On the dynamic interactions between sector-level REITs, their direct real estate counterparts and the stock market in Japan

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Abstract

Despite their short history of existence, Japanese REITs (J-REITs) play an increasingly important role as a vehicle for property investment. In this paper we examine the long-run relationship and short-run dynamics between REITs, direct real estate assets, and the stock market in Japan. Using a vector error correction model, we explore whether J-REITs behave like direct real estate assets or like common stocks. Our study is based on general and sector specific appraisal-based monthly real estate indices covering the retail, office, residential and hotel sectors. Cointegration as well as exclusion, and weak exogeneity tests indicate that in the long run J-REITs are good substitutes for direct real estate assets but not for stocks. That is, they are a liquid alternative to unsecuritised real estate which offers diversification benefits to long-horizon investment in the Japanese stock market. These findings are robust and hold across all real estate sectors. Analysis of forecast error variance decompositions and impulse responses shows that shocks to the J-REITs market have a substantial impact on the direct real estate market and the stock market. In contrast, shocks these two markets contribute substantially less of the forecast error variance of J-REITs. Further, Granger causality tests reveal a unidirectional causal relationship from J-REITs to the other asset classes providing evidence that information aggregation and price discovery occurs predominantly in the J-REITs market.

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Introduction

The innovation in capital market provides the avenue for investment in securitised real estate assets. Today, we have the Real estate investment trusts (REITs); which invest and hold portfolios of real estate assets. REITs are offering investment in liquid real estate assets and receipt of income derived from the lease activity in the underlying real estate. Nonetheless, we need to consider that REITs capital flows are also contingent to capital flow from equity market, since they are traded like the common stocks. Thus, REITs are hybrid security which exhibit the prevailing features from both direct real estate and common stock markets.

Since then, there are two questions of interests particularly on the hybrid nature of REITs; first, whether REITs behave like underlying (direct) real estate assets or socks. Secondly, whether there exists a price discovery mechanism between REITs and direct real estate. The first question lies on the theory of cointegration and portfolio choice (Gallo, Lockwood, & Zhang, 2013; Phengpis & Swanson, 2011); whether REITs are providing similar diversification and thus be close substitute to the lumpy direct real estate assets. If not, then REITs are akin to be like typical common stocks instead, and investor can allocate REITs and direct real estate together in their portfolio. Whilst REITs are trading like common stocks, the price discovery mechanism are necessary to highlight whether REITs are informationally efficient to transmit changes in real estate fundamentals to the pricing of direct real estate assets.

Over the years, Japan investors have grown their interest to include real estate in their investment portoflio (Maroney & Naka, 2006). However, the question on Japan REITs (J-REITs hereafter) as an asset for a portfolio choice remain unanswered. Therefore, our main objective in this study is to estimate empirically the theory of cointegration and portfolio choice by applying a Vector Error Correction Model. In particular, we incorporate the J-REITs, direct real estate and stocks in our empirical estimation and accompanied by weak exogeneity and long-run exclusion tests. To follow, we examine the price discovery processes between the J-REITs and direct real estate by estimating a Granger causality test.

We utilise the monthly data on REITs and appraisal-based direct real estate indices. Our data on these two indices are similar to Boudry, Coulson, Kallberg, & Liu (2012) which consist of adequate representative for general and specialised real estate, namely Residential, Retail, Office and Hotel sectors. Following Oikarinen, Hoesli, & Serrano (2011) and Hoesli & Oikarinen (2012), we use the national stock market index as the proxy for common stocks. The choice of sample are also similar with recent and previous studies, such as in US and UK market (Hoesli & Oikarinen, 2012, 2016), Yong & Pham (2015) in Australia as well as in other international markets (Yunus, Hansz, & Kennedy, 2012).

Our main results from this study are as follows. First, we found there is one cointegrating relation between REITs, direct real estate and stocks in the long-run. After, we normalise the long-run cointegrating relation with respect to REITs instead, not the direct real estate as in the previous study by (Hoesli & Oikarinen, 2012). We found the pairwise cointgeration between REITs and direct real estate, since we manage to exclude the stocks market in the long-run relation. These findings are consistent in general as well as the specific property sector. So, REITs and direct real estate are substitutable assets. In fact, REITs are found to be weakly exogenous, and hence be the source of the common cointegrating trend in the long-run relation. Thus, REITs are superior than the direct real estate in terms of real estate assets to be chosen by the investor. Second, REITs are found to Granger cause their respective direct real estate in each of the property sector. So, REITs be the leader in the price discovery mechanism; in which the latter market will impound the information from REITs and accordingly adjusts their price. Lastly, our findings on the tight long-run relationship between REITs and direct real estate are also robust when we replace the stocks with Listed Property Companies (LPCs)[4].

We claim three contributions in this paper. To the best of our knowledge this is the first study that empirically examine the issue of hybrid nature of J-REITs; as the substitute and preferable asset over the direct real estate in general and specialised real estate sector. In fact, with the availability of long period data, our contribution extends the recent conversation by Cho (2017) which notably focus on the performance of J-REITs in the specialised property sectors. Second, the findings on causality test in each of the property sector is empirically prove that information flow from J-REITs are necessary to estimate the direct real estate property prices. Stated differently, we extend the evidence made by Shimizu, Diewert, Nishimura, & Watanabe (2015) which previously put focus on the office property sector. Moreover, our findings on tight relationship between REITs and direct real estate are robust when we replace the stock market variable to non-REITs Japan Listed Property Companies (LPCs) index. Since then, our robustness check validates the claim by Glascock, Prombutr, Zhang, & Zhou (2017) where LPCs and REITs are not a substitutable asset, specifically for the J-REITs context. Overall, we contend that J-REITs permit greater opportunity for liquid real estate investment than the direct asset in specialised property class. As a matter of fact, since J-REITs are not similar with the LPCs, this should permit for a broad real estate diversification opportunity, in particular real estate investment and real estate management companies.

[4] The LPCs are non-REITs but real estate related stocks which participate actively in real-estate related activities, particularly on real estate management and development (Glascock et al., 2017; Newell & Chau, 1996). LPCs also are not being subjected to regulatory requirement on the dividend distribution as in the REITs.

The rest of the paper is organised as follows. The next section provides the background information of J-REITs. The “Literature review” highlights the past and recent research on REITs, direct real estate and stocks. The “Theoretical Background” provide an underlying theory to connect cointegration and portfolio choice. The “Data” section provide explanation for the J-REITs, direct real estate and stock indices plus descriptive statistics and correlation analysis. In the “Methodology” section, we discuss the Vector Error Correction Model. The “Result” section tabulates and discusses the empirical findings. In the “Robustness Check” we re-estimate the Vector Error Correction Model by replacing stocks with listed property companies. The “Conclusion” section discusses the implication of the results and provide overall conclusion.

Background Information on J-REITs

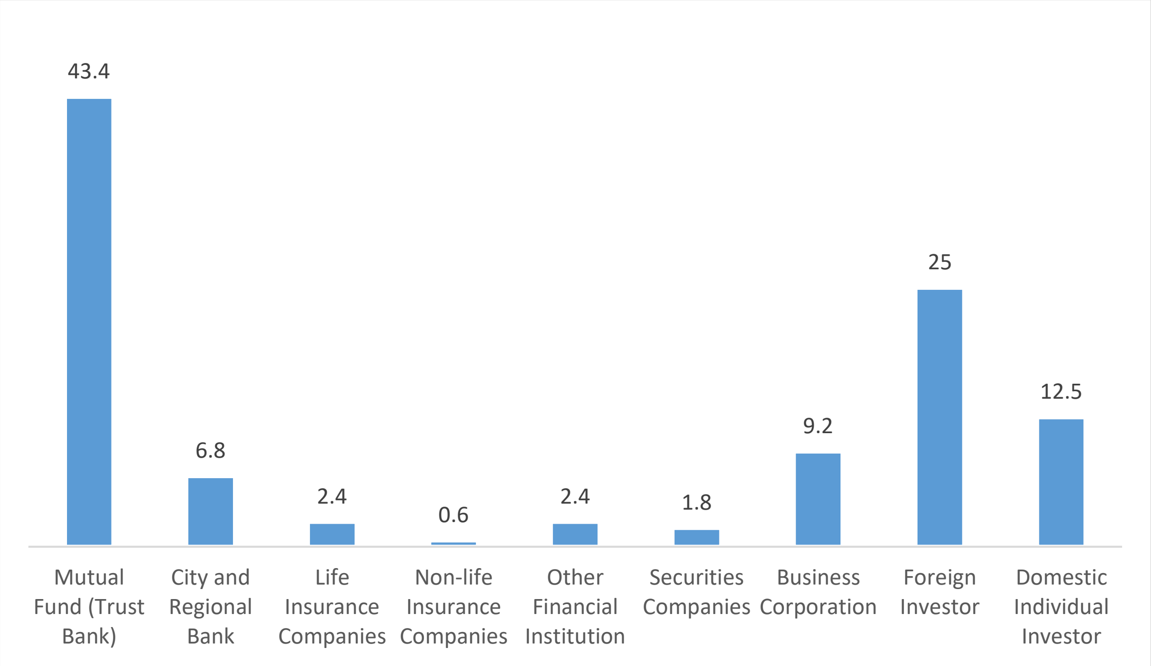
J-REITs begin their inception in year 2001, after the Investment Trust Law was enacted in year 2000. J-REITs are closed-end fund and publicly traded on the centralised stock exchange J-REITs are formed as an investment corporation. J-REITs are real estate asset holding corporations which involve in leasing real estate activities and being restricted to involve in real estate development activity. Their underlying real estate assets are externally managed. J-REITs income are taxable and subjected to corporate tax law with an effective rate of 35%. However, their taxable income being treated with the allowance on tax deductible, after which the remaining after income have been distributed as the dividends. Nevertheless, under the provision of Japanese Special Taxation Law, J-REITs are being subjected to distribute 90% of their income to their shareholders (EPRA, 2016).

In terms of market size, though they comprise 44% of listed real estate sector[5], their market capitalisation worth to $107Billion (BN). In fact, J-REITs are in the second place in terms of market size size only after the REITs market in the US, which have a market capitalisation of $1 Trillion. Since its introduction in year 2001, the number of listed J-REITs grow substantially from 2 in year 2001 up to 57 as at December 2016. Currently, J-REITs hold 3400 total properties with an estimated market values of $134BN. J-REITs declare 90% of income as dividends to the shareholders. Currently, J-REITs provide the shareholders with dividend yield averaging 4%. J-REITs provide a vehicle for investors to invest in liquid real

[5] Accordingly, the LPCs' account for 56% in the overall listed real estate sector in Japan (EPRA, 2015)

estate asset[6]. These attract investors in Japan REITs especially from institutional investors i.e. mutual funds, foreign investors and domestic individual investor (See Chart 1)[7].

