta\hat{u}_{t-1}$ and $Z_{t-1}^{-} = (1 - I_t)\Delta\hat{u}_{t-1}$ are obtained such that $I_t = 1$ if $\Delta u_{t-1} \geq \tau$ and $I_t = 0$ if $\Delta u_{t-1} < \tau$. v_t is a white-noise disturbance, τ is a threshold value and u_{t-1} is the previous period of the stochastic disturbance term in (3-1) or (3-2). By combining the stochastic disturbance term in the threshold ADL regression model with the adjustment coefficient of the TECM, we can increase the relationship between the cointegration and causality models to raise the validity and precision of our paper. The Granger-causality tests are examined by testing whether all of the coefficients of ΔP_{t-i}^{s} or ΔP_{t-i}^{h} (or ΔP_{t-i}^{h1} or ΔP_{t-i}^{h2}) jointly differ statistically from zero based on a standard F-test and/or whether the γ_j coefficients of the error-correction are also significant. Then, we take the REIT index and the corresponding stock index, for example. If H_0: $\theta_1 = \theta_2 = \gamma_1 = 0$ (or H_0: $\theta_1 = \theta_2 = \gamma_2 = 0$) is rejected, it implies that the REIT index is Granger-caused by the stock index above the threshold value (or below the threshold value); otherwise, the REIT index is not Granger-caused by the stock index above the threshold value (or below the threshold value). If H_0: $\delta_1 = \delta_2 = \gamma_1 = 0$ (or H_0: $\delta_1 = \delta_2 = \gamma_2 = 0$) is rejected, it implies that the stock index is Granger-caused by the REIT index above the threshold value (or below the threshold value); otherwise, the stock index is not Granger-caused by the REIT index above the threshold value (or below the threshold value).[10]

4. Empirical Results

4.1 Results of ADL threshold cointegration

This study uses the powerful ADL test for threshold cointegration, proposed by Li and Lee (2010), to separately examine the cointegration relationship between the REIT and stock indices and between the different REIT indices in Japan and Singapore. Because there is generally no prescribed rule about whether to use *Indicator A* or *Indicator B* in the ADL model, this study uses the model selection criterion of the Akaike Information Criteria (AIC) and Schwartz Criteria (SC) to select the adjustment mechanism. By using the AIC and the SC model selection criterion, the ADL model with *Indicator A* is favoured in the REIT and stock indices in Japan and in the J-REIT and S-REIT indices, with the exception of the REIT and stock indices in Singapore. The ADL model with the *Indicator A function* is used for the REIT and stock indices in Japan and for the J-REIT and S-REIT indices, while the ADL model with the *Indicator B function* is used for the REIT and stock indices in Singapore. The results of our ADL test for threshold cointegration using the Indicator A and Indicator B functions are illustrated in Tables 2-1 and 2-2, respectively. According to the results from Tables 2-1 and 2-2, the null hypothesis is rejected in favour of the alternative hypothesis for the REIT and stock indices in Japan and Singapore, while the null hypothesis is not rejected for the J-REIT and S-REIT indices. That is, the ADL test for threshold cointegration in our study showed evidence that a long-run equilibrium does indeed exist between the REIT and stock indices in Japan and Singapore and that the long-run adjustment process from the respective indices toward their equilibrium is asymmetric, as indicated by the significant coefficients of β_i (i = 1, 2, 3, 4) for these indices (Tables 2-1 and 2-2). However, there is no cointegration relationship between the J-REIT and S-REIT indices. The major policy implication that emerges from this study is that the long-run equilibrium between the REITs and the corresponding stock indices in Japan and Singapore could help investors who are simultaneously investing in REITs and stocks in the two Asian countries to make decisions about asset allocation. Investors in Japan and Singapore can use the cointegration relationship to predict the REIT and stock prices and determine whether they are over or undervalued to gain arbitrage opportunities. The investors in the two Asian countries cannot gain from arbitrage in J-REITs and S-REITs by using the cointegration equilibrium, but they can diversify the risks of investing in J-REITs and S-REITs, which is consistent with the results of Ro and Ziobrowski (2011).

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[10] *If $H_0 : \gamma_1 = 0$ is rejected, it implies that cointegration exists when the error term is larger than a threshold value. If $H_0 : \gamma_2 = 0$ is rejected, it implies that cointegration exists when the error term is smaller than a threshold value. Because the Granger-causality tests are highly sensitive to lag length selection, this study uses the AIC criterion to determine the appropriate lag lengths and finds the lag lengths of both k_1 and k_2 to be equal to one ($k_1 = k_2 = 2$)*

4.2 Results of the Threshold Granger-Causality Test

After identifying a non-linear equilibrium, this study then employs the threshold error-correction model (TECM) to separately capture the long-run and short-run dynamic adjustment process for the REITs and stock markets of the two Asian countries and for the S-REIT and J-REIT markets. The Granger-Causality tests are used to examine whether the γ_j coefficients of the error-correction term are significant and whether all of the coefficients of ΔP^{s}_{t-i} or ΔP^{h}_{t-i} (ΔP^{h1}_{t-i} or ΔP^{h2}_{t-i}) are significantly different from zero based on a standard F-test, with the appropriate lag lengths determined by the AIC criterion. Thus, the estimated coefficient of Z^{+}_{t-1} (Z^{-}_{t-1}) is the speed of adjustment for positive (negative) deviations from the equilibrium. $Z^{+}_{t-1} = I_t \hat{u}_{t-1}$ and $Z^{-}_{t-1} = (1 - I_t)\hat{u}_{t-1}$ are in Panels A and C of Table 3 because indicator A of the threshold ADL regression model is chosen, while $Z^{+}_{t-1} = I_t \Delta\hat{u}_{t-1}$ and $Z^{-}_{t-1} = (1 - I_t)\Delta\hat{u}_{t-1}$ are in Panel B of Table 3 because indicator B of the threshold ADL regression model is chosen.