Figure 1 Japan REITs investment by different types of investor

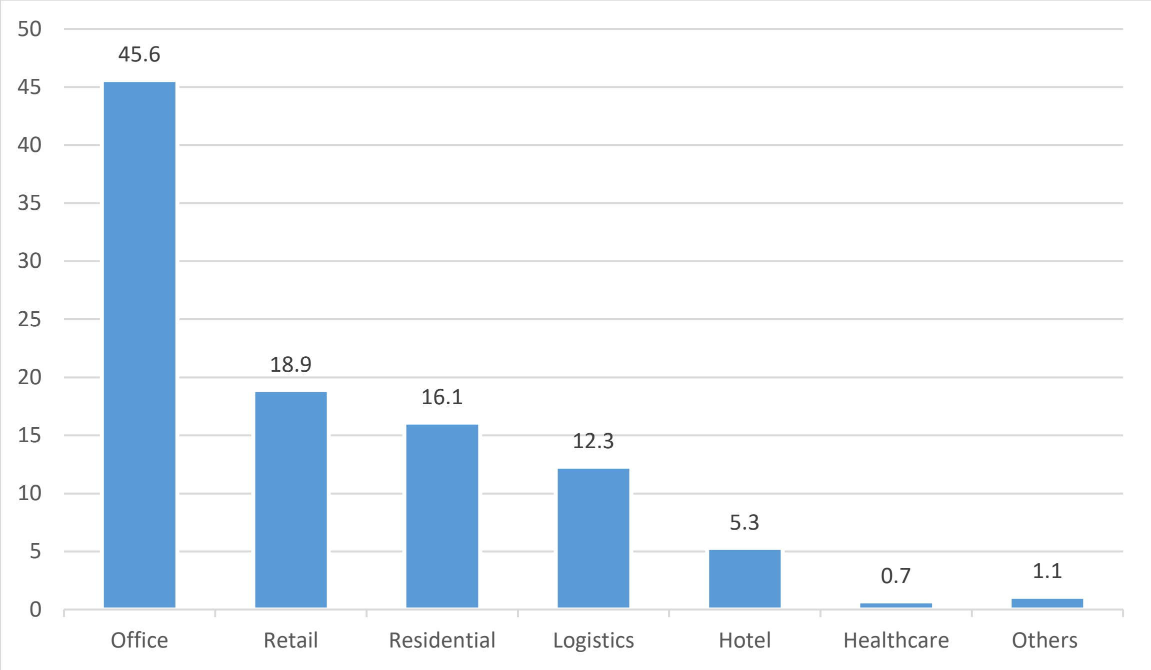


Source: Tokyo Stock Exchange

J-REITs invest in various property sectors. Based on chart 2, the largest investment is in the Office sector (45.6%), followed by Retail (18.9%) Residential (16.1%), Logistics (12.3%) and Hotel (5.3%). Since the inception, the underlying asset are performing well. For instance, the Office market, the vacancy level is only at 4% level, with the average rent of $165 per tsubo[8].The increase in space size for shopping centre contribute towards to Retail property sector, which generate a mean rent of $465.50 per tsubo. While in residential sector, construction of new housing contributes to the 40 000 units supply of rental apartments. Yet, the vacancy level ranges in between 10% to 16% level. The logistics sector has been growing significantly, with the increase in warehouse buildings and transportation vehicles for freight services in the domestic market. Though the hotel sector is small, the current occupancy rates exceed 70%. Hotel sector continues to grow, with the anticipation of 16000 available rooms in year 2020 (Nomura Research Institute, 2017). So, J-REITs provide the exposure to invest in real estate assets in a variety of property sector.

[6] In general, there are two types of REITs. Equity REITs are directly invest and hold physical real estate properties. While Mortgage REITs invest in mortgages either providing loans or purchasing commercial mortgage-backed securities (Hansz, Zhang, & Zhou, 2017). To the best of our knowledge, J-REITs only consist of the former type (equity REITs) and not mortgage REITs.
[7] The Association for Real Estate Securitisation. See https://j-reit.jp/en/about/
[8] Per tsubo is equal to per 3.3 square metre.

Figure 2 REITs Real Estate Investment According to Specific Property Sector



The above information on the J-REITs performance motivates us on the necessity to examine the fundamental characteristic embedded in the hybrid nature of J-REITs, either they behave like stocks or underlying direct real estate assets. In return, this investigation is hoping to spur the interest among investors to accept J-REITs as an important vehicle for real estate assets.

Literature Review

The question on REITs whether they can generate the same performance with respect to expected returns and diversification as their direct real estate counterparts or stocks has received a substantial attention both in the previous and recent literatures. Earlier on, several studies have found that REITs dynamics is closely linked to the dynamics of the stocks market. It is found that REITs prices follows a random walk (Seck, 1996). Similarly, the distribution of REITs return are exhibiting a negative autocorrelation pattern (Myer & Webb, 1993). The study by Ling & Naranjo (1999) contend REITs are similar with stocks as they are sharing the common macroeconomic factors. This argument support the notion that REITs can be a constitute in the stock market index (Ambrose, Lee, & Peek, 2007). Hence, REITs are found to be highly correlated with the stock market (Brounen & Eichholtz, 2003; Mueller & Mueller, 2003; Simon & Ng, 2009).

However, the linkages of REITs to stock yet to reach a conclusive evidence. For instance, The study by Clayton & Mackinnon (2003) argue that REITs return are susceptible to the large cap stocks. But this seems to be time-varying since REITs return become more sensitive to underlying real estate market in their latter period of investigation (i.e. year 1992-

1998). On the other hand, Hoesli & Camilo (2007) find the beta of REITs are decreasing relative to the stock market. Therefore, instead of correlation of REITs with stocks, latter studies highlight that REITs are positively and highly correlated with the direct real estate market (Ang, Nabar, & Wals, 2013; Mackinnon & Al Zaman, 2009)

So, it is worth for us to study the linkages of REITs with direct real estate without negating the liquid nature of REITs. To be specific, the liquidity implies REITs to be more informationally efficient to reflect changes in market information (Barkham & Geltner, 1995) . A preliminary investigation by Giliberto (1990) and Geltner & Kluger (1998) indicate REITs lead direct real estate for about two or three years. After all, the study by Stefek & Suryanarayanan (2012) ascertain REITs to be related to the direct real estate since REITs are leading the direct real estate market.

Hence, an important issue to be raised is whether REITs can be related to direct real estate, or similar with stocks in terms of portfolio choice of an investor. Before this, Mei & Lee (1994) and Geltner & Kluger (1998) argue that investment in REITs are able to replicate the performance of direct real estate investment. Nowadays, investors tend to switch into REITs for the purpose of real estate investment (Chiang & Lee, 2007; Lee, Lee, & Chiang, 2008). Therefore, it is worthwhile to show empirically whether substitutability holds for REITs as an alternative for direct real estate and not to be included together in a portfolio Otherwise, if REITs be alike a common stock then, there is a diversification benefit between REITs and direct real estate in a portfolio.

Thus, there are growing interest among researchers to see if REITs and direct real estate are tightly related in the long-run by applying the cointegration technique. The studies have been focused primarily on the US and UK where REITs are found to be cointegrated with the underlying real estate assets (Morawski, Rehkugler, & Fuss, 2008; Sebastian & Schatz, 2009). Furthermore, similar tight long-run relationship between REITs and direct real estate occur in the other international market like Australia and Netherlands (Yong & Pham, 2015; Yunus et al., 2012). Oikarinen et al. (2011) highlight the tight relationship between REITs and direct real estate exist since no cointegration between REITs and stocks in the long-run. Nonetheless, Hoesli & Oikarinen (2012) highlight cointegration between REITs and direct real estate with the ability to exclude stock market from the long-run cointegrating relation.

The tight long-run relationship of REITs with the direct real estate needs to account for specific real estate property sectors (Chiang, 2010; Pagliari, Scherer, & Monopoli, 2005; Riddiough, Moriarty, & Yeatman, 2005). This is vital since each different property sector is focusing to specific type of industry or business activities (Yavas & Yildirim, 2011). Latter studies are testing the cointegration between REITs and direct real estate according to specific property category. The study by Boudry et al. (2012) and Hoesli & Oikarinen (2012) indicate Retail, Apartment and Industry REITs in US are cointegrated with their underlying real estate assets. The investigation in UK indicate the Office and Retail REITs are cointegrated with their respective direct real estate assets (Hoesli & Oikarinen, 2012, 2016). The cointegration test conducted both in Aggregate and specific property sector proves substitutability holds since there is a tight economic forces keeping the assets jointly together in the long-run (Hoesli & Oikarinen, 2016). We can say that this argument is consistent with Pavlov, Steiner & Watcher (2018) which indicate REITs are more alike real estate and less likely linked to stocks in the long-run after controlling for specific property sector.

So, once after cointegration between REITs and direct real estate is examined, there are growing interest to see the short-run causal relationship between REITs and direct real estate by means of Granger Causality test. This is in accordance with initial arguments where REITs are more informationally efficient than the direct real estate market. In what follows, the study by Myer & Webb (1993) and Barkham & Geltner (1995) indicates REITs Granger Cause the direct real estate in US and UK markets respectively. Recent evidence support this causal relationship in other market like Australia and Netherlands (Yong & Pham, 2015; Yunus et al., 2012). Overall, these findings indicates price discovery generally initiates in REITs, since they react faster to changes in market information over the direct real estate market (Li, Mooradian, & Yang, 2009; Ling & Naranjo, 2015; Yavas & Yildirim, 2011).

However, the causal relationship can differ in the individual property sector. For example , Yavas & Yildirim (2011) find REITs lead direct real estate pertaining to their specific real estate sector, hotel and office. But, industrial and retail properties are also capable to granger cause their REITs respectively. Whilst, Hoesli, Oikarinen, & Serrano (2015) indicate office REITs Granger cause their underlying real estate properties, there are bidirectional causality between retail and industrial REITs with their respective direct real estate counterparts. This indicates the possibility of feedback effect running from the direct real estate market. As a result, the bidirectional causality from REITs to direct real estate can occur due to slow adjustment of REITs with respect to information from direct real estate market ; despite these causality can differ due to specific industry within the individual property sector (Hoesli et al., 2015; Yavas & Yildirim, 2011).

In Asian countries, existing studies are focus to the linkages between listed property companies and direct real estate market. Among others, no cointegration exist between listed property companies and direct real estate in Singapore (Eng, 1995). Newell & Chau (1996) claim no linkages between retail and office real estate with the property companies in

Hong Kong since there is low correlation between them. Nevertheless, the Granger causality test indicate listed property companies lead direct real estate in China and Hong Kong market (Newell & Chau, 1996; Newell, Chau, Wong, & McKinnell, 2005). Surprisingly, stocks can be a substitute to investment in Japan real estate since these two market are cointegrated in the context of Japan (Lin & Lin, 2011). Whilst Su, Huang, & Pai (2010) argue J-REITs are like stocks and providing a stable income stream like bonds. An extensive study on REITs in Japan and other Asian countries are yet to provide compelling arguments due to the lack of reliability and inadequacy for real estate time series data (Serrano & Hoesli, 2009).

To conclude, we seek to join conversation in studying the linkages between REITs either with direct real estate or stocks in Japan market. We set to focus both general and specific property sector. We contribute to the literature by first examining the long-run relationship between J-REITs with direct real estate or stocks. We contend substitutability hold if REITs are tightly related to direct real estate in the long-run. Second, we investigate the short-run causal relationship between REITs and direct real estate assets. Therefore, our second contribution examine if REITs can lead direct real estate in price discovery processes.

Theoretical Background

In this section, we discuss the theory of cointegration and portfolio choice, particularly on asset substitution. Simply put, cointegration can be portrayed as a linear combination of two or more non-stationary series in the long-run. To illustrate formally, suppose that there are three non-stationary series $\mathrm{i_t}$, $\mathrm{j_t}$and $\mathrm{k_t}$. According to Engle & Granger (1987), the series $\mathrm{i_t}$, $\mathrm{j_t}$and $\mathrm{k_t}$ are bound to be cointegrated, if they are integrated at the same order one, I (1) while their combination ϵ_t is I (0) stationary. Besides, there exist a long-run cointegrating vector denoted by b where $\mathrm{b} \neq 0$. We represent the cointegration between $\mathrm{i_t}$, $\mathrm{j_t}$and $\mathrm{k_t}$ by using the following notation:

$\epsilon_\mathrm{t} = \mathrm{i_t} - \mathrm{bj_t} - \mathrm{bk_t}$ where $\mathrm{E}[\epsilon_\mathrm{t}] = 0$

However, if the $\mathrm{E}[\epsilon_\mathrm{t}] \neq 0$, ϵ_t is no longer I (0) stationary then the two series are not cointegrated in the long run. As a result, all the 3 series $\mathrm{i_t}$, $\mathrm{j_t}$and $\mathrm{k_t}$ are all independent.

To follow, cointegration between these series can be extended further with the aspect of portfolio choice (Gallo et al., 2013; Phengpis & Swanson, 2011). Now, we assume the series $\mathrm{i_t}$, $\mathrm{j_t}$and $\mathrm{k_t}$ as three individual assets, REITs, direct real estate and stocks respectively in Japanese market. Our particular motivation is to examine whether J-REITs are akin to be real estate or common stocks. Hence, we form Johansen test of cointegration between these 3 assets. We assume there exist cointegration between these three assets in the long-run.

Then, we procced with exclusion test, where we presume stocks to be excluded from the long-run cointegration equation. If the exclusion hold, stocks are independent asset and REITs are not alike as common stock.

Later, we shall focus on the cointegration exist between REITs and direct real estate. It implies a long-run comovement between these two assets since there are expecting to generate expected cash flows or income from the same underlying real estate properties (Hoesli & Oikarinen, 2016; Oikarinen et al., 2011). So, an important question is which assets shall be selected over one another in the portfolio. In this regard, we proceed further with weak exogeneity test[9]. This test highlights an asset to be weakly exogenous which is not deviate(adjust) from(to) their long-run equilibrium. This asset serves as the source of common cointegration trend which are going to be shared with the other (endogenous) assets in the long-run equilibrium (Gallo et al., 2013; Phengpis & Swanson, 2011). This occurs since endogenous variable may deviate(adjust) from(to) their equilibrium. In other words, weakly exogenous is superior than the endogenous assets since the former helps to maintain their long-run cointegrating relation. Henceforth, an asset shall be selected over the other if they are found to be a weakly exogenous.

However, there is also a possible circumstance where weakly exogenous asset cannot be established. So, the two assets are endogenous. As a result, these two assets may deviate (adjust) from(to) their long-run equilibrium. Consider the case when REITs and direct real estate are endogenous. Thus, we can say that neither REITs nor direct real estate be the main source of common cointegrating trend to retain their long-run equilibrium[10]. Hence, the two assets will contribute their common cointegrating equilibrium (Glascock et al., 2017). In terms of portfolio choice, these two cointegrated assets provide the same diversification benefits, where it is not necessarily that these two assets can be included together in the portfolio. Therefore, we contend that the choice of asset shall be made based on the speed of adjustment, where we pick the asset which has higher speed than the other, whilst the asset adjusts itself once after it deviates from the long-run cointegrating equilibrium[11].

To follow, cointegration also allows us to examine the short-run causal relationship between REITs and direct real estate[12]. According to Alexander (2002) and Yunus et al.(2012), we

[9] We provide the empirical step to conduct weak exogeneity and exclusion test in the “Postestimation Test: Weak Exogeneity and Long-run Exclusion” subsection.
[10] The two assets are rendered to be endogenous when both may deviate(adjust) from(to) their long-run cointegrating equilibrium.
[11] The argument is not contradicting with the past literature. For instance, Hoesli & Oikarinen (2012) found UK REITs are not weakly exogenous. Nevertheless, this does not undermine their substitutability for direct real estate investment.
[12] We also examine the short-run causality test between REITs and stocks. We provide the empirical findings in the “Granger Causality Test” subsection.

can interpret this causal relationship as a price discovery mechanism. For instance, if REITs lead direct real estate, then price discovery occurs in the former market. Whilst the REITs prices will be adjusted accordingly to changes in market information, REITs also serve as the channel to transmit relevant market information to the pricing of direct real estate asset (Ling & Naranjo, 2015). This exhibit implies that the lead, REITs is more informationally efficient than the lag, direct real estate in adjusting their asset price. Stated differently, the lead-lag causal relationship indicates the violation of efficient market hypothesis by Fama (1970), whereby each asset should respond towards changes in market information simultaneously and making adjustment accordingly in their own asset prices (Tarbert, 1998; Tse, 1999).

Data

This study chooses proper benchmarks that track the performance both of REITs and direct real estate markets for the case of Japan. For REITs, we choose the Datastream Japan REITs indices in general and specific property classifications. The properties classified as, Office, Retail, Hotel and Residential sectors. In terms of direct real estate indices, this study adopts the data produced by The Association for Real Estate Securitisation (ARES) Japan. These indices have been known as ARES Japan Property Indices (AJPI) appraisal-based indices[13]. This study employs these indices both general and sectorial properties; similar with the REITs counterpart which are Office, Retail, Hotel and Residential direct real estate indices. The construction of these indices mimics the US National Council of Real Estate Investment Fiduciaries' (NCREIF) Property Index. These indices comprise income-producing properties owned by institutional real estate investors; both listed REITs and unlisted real estate funds. In particular, these indices are being derived from a weighted-average income (net operating income) and capital (changes in appraisal values) owned by institutional real estate investors[14,15]. As a data frequency, these indices are published on monthly basis.

This study adopts Tokyo Price Index (TOPIX) as the proxy for stock market series. We use total return indices rather than price indices [16]. In addition, to control for leverage on direct real estate indices, we adopt the Barclays Japan Asia-Pacific BAA Corporate Bond redemption yield, as a proxy for the cost of debt. Hence, the levered direct real estate indices can be restated by following the (Modigliani & Miller, 1958) formula:

$$r_{lit} = (r_{uit} - k_{dt}LTV)/(1 - LTV) \qquad (1)$$

[13]See https://index.ares.or.jp/en/ajpi/
[14] See https://index.ares.or.jp/en/about/ .
[15] See https://index.ares.or.jp/en/ajpi/download.php
[16] Total return indices at levels is derived by taking into account changes in share price over specified period and dividends which are assumed to be re-invested to purchase additional units of shares. Source (Datastream).

where r_{lit} = levered direct real estate indices of general or sector i at time t, r_{uit} = the unlevered direct real estate indices, k_{dt} the cost of debt in time t, LTV as loan to value ratio of Japan REITs (both general and sectors) which we set at 55% level during throughout study period (Sumitomo Mitsui Trust Research Institute, 2016)[17]. Besides, we also choose to adopt real indices, instead of nominal indices. Thus, this study deflates nominal index values by consumer price index (CPI) data taken on a monthly basis[18]. Overall, we express the REITs, direct real estate and stock market indices in the form of natural log[19]. In terms of data frequency, we choose to follow the monthly frequency; similar with the frequency reported by AJPI direct real estate indices. The data availability on REITs and direct real estate indices dictates the period of observation to be conducted in this study. In order to set the same level of playing field, we set the starting period of observation from April 2004 (2004m4) to December, 2017 (2017m12). Except for the hotel sector, where we start the observation from June 2006 (2006m6). We provide the details on the summary of data collection for each of property sector in the Table 1.

[17] The survey conducted by Sumitomo Mitsui Trust Research Institute in year 2016 indicate the J-REITs real estate managers favour to control their LTV of more than 50% and less than 60%. Hence, we set the LTV for this study at the 55% level.

[18] Unless stated elsewhere, this study collects the data from Datastream. Since we adopt secondary data, there should not be any ethical issues, but we make sure that the collected data are retrieved from reliable and authentic sources. As an example, see the study by Peng & Schulz (2013) which adopts the indices produced by Datastream.

[19] For example, see Yunus et al., (2012), Oikarinen et al., (2011) and Hoesli & Oikarinen (2012) since these studies apply the same data treatment.

Table 1 The summary of data collection

Variable	Abbreviation	Source	Period
Direct Real Estate			
General	DRE	AJPI Aggregate and Sectorial Direct Real Estate Indices	2002:m6-2017:m12
Residential	Res_DRE		2004:m4-2017:m12
Retail	Rtl_DRE		2003:m6-2017:m12
Office	Ofc_DRE		2001:m12-2017:m12
Hotel	Htl_DRE		2006:m6-2017:m12
REITs			
General	REIT	Datastream Japan REITs	2002:m6-2017:m12
Residential	Res_REIT	Datastream Japan Residential REITs	2004:m4-2017:m12
Retail	Rtl_REIT	Datastream Japan Retail REITs	2003:m6-2017:m12
Office	Ofc_REIT	Datastream Japan Office REITs	2001:m12-2017:m12
Hotel	Htl_REIT	Datastream Japan Hotel REITs	2006:m6-2017:m12
Overall stock market	STOCK	Tokyo Price Index (TOPIX)	2001:m12-2017:m12
Listed Property Market	LPC	Datastream Real Estate Investment and Management	2001:m12-2017m12
Cost of debt	K_DEBT	Barclays Asia-Pacific Japan BAA Corporate Bond Redemption Yield	2001:m12-2017:m12
Consumer Price Index	CPI	Japan Consumer Price Index (National)	2001:m12-2017:m12

Notes: This table provides the information for all collected data. In exception to Direct Real Estate indices, this study collects the data for all variables from Datastream.

Table 2 reports some descriptive statistics for all indices used in this study. We compute and report the descriptive statistics by taking the difference in logs. In general, REITs (except Residential REITs) have higher mean compared to direct real estate indices[20]. However, the findings indicate to us that the direct real estate indices are less volatile than REITs indices; since their standard deviation ranges in between 0.0043 to 0.0065. While the standard deviation of REITs indices ranges in between 0.0617 to 0.1078[21,22]. The standard deviation

[20] The computation of mean return is in a continuously compounded.

[21] According to Sun, Titman, & Twite (2015) direct real estate indices seem to be less volatile than REITs indices. This exhibit arises since the direct real estate indices are being constructed as appraisal-based, where appraisers may rely on past information in valuing the underlying properties (Yong & Pham, 2015). Since then, appraisers tend underreact to changes in current market condition (Li et al., 2009). Nevertheless, the subsequent cointgeration analysis is believed not to

for stock market reports even with lower level of volatility as compared to REITs. While the LPCs is more volatile than the REITs since it has the highest standard deviation, 0.0872. All return series are negatively skewed, except for the Hotel real estate. In summary, the kurtosis of the return series, especially for all REITs, are higher than 3; which indicate the series are not normally distributed.

Table 2 Descriptive Statistics

Variables	Mean	Standard Deviation	Min	Max	Skewness	Kurtosis
∆STOCK	0.0041	0.0541	-0.1397	0.1379	-0.39062	3.2771
∆LPC	0.0042	0.0872	-0.2632	0.2769	-0.2636	3.7908
∆ REIT	0.0055	0.0689	-0.5283	0.1533	-2.7778	23.5342
∆Res_REIT	0.0019	0.0617	-0.3765	0.1625	-1.3042	10.8728
∆Rtl_REIT	0.0054	0.0707	-0.4601	0.1872	-1.7394	13.7694
∆Ofc_REIT	0.0052	0.0711	-0.4957	0.1964	-2.1010	17.0970
∆Htl_REIT	0.0099	0.1078	-0.6529	0.4639	-0.9817	14.4597
∆DRE	0.0044	0.0052	-0.0145	0.0159	-0.5281	3.7415
∆Res_DRE	0.0039	0.0043	-0.0132	0.0123	-0.9822	4.4648
∆Rtl_DRE	0.0044	0.0049	-0.0146	0.0147	-1.0269	4.7925
∆Ofc_DRE	0.0042	0.0059	-0.0156	0.0181	-0.2545	3.4261
∆Htl_DRE	0.0060	0.0065	-0.0108	0.0236	0.43469	3.1652

Notes: This table reports the descriptive statistic for all indices. These indices are all inflation-adjusted, after being deflated by monthly CPI. The indices for direct real estate are levered. We compute and report the statistics for all the series (REITs, direct real estate and stocks) in the form of difference in logs, as denoted by "∆" symbol. The frequency for all the variables is reported on monthly basis. The abbreviation is explained as in the Table 1.