For the adjustments toward the equilibrium above and below the threshold value of -0.044 between the stock and REIT indices in Japan, Panel A of Table 3 shows that there are different findings for the estimates of the adjustment coefficients. It is significant that the stock prices in Japan adjust by approximately 0.631 (12.91) of a unit positive (negative) change in the deviation from the equilibrium. Conversely, there are -0.065 (1.373) adjustments in real estate prices for a unit positive (negative) change in the deviation from the equilibrium, which are not significant. Nevertheless, the results of Panel B (Panel C) of Table 3 find that the adjustments of REIT prices between the real estate and stock markets in Singapore (S-REIT prices between the J-REIT and the S-REIT markets) toward a long-run equilibrium are more rapid when the changes in the deviation are positive (negative) than when they are negative (positive). This result implies that there are larger adjustments in the real estate prices in Singapore (S-REIT prices) than adjustments in the stock prices (J-REIT prices) when the threshold variable is above (below) the threshold value.

More importantly, Table 3 also shows the results of the Granger Causality tests based on the TECM for the stock and the REIT indices in Japan and Singapore and for the J-REIT and S-REIT indices, respectively. The results of Panel A reveal that there exists a bidirectional causality between the stock and REIT markets in Japan regardless of whether the threshold variable is above or below -0.044, thereby rejecting the null hypothesis of both $H_0: \theta_1 = \theta_2 = \gamma_1 = 0, H_0: \theta_1 = \theta_2 = \gamma_2 = 0$ and $H_0: \delta_1 = \delta_2 = \gamma_1 = 0, H_0: \delta_1 = \delta_2 = \gamma_2 = 0$. Thus, we find the existence of both the wealth and the credit price effects between the stock and the REIT markets in Japan. However, the results of Panel B clearly indicate the unidirectional causality running from the stock market to the real estate market regardless of whether the threshold variable is above or below 0.062, thereby rejecting the null hypothesis of $H_0: \delta_1 = \delta_2 = \gamma_1 = 0, H_0: \delta_1 = \delta_2 = \gamma_2 = 0$. Thus, we find the existence of the credit price effect between the two markets in Singapore. Then, the results of Panel C show that there is a bidirectional causal relationship between the J-REIT and S-REIT markets regardless of whether the threshold variable is above or below -0.154, thereby rejecting the null hypothesis of both $H_0:\theta_1=\theta_2=\gamma_1=0, H_0:\theta_1=\theta_2=\gamma_2=0$ and $H_0:\delta_1=\delta_2=\gamma_1=0, H_0:\delta_1=\delta_2=\gamma_2=0$. Hence, we demonstrate the existence of a feedback effect between the J-REIT and S-REIT markets, even if the J-REITs tend to invest only in real estate in Japan.

5. Conclusions

This paper uses the powerful ADL test for threshold cointegration proposed by Li and Lee (2010) to examine whether the non-linear cointegration equilibrium exists between the REIT and stock indices in Japan and Singapore and between the J-REIT and S-REIT indices. The empirical results provide evidence that there is a long-run equilibrium between the REITs and stock markets in Japan and Singapore, while there is no equilibrium between the J-REIT and S-REIT markets. Our study implies that institutional and individual investors in Asian countries can follow the non-linear cointegration relationship between the REITs and stock markets in Japan and Singapore with asymmetric adjustments to gain arbitrage opportunities; however, they cannot use the relationship between the J-REIT and S-REIT markets to gain from arbitrage except for diversification benefits.

This paper then employs the Granger causality test based on the TECM to examine the leading effect between the REITs and stock markets and between the J-REIT and S-REIT markets. On the one hand, we find that feedback effects exist between the REITs and stock markets in Japan and between the S-REIT and J-REIT markets. On the other hand, we confirm a unidirectional causality from the stock market to the REIT market. That is, we demonstrate that the wealth effect and the credit price effect simultaneously occur in Japan, that the wealth effect occurs in Singapore, and that the feedback effect exists between the J-REIT and S-REIT markets.

The ADL test for threshold cointegration can provide evidence on whether there are non-linear asymmetric co-movements under different regimes across the stock and real estate markets or across the different real estate markets. The Granger Causality test based on TECM can point to the existence of unidirectional and bidirectional causality both above and below the threshold values between the stock and real estate markets and between the two real estate markets in the Asian countries. Combining the ADL test for threshold cointegration and the Granger Causality test will clearly clarify whether the price transmissions between the stock and real estate markets or between the different real estate markets are asymmetric. This paper combines the two asymmetric methods to deepen the analysis between the two asset markets to help investors allocate their investment portfolios.

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