Finally, this study reports the preliminary findings on correlation between REITs (general and specialised) with stocks, LPCs and direct real estate market. There is insignificant correlation between general and specialised REITs with their respective direct real estate counterpart, except for the Residential REITs. There is a positive but low correlation between office REITs with retail direct real estate at 5% level. There are also positive and high significant correlation between Residential REITs with retail and hotel direct real estate market. However, these correlations may not be too meaningful given that the correlation are not occur between their own real direct real estate indices. REITs in general is moderately correlated with stocks and LPCs at 0.37 and 0.33 respectively. The Residential REITs has the highest correlation with stocks and the LPCs. Yet, other REITs are also moderately correlated with the stocks market, where Retail REITs, Office REITs are positively correlated with stock market at 0.36 and 0.39 respectively. Hotel REITs has the lowest correlation with stocks. All in all, these preliminary findings on correlation are insufficient for us to argue to conclude whether REITs behave neither with direct real estate nor with stocks market.

be affected by this data complication (Hoesli & Oikarinen, 2012, 2016; Yunus et al., 2012).

[22] Hotel REITs index is the most volatile, where it has an extreme minimum and maximum return. In our opinion, this occurs since the index constitutes only two Hotel REITs firms.

Table 3 Correlation Analysis

	∆REIT	∆Res _REIT	∆Rtl_REIT	∆Ofc_REIT	∆Htl_REIT
∆ REIT	1.000	0.3083***	0.9369***	0.9594***	0.6202***
∆Res _REIT	0.3083***	1.000	0.3439***	0.3029***	0.2540***
∆Rtl_REIT	0.9369***	0.3580***	1.000	0.8841***	0.6411***
∆Ofc_REIT	0.9594***	0.3029***	0.8841***	1.000	0.5770***
∆Htl_REIT	0.6202***	0.2540***	0.6411***	0.5770***	1.000
∆ DRE	0.1016	0.1104	0.0272	0.1071	0.0837
∆Res_DRE	0.1412*	0.1958***	0.0882	0.1339*	0.1767**
∆Rtl_DRE	0.1667**	0.2182***	0.1065	0.1626**	0.1774**
∆Ofc_DRE	0.0631	0.0488	-0.0169	0.0739	0.0212
∆Htl_DRE	0.1268	0.1901***	0.0799	0.1249	0.1419*
∆STOCK	0.3702 ***	0.5177***	0.3642***	0.3892***	0.1682**
∆ LPC	0.3315***	0.4649***	0.3260***	0.3333***	0.0552

Notes: This table reports the correlation between the variables. We present the correlation by treating all variable in their form of difference in logs, denoted by "∆" symbol. *** and** and * indicate these correlations are significant at 1%, 5% and 10% level respectively[23].

Methodology

We estimate a vector error correction model to study the long-run cointegrating relationship between REITs, direct real estate and stocks. Suppose that y_t consists of 3-dimensional, *N*=3 vectors of indices, that are REITs, direct real estate and stocks. So $y_t = [\,j\_\mathrm{REIT}_{t-1}, j\_\mathrm{DRE}_{t-1}, S\mathrm{TOCK}_{t-1}]$. We further specify REITs, direct real estate into general and specific property sector where $j \in \ (Rtl, Ofc, Htl, Res)$[24]. Thus, the VECM equation can be represented as

$$\Delta y_t = v + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \alpha\beta' y_{t-1} + \epsilon_t \tag{2}$$

where, $\Delta y_t = [\Delta j\_\mathrm{REIT}_t, \Delta\, j\_\mathrm{DRE}_t,\ \Delta\, \mathrm{STOCK}_t]$, v is three – dimensional (3 x 1) vectors of drift terms, ϵ_t is the 3-dimensional (3 x 1) vector of normally distributed white noise error terms with zero mean and constant variance. Γ_i is 3 x 3 matrix of coefficients for the lagged differences of the indices at lag *i,* with *p* as the maximum lags to be included in the equation (2). The number of lags play a crucial role to avoid the problem of autocorrelation. In what follows, α is the vector of speed of adjustment parameter (in 3 x *r* matrix) and β' as the

[23] For example, see Oikarinen et al.,(2011) and Hoesli & Oikarinen (2012) which apply the difference in logs for all variable while computing and reporting the descriptive statistics; as well as in presenting the correlation between the variables.

[24] These abbreviation stand for Retail, Office, Hotel and Residential property sector respectively.

long-run cointegrating vector (in *r* x 3 matrix). Alternatively, $\alpha\beta'$ can be expressed as Π which can be considered as a 3 x3 long-run impact matrix[25,26].

Deterministic Trend and (or) Intercept Term in the VECM Equation

Another crucial aspect before estimating the vector error correction model in equation (2) is considering the role of deterministic trend and (or) intercept, captured by the drift term, v. In particular, v in equation (2) can be expressed as

$$v = \pi + \delta t \qquad (3)$$

where the RHS of the equation (5) component of π and δ can be decomposed into

$$\pi = \alpha\mu + \gamma \qquad (4)$$

$$\delta = \alpha\rho + \tau \qquad (5)$$

Accordingly, the first term for the RHS in equation (4) and (5) captures the intercept and trend components for the long-run cointegrating relation. Specifically, α is represented in the form of 3 x r matrix while μ and ρ vectors are in the form of *r* x 1 matrix. Besides, the second term for the RHS in these two equations consider for intercept and trend component in the Δy_t (Hendry & Juselius, 2001), which can be represented in the form of 3 x 1 matrix. Johansen (1994) outlines five different cases for the deterministic trend and (or) intercept for vector error correction model as in equation (2) where;

Case 1. No restriction on π and δ where the quadratic trend is permitted in the levels of the data series y_t. So, equation (2) becomes

$$\Delta y_t = \gamma + \tau t + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \alpha\mu + \alpha\rho t + \alpha\beta' y_{t-1} + \epsilon_t$$

Case 2. The $\tau = 0$ while no constrain being imposed in γ, π and ρ. In this regard, there is a linear time trend restricted in the cointegrating relation. It is assumed that the linear time trend in the variable(s) is not eliminated in the long-run cointegrating relation. Equation (2) now be written as

[25] We represent the 3-D vectors of indices accordingly to specific REITs and direct real estate sectors. Hence, there are 5 different models to be estimated. Overall, we estimate the VECM as in equation (2) by using STATA application.

[26] As we said earlier, the availability of REITs and direct real estate data determine the period of investigation. Therefore, the stock market variable will be entered just as the total number of observations similar to the REITs and direct real estate indices.

$$\Delta y_t = \gamma + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \alpha\mu + \alpha\rho t + \alpha\beta' y_{t-1} + \epsilon_t$$

Case 3. The $\delta = 0$ with no restriction on π. Thus, the linear trend in the levels of data have been cancelled out in the cointegrating relation, only intercept be included in the Δy_t . The formula of equation (2) becomes

$$\Delta y_t = \gamma + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \alpha\mu + \alpha\beta' y_{t-1} + \epsilon_t$$

Case 4. The $\delta = 0$, $\gamma = 0$ while $\mu \neq 0$. While the $E[\Delta y_t] = 0$. The trend terms in equation (2) disappear, with exception to the intercept term is allowed in cointegrating relation.

$$\Delta y_t = \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \alpha\mu + \alpha\beta' y_{t-1} + \epsilon_t$$

Case 5. There is no trend and intercept in the equation (2) since $\delta = 0$ and $\pi = 0$. Thus, equation (2) becomes

$$\Delta y_t = \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \alpha\beta' y_{t-1} + \epsilon_t$$

Overall, these 5 cases highlight the importance to determine the deterministic trend and intercept in the vector error correction model in equation (2). Nonetheless, they will affect the asymptotic distribution in Johansen test of cointegration, both trace test and maximum eigenvalues test (which will be explained in the Empirical Estimation subsection) (Doornik, Hendry, & Nielsen, 1998). Asteriou & Hall (2016) suggest that case 1 is unlikely to occur since quadratic trend may give doubtful interpretation of cointegrating relationship neither in decreasing nor increasing rate of change. While intercept component cannot be neglected as in case 5. These left three possible cases to be considered. Thus, Johansen (1992) suggests the application of Pantula rule where the possible case deterministic trend and intercept be made by testing from the most restricted case, that is case 4, to the least restricted model, case 2. This test stops when the null hypothesis of maximum number of cointegrating relation, *r* is failed to be rejected.

Empirical Estimation

To estimate the equation (2), we apply Johansen (1988) and Johansen & Juselius (1990) maximum likelihood estimation method. This method is preferable rather than Engle & Granger (1987) method since there are possibilities to have more than one long-run cointegrating relationships between the series. This can be occurred since we have *N*=3, 3-Dimensional vectors of indices. Therefore, the maximum likelihood estimation is useful to determine the number of cointegrating relations or rank, *r* of matrix Π in equation (2). Johansen proposes two maximum likelihood test statistic; with trace test statistic is formulated as

$$\lambda_{trace(r)} = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \tag{6}$$

Where *T* is the number of observations, λ_i are the estimated eigenvalues of Π. This trace statistics test for the null hypothesis of no more than r cointegrating relations. As a result, large values of this statistics cause the null hypothesis to be rejected. While maximum eigenvalue test can be formulated as

$$\lambda_{\max(r,r+1)} = -T \ln(\,1 - \lambda_{r+1}) \tag{7}$$

With *T* as the number of observations and λ_{r+1} is the estimated $r+1^{\text{th}}$ estimated eigenvalues of Π. The maximum eigenvalues tests for the maximum number of *r* cointegrating relations against the *r+1* cointegrating relations. Consequently, these two statistics are continuous iterative process until the null hypothesis of *r* number of cointegrating relations failed to be rejected. In actual, there are 3 possible case of *r* which are: rank of Π equal to zero, then there is no linear combination of y_t that is stationary; or Π can be a full rank, *r*=*N* where *N* =3 that cause the vector process to be stationary. This extreme contradicts with the non-stationary data generating process of all the indices. In intermediary, there exists at most r≤ *N* -1 number of cointegrating vectors that indicates there is (are) *r* linear combination(s) of y_t that is stationary and cointegrated. As a result, if there is more than one or at most *r*≤ *N* -1 number of cointegrating vectors, then the Π matrix in equation (2) can be further estimated to obtain the vectors of α and β' by maximum likelihood estimation method. Since we have *N* =3 series, the possible number of *r* =1 number of cointegrating vectors, or at most *r* = 2. We can illustrate the possible long-run cointegrating equation as follows [27]:

[27] Our illustrative example of long-run cointegrating equation does not take any normalisation, where any β_{ij} coefficient has not been restricted to be equal to 1.

i) When N =3, r =1,

$$\Delta y_t = \begin{pmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\end{pmatrix} + \begin{pmatrix}\tau_1\\ \tau_2\\ \tau_3\end{pmatrix} + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \begin{pmatrix}\alpha_{11}\\ \alpha_{12}\\ \alpha_{13}\end{pmatrix} \left[[\beta_{11}\ \beta_{12}\ \beta_{13}] \begin{bmatrix} j\_REIT_{t-1}\\ j\_DRE_{t-1}\\ STOCK_{t-1}\end{bmatrix} + \mu + \rho t \right]$$

$$\Delta y_t = \begin{pmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\end{pmatrix} + \begin{pmatrix}\tau_1\\ \tau_2\\ \tau_3\end{pmatrix} + \textstyle\sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \begin{pmatrix}\alpha_{11}\\ \alpha_{12}\\ \alpha_{13}\end{pmatrix}$$
$$[\beta_{11} j\_REIT_{t-1} + \beta_{12} j\_DRE_{t-1} + \beta_{13} STOCK_{t-1} + \mu + \rho t]$$

Thus, when r=1 the long-run cointegrating equation are

$\beta_{11} j\_REIT_{t-1} + \beta_{12} j\_DRE_{t-1} + \beta_{13} STOCK_{t-1} + \mu + \rho t$

ii) When N =3, r =2, then

$$\Delta y_t = \begin{pmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\end{pmatrix} + \begin{pmatrix}\tau_1\\ \tau_2\\ \tau_3\end{pmatrix} + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \begin{pmatrix}\alpha_{11} & \alpha_{21}\\ \alpha_{12} & \alpha_{22}\\ \alpha_{13} & \alpha_{23}\end{pmatrix}$$
$$\left[\begin{bmatrix}\beta_{11} & \beta_{12} & \beta_{13}\\ \beta_{21} & \beta_{22} & \beta_{23}\end{bmatrix} \begin{bmatrix} j\_REIT_{t-1}\\ j\_DRE_{t-1}\\ STOCK_{t-1}\end{bmatrix} + \begin{bmatrix}\mu_1\\ \mu_2\end{bmatrix} + \begin{bmatrix}\rho_1\\ \rho_2\end{bmatrix} t \right]$$

$$\Delta y_t = \begin{pmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\end{pmatrix} + \begin{pmatrix}\tau_1\\ \tau_2\\ \tau_3\end{pmatrix} + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \begin{pmatrix}\alpha_{11} & \alpha_{21}\\ \alpha_{12} & \alpha_{22}\\ \alpha_{13} & \alpha_{23}\end{pmatrix}$$
$$\begin{bmatrix} \beta_{11} j\_REIT_{t-1} + \beta_{12} j\_DRE_{t-1} + \beta_{13} STOCK_{t-1} + \mu_1 + \rho_1 t\\ \beta_{21} j\_REIT_{t-1} + \beta_{22} j\_DRE_{t-1} + \beta_{23} STOCK_{t-1} + \mu_2 + \rho_2 t\end{bmatrix}$$

Thus, when r=2 the long-run cointegrating equation are

$\beta_{11} j\_REIT_{t-1} + \beta_{12} j\_DRE_{t-1} + \beta_{13} STOCK_{t-1} + \mu_1 + \rho_1 t$

$\beta_{21} j\_REIT_{t-1} + \beta_{22} j\_DRE_{t-1} + \beta_{23} STOCK_{t-1} + \mu_2 + \rho_2 t$

Post-estimation Test: Weak Exogeneity and Long-run Exclusion

The estimated of α and β' vectors can be restricted in two different ways. Firstly, weak exogeneity test in which the coefficient of α for an individual series can be restricted to be zero (Hunter, 1992). As a result, if the restriction is valid, then we indicate the series will not be deviated (adjusted) from (to) from the long-run cointegrating equilibrium. This implies that the series be the source of common trend which are going to be shared with the other cointegrated series in the long-run relation. Secondly, exclusion test, whereby an individual series is allowed to be excluded in the long-run cointegrating relation (Hunter, 1992; Juselius, 1995). We conduct this test by restricting the β coefficient correspond to an individual series be equal to zero. These two tests follow a Chi-square test statistic. The restriction of coefficients either in α or β' vectors are valid if the p-value for the restriction test are greater than 0.05.

Results

Prerequisite: Unit Root Test

An initial test prior to estimate equation (2) is to examine whether the series exhibit unit root. This reflects the nature of non-stationary or random walk process for all series; with non-constant mean and variance (Hendry & Juselius, 2000; StataCorp, 2009). So, this study chooses to apply two unit root tests where the first one is Philips & Perron (1988) unit root test. Secondly, we apply Dickey-Fuller Generalised Least Squares (DF-GLS) unit root test, developed by (Elliott, Rothernberg, & Stock, 1996).First, we show a time series plot for all series at the levels[28]. The time series plot clearly indicates no linear time trend for the stock market and all REITs (general and sectorial) indices. In exception for all direct real estate indices in which there exist a linear time trend. So, we include the trend component for series that reveal a linear time trend. Therefore, the unit root tests conduct on the level for all series indicate series are non-stationary and exhibit a unit root. So, the null hypothesis of random walk is failed to be rejected. Consequently, we follow Hendry & Juselius (2000) recommendation by taking transformation for all series by taking the difference in logs. As we can see from table 4, both unit root tests indicate the indices for all REITs, direct real estate and stock market are only stationary after taking the difference in logs, at least with 5% significance level. In short, the stationarity of all series after taking the first difference indicates they are integrated at the order one, I (1). Thus, our prerequisite tests fulfil the conditions that all series are non-stationary and integrated at I (1). Hence, we can incorporate the series for estimating the vector error correction model, as formulated in equation (2).

[28] See Appendix 1

Table 4 Unit Root Test

	Philips & Perron		DF-GLS	
Variable	Level	First difference	Level (Lags)	First difference (Lags)
STK	-1.241	-12.590***	-0.619 (1)	-7.917 *** (1)
REIT	-1.428	-13.596***	0.173 (1)	-12.847*** (0)
Res_REIT	-1.127	-9.907***	-1.024 (1)	-2.983 *** (2)
Rtl_REIT	-1.396	-12.757***	-0.060(1)	-11.895*** (0)
Ofc_REIT	-1.544	-14.124***	0.203 (1)	-10.077*** (0)
Htl_REIT	-0.338	-11.159***	-0.101(1)	-11.171***(1)
DRE^{l}	-1.100	-5.326***	-2.050 (4)	-4.237*** (1)
Res_DRE^{l}	-0.083	-6.555 ***	-0.600 (1)	-5.285*** (1)
Rtl_DRE^{l}	-1.389	-5.425 ***	-2.113 (4)	-4.227 *** (1)
Ofc_DRE^{l}	-1.131	-4.570***	-2.142 (4)	-3.853***(1)
Htl_DRE^{l}	-0.162	-4.452***	-0.934 (1)	-3.350** (1)

Notes: This table shows the Phillips & Perron and Dickey- Fuller GLS (DF-GLS) unit root test for all series; REITs, stock market and direct real estate indices. ^{l} denotes an additional linear time trend component for both unit root tests. The critical values for Phillips & Perron test at 1% and 5% significance level are -4.010 and -3.440 when a trend component is included and -3.480 and -2.880 when trend component is excluded in the test. While, the critical values for DF-GLS at 1% and 5% significance level are -3.490 and -2.950 when a trend component is included and -2.590 and -1.950 when trend component is excluded in the test. *** and ** indicate significance level at 1% and 5% level respectively.

Cointegration Test

We set to estimate the vector error correction model, equation (2) in multivariate system by incorporating REITs, direct real estate and stock market as 3-dimensional vector of indices. We form five different models which include general property sector as well as specific property sectors; Retail, Office, Hotel and Residential sectors. Initially, we determine the optimal lag length in equation (2) by means of Hannan Quinn Information Criteria (HQIC). Additionally, more lags are included up to four lags if the problem of autocorrelation cannot be eliminated, as evidenced in Lagrange Multiplier test. We follow the Pantula principle to determine the inclusion of deterministic trend and (or) intercept in the equation (2). Henceforth, we indicate the deterministic intercept shall be included in the cointegrating equation as in Case 4 for the General REITs plus Retail, Office and Hotel REITs sector. In exception to Residential REITs, where we find that Case 2 is suitable to be used for the Residential REITs, by allowing a linear time trend, t in the long-run cointegrating relations.

We present the Johansen test for determining the number of cointegrating relations in the table 5. Both trace test and maximum eigenvalue test indicate there is one long-run cointegrating relationship between REITs, direct real estate and stock market for General and all property sector REITs in Japan Market at 5% significance level.

Table 5 Johansen Cointegration Test

Null	Trace TEST	Critical Values CV 5%	Maximum Eigenvalues	Critical Values 5 % CV
General				
r ≤ 0	60.4068	34.910	46.4534	22.000
r ≤1	13.9534**	19.960	10.9267**	15.670
Residential				
r ≤ 0	51.8451	42.440	37.0465	25.540
r ≤1	14.7986**	25.320	8.6875**	18.960
Retail				
r ≤ 0	57.0647	34.910	42.6614	22.000
r ≤1	14.4033**	19.960	9.1238**	15.670
Office				
r ≤ 0	59.9276	34.910	44.2239	22.000
r ≤1	15.5956**	19.960	12.4831**	15.670
Hotel				
r ≤ 0	37.297	34.910	25.637	22.000
r ≤1	11.660**	19.960	9.656**	15.670

Notes: This table shows the Johansen test for cointegration between REITs, direct real estate and stocks both in General and specific property sector. We apply two tests for cointegration that are Trace Test and Maximum Eigenvalues statistic. The null hypothesis is there is no more than r number of cointegrating relation. ** indicates the significance at 5% level.

We normalise the long-run cointegrating equation with respect to REITs, whilst in attempt to intuitively understand their hybrid nature. Thus, the β coefficient with respect to REITs is set equal to 1. We present the result in the table 6. Our analysis on exclusion test highlight the validity to exclude stock market in the long-run cointegrating relation. This occurs since the p-values for the restriction of β's for the stock market series equal to zero is greater than 0.05. Since then, stock market can be excluded in the long-run cointegrating relation, both in general and all property sectors in the Japan market. Moreover, as evidenced in our five separate models, the stocks can be restricted as the weakly exogenous variable. This exhibit is consistent with our expectation where, since stock can be excluded, stocks market variable should not be allowed to deviate or adjust themselves in the long-run relation.

Therefore, we emphasise that J-REITs are cointegrated with the direct real estate in the long-run. Whilst this implies REITs and direct real estate are substitutable, the practical aspect on the portfolio choice could be indicated by the weak exogeneity test. Our test indicate direct real estate is not weakly exogenous, particularly in general and the other property sectors; Retail, Office and Residential sectors. Subsequently, REITs contribute to drive and share the common trend with the direct real estate and only the latter variable (asset) can be deviated from the long-run cointegrating relations. In exception to the hotel sector, where the Hotel REITs and its direct market are endogenous. In this regard, we contend that the portfolio choice lies in the aspect on speed of adjustment parameter α. Our result indicate Hotel REITs has higher α (in absolute value) than the direct; in which Hotel

REITs is faster than direct real estate to adjust their deviation from the long-run cointegrating equilibrium.

In summary, the tight long-run relationship between J-REITs with their respective direct real estate market indicate J-REITs characteristics are assembling like their underlying real estate assets not with the stock market. The findings on J-REITs are not contradict with the evidence from other market like US and UK market (Hoesli & Oikarinen, 2012, 2016). Since J-REITs are not behave as common stocks, they will provide the same diversification benefits like the direct real estate asset. In fact, our estimations also prove J-REITs are superior to be chosen as the real estate asset in the portfolio. Accordingly, our findings indicate there are various options available to the investor to allocate REITs in specific property sector.

Table 6 Vector Error Correction Model Results for General and Specific Property Sector REITs

General (k=2)			
Long-run relations	**REIT= 5.5094 + 1.6529 DRE**		
(Standard Error)	(0.6189) (0.1699)		
	DRE	**REIT**	**STOCK**
P-value in weak exogeneity test	0.0000	0.1201	0.6439
Speed of adjustment parameter	0.0081 (0.0012)		P-value in the exclusion test for STOCK 0.464
Retail (k=2)			
Long-run relations	***Rtl*_REIT= 5.3380 + 1.6861*Rtl*_DRE**		
(Standard Error)	(0.6943) (0 .1943)		
	***Rtl*_DRE**	***Rtl*_REIT**	**STOCK**
P-value in weak exogeneity test	0.000	0.0978	0.4935
Speed of adjustment parameter	0.0067 (0.0011)		P-value in the exclusion test for STOCK 0.111
Office (k=2)			
Long-run relations	**Ofc_REIT= 5.9936 + 1.8087 Ofc_DRE**		
(Standard Error)	(0.6475) (0.1774)		
	***Ofc*_DRE**	***Ofc*_REIT**	**STOCK**
P-value in weak exogeneity test	0.000	0.2791	0.3544
Speed of adjustment parameter	0.0089 (0.0013)		P-value in the exclusion test for STOCK 0.551
Hotel (k=2)			
Long-run relations	***Htl*_REIT = 6.7516 + 1.8920 *Htl*_DRE**		
(Standard Error)	(1.0601) (0.3100)		
	***Htl*_DRE**	***Htl*_REIT**	**STOCK**
P-value in weak exogeneity test	0.000	0.0214	0.1332
Speed of adjustment parameter	0.0039 (0.0008)	-0.0554 (0.0242)	P-value in the exclusion test for STOCK 0.744
Residential (k=2)			
Long-run relations	***Res*_REIT= 0 .0228*t* + 6.3518 *Res*_DRE**		
(Standard Error)	(0**.0022**) (0**.6048**)		
	***Res*_DRE**	***Res*_REIT**	**STOCK**
P-value in weak exogeneity test	0.000	0.5512	0.3797
Speed of adjustment parameter	0.0078 (0.0012)		P-value in the exclusion test for STOCK 0.861

Notes: This table shows the estimation of long-run cointegration equation in the Vector Error Correction Model as in equation (2). The k indicates the lag length incorporated to estimate the VECM as in equation (2). We also include the p-values for the weak exogeneity test and exclusion test, as determined by chi-square test statistic. The number in parentheses indicates the standard error.

Granger Causality Test

In this section, we investigate the causal relationship between one asset and another using Granger Causality Test. Consistent with Yunus et al. (2012) and Hoesli et al. (2015), our test on short-run causal relationship between the assets is based on the Vector Error Correction Model (VECM):

$$\Delta y_t = \mu + \Gamma_i y_{t-i} + \Gamma_i y_{t-p} + \alpha ECT_{t-1} + \varepsilon_t \quad (8)$$

Where Δy_t =($\Delta j\_\mathrm{REIT}_t, \Delta j\_\mathrm{DRE}_t, \Delta S\mathrm{TOCK}_t$) .According to (Granger, 1988) there are two sources of causation. The first source is through the lagged values of independent variables, as measured by the non-zero coefficients of Γ_i. Or alternatively through the coefficients of speed of adjustment parameter, α. The latter source of causality is associated with error correction mechanism, whereby the dependent variables adjust to deviations from the long-run cointegrating relation in the period of $t-1$. To illustrate, suppose that we set general direct real estate, $\Delta\mathrm{DRE}_t$ as dependent variable and equation can be rewritten as

$$\Delta\mathrm{DRE}_t = \mu + \sum_{t=1}^{p} \Gamma_i \Delta\mathrm{REIT}_{t-i} + \sum_{t=1}^{p} \Gamma_i \Delta\mathrm{DRE}_{t-i} + \sum_{t=1}^{p} \Gamma_i \Delta\mathrm{STOCK}_{t-i} + \alpha\, ECT_{t-1} + \varepsilon_t \quad (9)$$

Where $ECT_{t-1} = \mathrm{DRE}_{t-1} - \mathrm{DRE}^*_{t-1}$. In general, we can say that REITs granger cause the direct real estate when

- The coefficients of on the lagged $\Delta\mathrm{REIT}_{t-i}$ are jointly significant as measured by the F-Statistic, or
- The coefficients of α which belongs to $\Delta\mathrm{DRE}_t$ is significant as calculated by the t-statistic (Yunus et al., 2012).

We conduct the test for the J-REITs in overall and specific property sectors either with stock market or the respective direct real estate indices. We present the findings on Granger causality test on the table 7.

We can distinguish the differences in the causality both in general and specific property sector. In general, REITs granger cause both stock and direct real estate market. Stock can only granger cause the direct real estate, except for the Hotel sector where the direct market can also granger cause the stock market. Meanwhile, the Office, Hotel and Residential sector, their REITs can Granger cause their respective direct real estate, and no feedback from the latter market. In retail sector, however, there is a feedback effect between their REITs and the stocks. The differences in the causality relationship occur as the J-REITs be specialised in their underlying direct real estate assets. We could say that each of property sector in Japan is not growing in the same phase. This argument is in accordance with the causality in the specific sector REITs found in (Yavas & Yildirim, 2011) study, since it subjects to the maturity of the sector and their nature of business. For instance, we can see clearly that, Office sector has similar causality picture with causality formed in the general property sector. This is unsurprising since the inception of J-REITs are being pioneered by the Office sector.

Our result on the causality pattern in between J-REITs, direct real estate and stocks are peculiar for at least to Japan market. In particular, stocks manage to Granger cause the direct real estate market, not the J-REITs market. Likewise, this could be possible indication that stocks market is less informationally efficient than the listed J-REITs, though they are traded on the same platform. Nevertheless, our findings support the evidence of leading role of J-REITs over to stock market occurred in Japan market in year 2007[29]. More importantly, we could say that REITs, are more informationally efficient than their direct real estate market; to reflect and absorb changes in the real estate fundamentals. Hence, REITs be the leader in price discovery mechanism for the general and accordingly to their specific property sector. The findings are not uncommon with the liquid nature of REITs which are more frequently traded than the direct real estate market. We contend our findings are novel to the recent study by (Shimizu et al., 2015) since they highlight the usefulness of J-REITs market information only to the office sector. Our findings support the recent findings Pavlov et al. (2018) where REITs are helping to improve the pricing efficiency of direct real estate market. In fact, our findings are on causality in all property sector indicate the information from REITs are necessary to the pricing of direct real estate properties.

[29] In year 2007, it is found that REIT index peaked out two months before a separate high in Nikkei 225 share. See https://www.japantimes.co.jp/news/2006/04/21/business/reit-market-following-resurgence-in-land-prices/#.WuwtzuSWyUk

Table 7 Granger Causality Test

General		Independent Variables		
Dependent Variables	ΔREIT	ΔDRE	ΔSTOCK	Adjustment speed, α
ΔREIT	-	0.9560	0.7157	0.0976
ΔDRE	0.0000***	-	0.0000	0.0000
ΔSTOCK	0.0022***	0.5260	-	0.6985
Retail		Independent Variables		
Dependent Variables	ΔRtl_REIT	ΔRtl_DRE	ΔSTOCK	Adjustment speed, α
ΔRtl_REIT	-	0.8093	0.0472**	0.0978
ΔRtl_DRE	0.0000 ***	-	0.0000***	0.000***
ΔSTOCK	0.0004***	0.3249	-	0.4935
Office		Independent Variables		
Dependent Variables	ΔOfc_REIT	ΔOfc_DRE	ΔSTOCK	Adjustment speed, α
ΔOfc_REIT	-	0.4337	0.5226	0.2654
ΔOfc_DRE	0.0000***	-	0.0000***	0.000***
ΔSTOCK	0.0317***	0.5351	-	0.4014
Hotel		Independent Variables		
Dependent Variables	ΔHtl_REIT	ΔHtl_DRE	ΔSTK	Adjustment speed, α
ΔHtl_REIT	-	0.6367	0.1424	0.0214
ΔHtl_DRE	0.0000***	-	0.0000***	0.0000***
ΔSTOCK	0.0005***	0.0087***	-	0.1332
Residential		Independent Variables		
Dependent Variables	ΔRes _REIT	ΔRes_DRE	ΔSTOCK	Adjustment speed, α
ΔRes _REIT	-	0.2983	0.1536	0.5512
ΔRes_DRE	0.0000***	-	0.0058***	0.0000***
ΔSTOCK	0.0092***	0.0628	-	0.3797

Notes: The table reports the p-values for the Granger causality test. The null hypothesis is no Granger causality between one series with another. First, is the p-values associated with lagged values of independent variables, measured by F-statistic. Second is the p-values associated with speed of adjustment parameter, α, determined by t-statistic. *** and ** denotes significance at 1% and 5% level.

Variance Decomposition

The variance decomposition discloses the proportions of forecast error variance in each index owing to shock in the other asset and within the individual asset. We estimate the forecast error variance for REITs, direct real estate and stocks in each property sector approximately for 4 years or 48 months period.

Based on the table 8, we can see that shocks within the REITs are capable to explain its own forecast error variance. Shocks from REITs drive the forecast error variance for direct real estate market. To be specific, shocks from REITs explain 85.85% of forecast error variance for direct real estate market. The shocks to Residential REITs capable to explain at most 97.39% of the variance for its underlying direct real estate market. Shocks to Office REITs drive the forecast error variance for its own direct market for about 97%. Meanwhile, shocks to Retail and Hotel REITs manage to explain the forecast error variance for their respective underlying real estate market about 80% and 65% respectively. Shocks to direct real estate are not contributing a lot towards the forecast error variance of REITs, particularly in the specific property sectors. For instance, the highest composition of shocks by direct real estate occur in Hotel sector, where the direct retail market explains at most 20% of forecast error variance for retail REITs. Shocks to stock market give negligible impact over the real estate market, particularly in Retail, Office, Hotel and Residential property sector, since stocks explains each of respective REITs and direct market not more than 0.70%. However, shocks to REITs also give a large portion in the forecast error variance of stocks, especially in Office, Retail and Residential REITs, which are 44%, 52% and 58% respectively. Besides, shocks to REITs and Hotel REITs manages to explain the forecast error variance of stocks for about 43% and 36% respectively.

To sum, the findings of variance decomposition are consistent with the short-run causality test; where REITs Granger cause direct real estate. The findings on stocks are not contradict with the short-run causality between REITs and stock market in the Japan market. Therefore, the variance decomposition test indicates REITs to be tightly linked to direct real estate, not with the stock market. Overall, this is in line with the evidence of cointegrating relationship between REITs and direct real estate in the long-run.

Table 8 Variance Decomposition

General		Shock to	
Variance Decomposition of	REIT	DRE	STOCK
REIT	93.86	6.11	0.03
DRE	85.85	14.08	0.07
STOCK	43.02	1.38	55.60
Retail		Shock to	
Variance Decomposition of	*Rtl*_REIT	*Rtl*_DRE	STOCK
*Rtl*_REIT	91.26	8.27	0.47
*Rtl*_DRE	80.31	19.03	0.66
STOCK	52.41	2.16	45.43
Office		Shock to	
Variance Decomposition of	*Ofc*_REIT	*Ofc*_DRE	STOCK
*Ofc*_REIT	96.66	3.33	0.01
*Ofc*_DRE	90.65	9.26	0.05
STOCK	43.66	0.08	56.26
Hotel		Shock to	
Variance Decomposition of	*Htl*_REIT	*Htl*_DRE	STOCK
*Htl*_REIT	80.05	19.93	0.02
*Htl*_DRE	64.48	35.46	0.06
STOCK	36.25	0.54	63.21
Residential		Shock to	
Variance Decomposition of	*Res*_REIT	*Res*_DRE	STOCK
*Res*_REIT	98.84	0.47	0.69
*Res*_DRE	97.39	2.06	0.55
STOCK	58.15	0.76	41.09

Notes: This table reports forecast error variance decomposition. Each row presents the variance decomposition of a series due to contribution of each source of shock, (in column). The variance decomposition is reported in (%) terms.

Impulse Response Function

The impulse response function accentuates the magnitude of a series to one standard deviation of shocks derived from other market. This can be represented with a diagram where the horizontal axis be the period from the shocks while vertical axis measures the speed of a series to shocks occurring from other market. We derive the impulse response function for REITs, direct real estate and stocks both general and specific property sector in 48-month window. To illustrate, we represent the impulse response function in between REITs, direct real estate and stocks in general and specific property sector. In Residential property sector, its REITs and quickly reacts to shocks from Residential direct real estate market before it dies out after several months. The shocks to REITs affecting direct real estate and stocks market. We can see clearly that direct real estate market in general and property sector respond sluggishly to shocks from REITs and continues for several years. Shocks from REITs affect stocks with higher level of magnitude yet continues for several years. Whereas, REITs respond quickly in correspond to shocks from direct real estate, before it plateaued out after several months. REITs in general and all property sectors do not react to shocks from stock market. These findings is not contradict with Glascock et al. (2017) where lagged asset market slowly respond to shocks from the lead market. Besides, all direct real estate seems to give negligible response to the shock from the stocks, despite of causality flows from the stock market. Therefore, the findings on impulse response function is consistent with the variance decomposition where shocks to direct real estate do not affect REITs in a long period of time, since REITs actively adjust to shocks generating from their direct real estate counterparts. Meanwhile stocks market is vulnerable to shocks from the real estate market. More importantly, the findings do not negate the pairwise cointegration found between REITs and direct real estate market. All in all, we agree that these findings are in distinguish and reaffirm the substitutability of direct real estate to the REITs as the real estate assets.

Robustness Check

As a robustness check for the tight long-run relationship of REITs with direct real estate, we re-estimate the VECM as in equation (2) by replacing the stock market variable with listed property companies (LPCs).

We present the findings on the robustness check in table 9 and 10. Our empirical estimation indicates one cointegrating relation between REITs, direct real estate and LPCs in the long-run in the case of Japan. Similar with stocks, the LPCs then can be excluded from the long-run cointegrating relation. Therefore, we can say that LPCs do not negate the earlier findings on pairwise cointegration between REITs and direct real estate in the long-run. The findings also are not contradicting with our initial claim that investor shall choose REITs over direct asset as their portfolio choice for real estate asset investment. In terms of portfolio choice, we assert that our findings indirectly confirms the recent evidence by Glascock et al., (2017) that LPCs are not capable to be substitute to REITs. This is in accordance with our findings that REITs are bound to be tightly related to direct real estate in the long-run.

Table 9 Johansen Cointegration Test by Incorporating LPCs

Null	Trace TEST	Critical Values CV 5%	Maximum Eigenvalues	Critical Values 5 % CV
General				
r ≤ 0	58.6673	34.91	45.8578	22.00
r ≤1	12.8094**	19.96	10.1511**	15.67
Residential				
r ≤ 0	47.9999	42.44	35.4662	25.54
r ≤1	12.5337**	25.32	7.2014 **	18.96
Retail				
r ≤ 0	52.5325	34.91	40.7633	22.00
r ≤1	11.7692**	19.96	8.3437**	15.67
Offices				
r ≤ 0	55.9049	34.91	41.1929	22.00
r ≤1	14.7120**	19.96	11.0952**	15.67
Hotel				
r ≤ 0	36.7109	34.91	27.8183	22.00
r ≤1	8.8926**	19.96	7.7545**	15.67

Note: This table shows the Johansen test for cointegration between REITs, direct real estate and LPCs both in General and specific property sector. As indicated earlier, we apply two tests for cointegration that are Trace Test and Maximum Eigenvalues statistic. The null hypothesis is there is no more than r number of cointegrating relation. ** indicates the significance at 5% level.

Table 10 The Estimation of Vector Error Correction Model by Replacing Stocks with LPCs

General (k=2)			
Long-run relations (Standard Error)	**REIT= 5.6073 + 1.6777 DRE** (0.6453) (0.1772)		P-value in the exclusion test for LPC 0.210
P-Values in Weak exogeneity test	**REIT** 0.1303	**DRE** 0.000	**LPC** 0.7186
Retail (k=2)			
Long-run relations (Standard Error)	**Rtl_REIT = 5.5829 + 1.7482 Rtl_DRE** (0.7565) (0.2117)		P-value in the exclusion test for LPC 0.067
P-Values in Weak exogeneity test	**Rtl_REIT** 0.1130	**Rtl_DRE** 0.000	**LPC** 0.6311
Office (k=2)			
Long-run relations (Standard Error)	**Ofc_REIT = 6.1062 + 1.8382 Ofc_DRE** (0.6867) (0.1882)		P-value in the exclusion test for LPC 0.883
P-Values in Weak exogeneity test	**Ofc_REIT** 0.2883	**Ofc_DRE** 0.000	**LPC** 0.5445
Hotel (k=2)			
Long-run relations (Standard Error)	**Htl_REIT = 7.1626 + 2.0059 HOTEL_DRE** (1.1242) (0.3288)		P-value in the exclusion test for LPC 0.168
P-Values in Weak exogeneity test	**Htl_REIT** 0.0253	**Htl_DRE** 0.1782	**LPC** 0.4115
Residential (k=2)			
Long-run relations (Standard Error)	**Res_REIT = 0.0234 t + 6.5251 Res_DRE** (0.0023) (0.6191)		P-value in the exclusion test for LPC 0.652
P-Values in Weak exogeneity test	**Res_REIT** 0.4741	**Res_DRE** 0.000	LPC 0.2989

Notes: This table shows the estimation of long-run cointegrating equation in the Vector Error Correction Model as in equation (2) by replacing stocks with LPCs variable instead. The k indicates the lag length incorporated to estimate the VECM as in equation (2). We also include the p-values for the exclusion test, as determined by chi-square test statistic. The number in parentheses indicates the standard error.

Conclusion

REITs are liquid securities which hold lumpy real estate assets, like shopping complexes or apartments. Investors are puzzled on the hybrid nature of REITs, either they are tightly related to the stock market or underlying direct real estate asset in the long-run. The failure to resolve this puzzle may inhibit the portfolio choice process for the investors. To be specific, if REITs are tightly related to their underlying real estate, then REITs can be substitute to the direct real estate investment. Or else, REITs may not give similar diversification benefits like underlying real estate if REITs akin to be like stocks instead. Up to this stage, it looks like Japan real estate market is falling behind to discuss this issue, since focus has been made on US and UK market. Our particular interest is to empirically examine the substitutability between J-REITs and the underlying real estate asset both in general and specific property sector, retail, office, hotel and residential sectors.

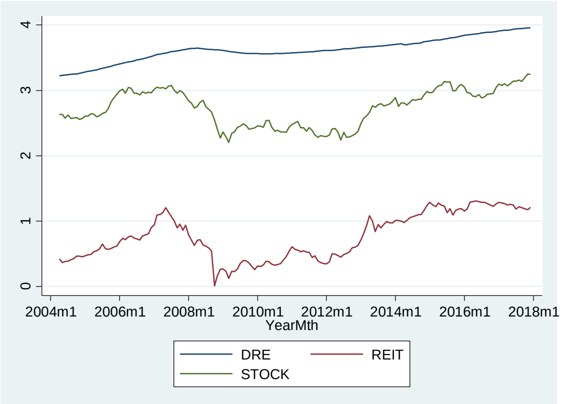
By means of vector error correction model, we show that there is one cointegrating relation between J-REITs, direct real estate and stocks in the long-run. We manage to exclude stock market series from the long-run relation. Thus, J-REITs are cointegrated with the underlying real estate in the long-run Overall, J-REITs are providing the commons in the long-run cointegrating relation. As a result, investor should select J-REITs over the direct real estate properties as the real estate assets.Our findings are robust since the inclusion of LPCs to replace the stocks market variable does not negate the pairwise cointegration between REITs and direct real estate. The Granger causality test indicate J-REITs in general, lead direct real estate and even the stocks market. Overall, our findings are consistent across the specific property sectors.

Since then, the cointegration indicate J-REITs are substitutable asset for direct real estate investment. Furthermore, we manage to empirically show that REITs are superior than direct real estate whilst maintaining their long-run relation and hence, should be selected as the real estate investment vehicle. Meanwhile, the causality test indicates REITs lead the direct real estate in the market information processes. So, J-REITs are found to be more informationally efficient than the direct real estate. As a result, direct real estate will use the information from J-REITs and accordingly will correct their price. All in all, investors are encouraged to choose REITs over direct real estate as their portfolio choice, ever since REITs allow investment in liquid real estate assets and lower transaction costs than the latter real estate asset. Besides, investors have the wide options among the property classes as well as the investment in real estate management companies, as represented by LPCs.

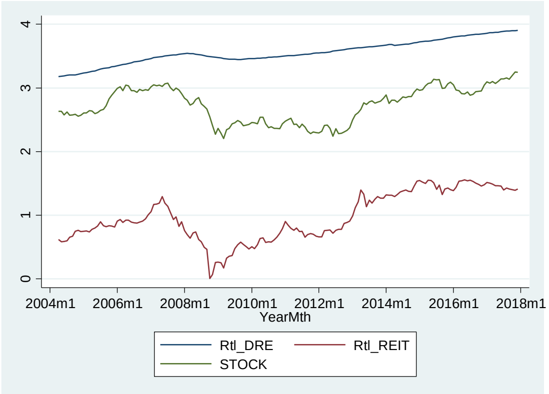
Appendix for Chapter 1

Appendix 1 Time Series Plot for All Indices

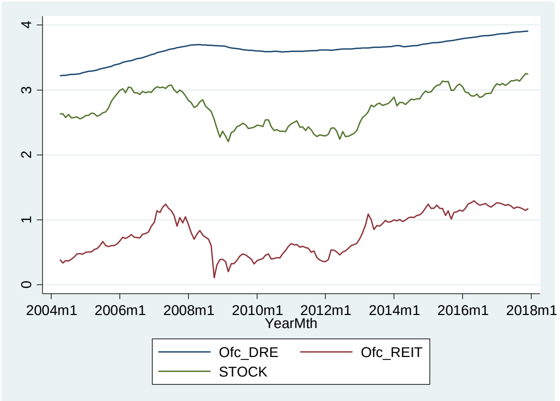
General



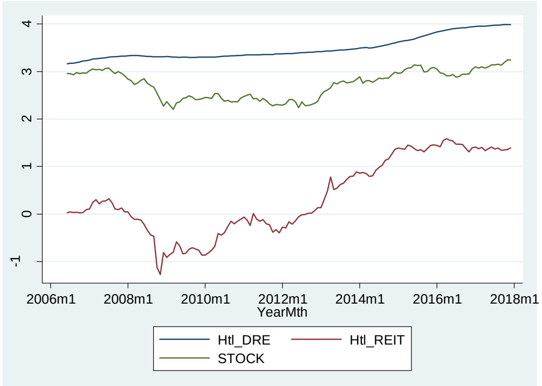
Retail



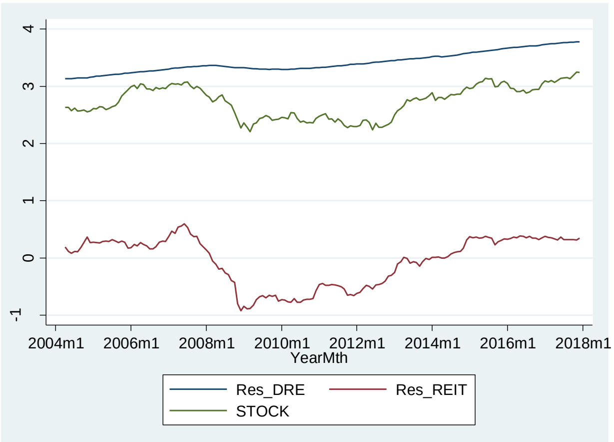
Office



Hotel

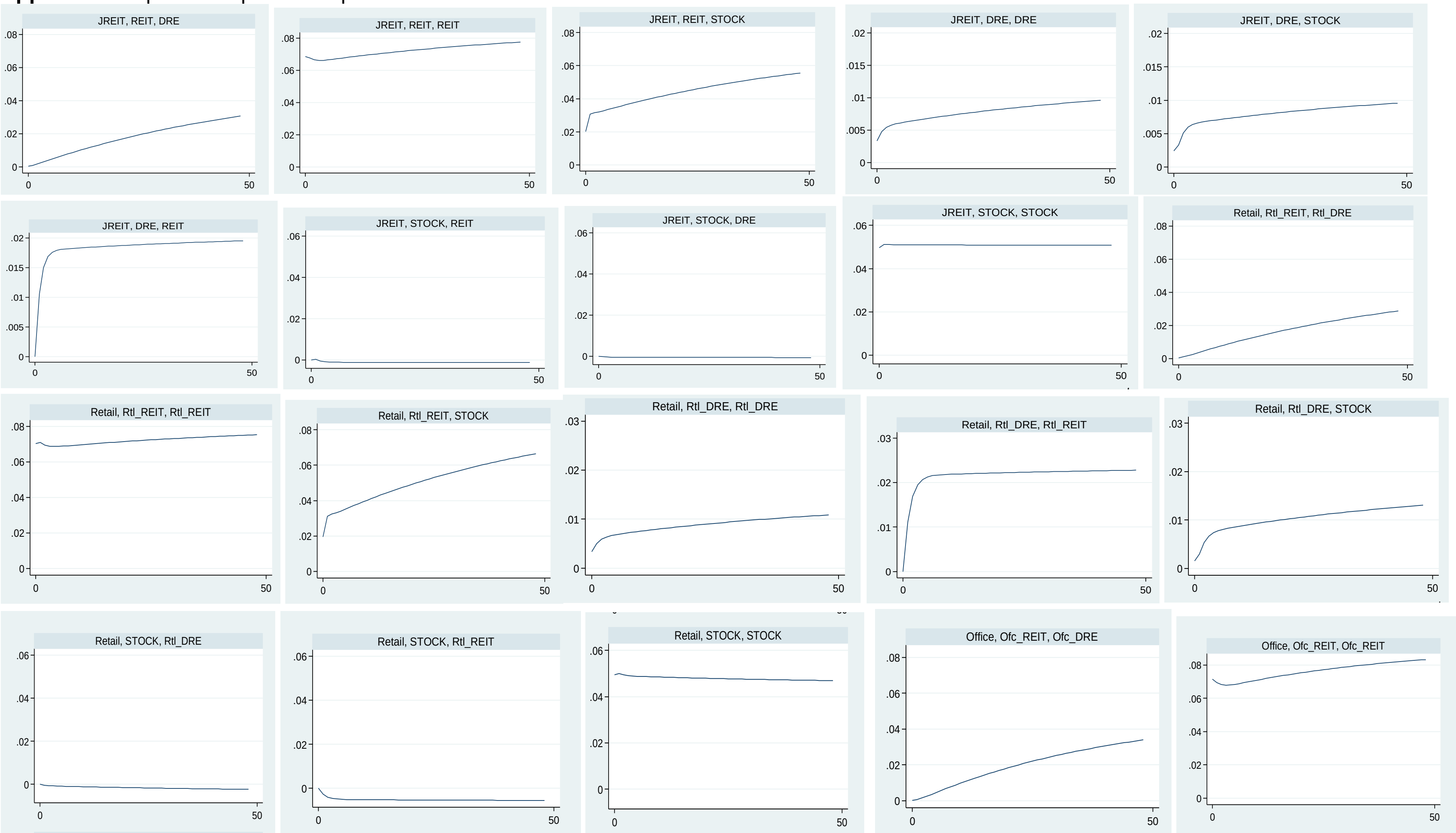


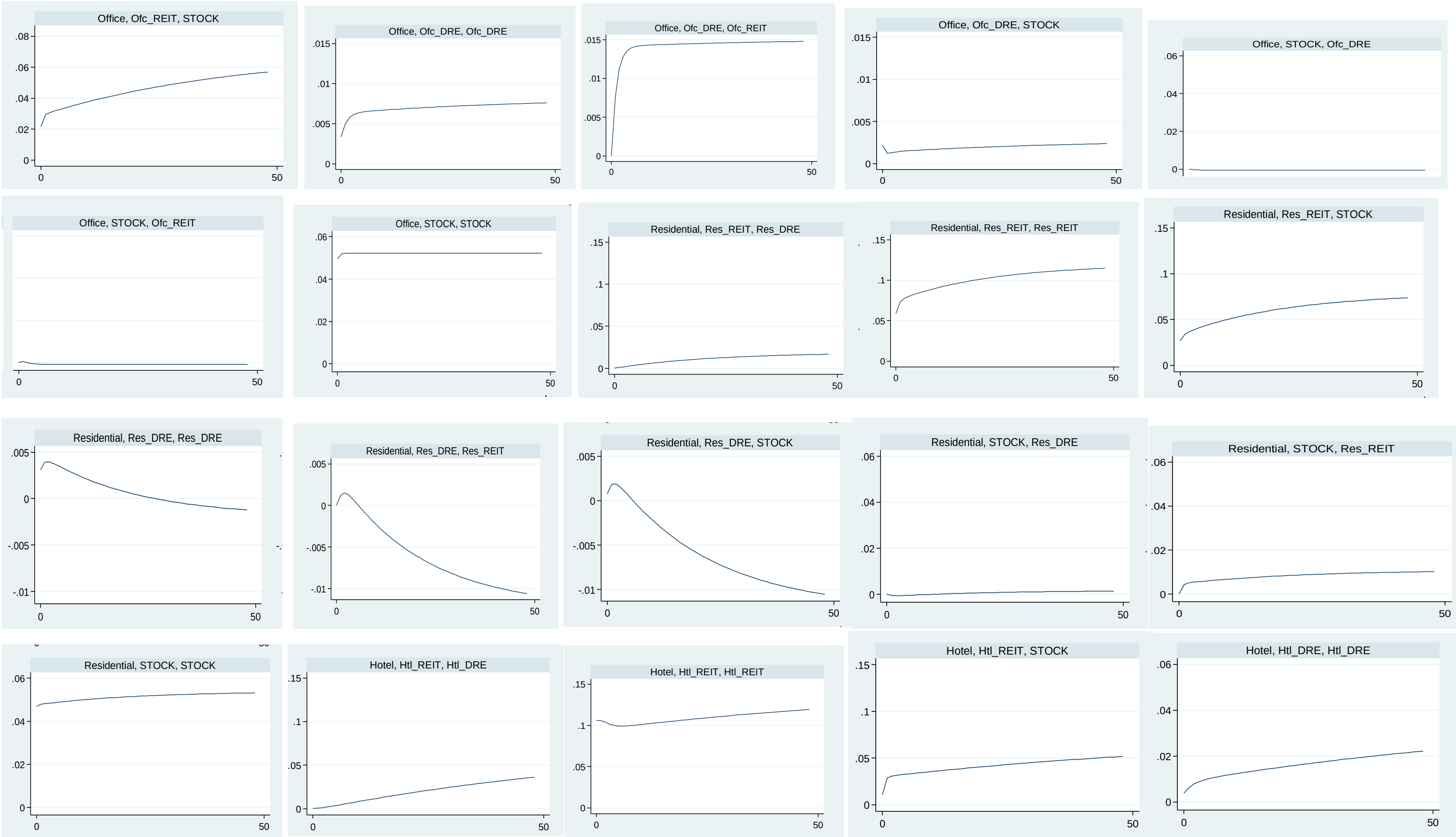
Residential



Note: The time-series plot for respective REITs, Direct real estate and Stocks indices are in red, blue and green respectively.

Appendix 2 Impulse Response Graph




Office, Ofc_REIT, STOCK
.08
.06
.04
.02
0
0
50
Office, Ofc_DRE, Ofc_DRE
.015
.01
.005
0
0
50
Office, Ofc_DRE, Ofc_REIT
.015
.01
.005
0
0
50
Office, Ofc_DRE, STOCK
.015
.01
.005
0
0
50
Office, STOCK, Ofc_DRE
.06
.04
.02
0
Office, STOCK, Ofc_REIT
0
50
Office, STOCK, STOCK
.06
.04
.02
0
0
50
Residential, Res_REIT, Res_DRE
.15
.1
.05
0
0
50
Residential, Res_REIT, Res_REIT
.15
.1
.05
0
0
50
Residential, Res_REIT, STOCK
.15
.1
.05
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50
Residential, Res_DRE, Res_DRE
.005
0
-.005
-.01
0
50
Residential, Res_DRE, Res_REIT
.005
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-.005
-.01
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Residential, Res_DRE, STOCK
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Residential, STOCK, Res_DRE
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Residential, STOCK, Res_REIT
.06
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.02
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0
50
Residential, STOCK, STOCK
.06
.04
.02
0
0
50
Hotel, Htl_REIT, Htl_DRE
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.1
.05
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Hotel, Htl_REIT, STOCK
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Hotel, Htl_DRE, Htl_DRE
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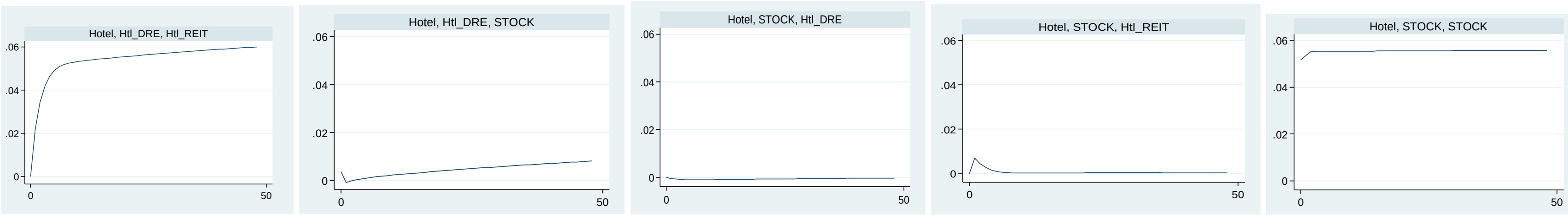
50



Notes: These figures represent the impulse response function. We derive possible impulse and response combination in between REITs, direct real estate and stock market. Each figure is labelled as Sector, Impulse variable and Response variable (separate by comma).

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