Dynamic modelling of real estate investment trusts and stock markets

Chien-Chiang Lee a,⁎, Mei-Se Chien b, Tsoyu Calvin Lin c

a Department of Finance, National Sun Yat-sen University, Kaohsiung, 804, Taiwan
b Department of Finance, National Kaohsiung University of Applied Sciences, Kaohsiung, Taiwan
c Department of Land Economics, National ChengChi University, Taipei, Taiwan

Abstract
Taiwan launched the first case of real estate securitization in 2005. The interrelationship between Taiwan Real Estate Investment Trusts (T-REITs) and the aggregate equity markets and segmented industries has drawn the interests of both investors and academia. This paper employs Toda and Yamamoto’s (1995) procedure and the generalized impulse response approach to uncover the extent and the magnitude of the relationship between T-REITs and aggregate and segmented stock prices. We collected daily data of the first two issued T-REITs, Fubon No.1 and Cathay No. 1, from March 2005 to March 2010 and October 2005 to March 2010, respectively, to examine their causal relationships with aggregate stock markets, the financial sector, and the construction sector. The empirical results indicate that all variables have break points, reflecting shocks from the Subprime Mortgage Crisis or deregulation of the Qualified Domestic Institutional Investors (QDII) for Mainland Chinese to invest in Taiwan. We also discover that an individual T-REIT may lead or lag behind stock price indices due to its capitalization scale or business type. The transitory initial impacts of innovations in T-REITs on stock price indices are observed herein.

1. Introduction

Research studies have broadly explored the price, risk, and return of real estate markets, and the influential factors and interrelationships with other investment vehicles (Sing et al., 2006). The first strand of related research focuses on the influence of macroeconomic factors, such as interest rates and inflation on real estate investment trusts (REITs, hereafter). Gyourko and Keim (1992) found that important information about property market fundamentals is impounded in REIT returns, especially when they are adjusted to control for general market factors. Liang and Webb (1995) further stressed that the market risk of mortgage REITs (MREITs) is mostly interest rate risk, which is not diversified away. Mei and Gao (1995) also concluded that REITs’ returns could be explained by a function of fundamental economic variables. Most of the research in this strand indicated that the returns of REITs are influenced by some macroeconomic factors, such as inflation, interest rates, and economic growth (Kim et al., 2007).

The second category of real estate literature engages in exploring the interrelationship between REITs. Nelling and Gyourko (1998) found that there is only weak evidence of predictability of REIT returns based purely on past performance. Subrahmanyam (2007) explored the existence of joint dynamics across the REIT and non-REIT sectors. Impulse response functions and Granger causality tests indicate the existence of persistent liquidity spillovers running from REITs to non-REITs. Moreover, Liow and Webb (2009) demonstrated that the magnitude to which correlations are shown in international securitized real estate markets might largely be through the increasing integrated nature of the world real economy, rather than a result of the globalization of financial markets.

The third group of related studies attempts to discover the interrelationship between real estate investment and other vehicles, particularly stock markets. He et al. (1996) examined the relationship between REITs’ returns and bank stock returns. They found that MREIT explains the risks and returns of bank stocks better than equity REITs. Lizieri and Satchell (1997) explored that the wider equity market and the real estate market in the short term, however, positive real estate returns may point to negative future returns in the rest of the economy in the long run. Ling et al. (2000) indicated that an out-of-sample prediction of excess returns on an equity REIT has a lower power than an in-sample prediction. Hoesli and Camilo (2007) showed in an international analysis that securitized real estate returns are positively associated with stock and real estate returns, but negatively related to bond returns. More related studies also have shown that REITs and the general stock market are integrated (Ambrose et al., 2007; Laopodis, 2009; Liu et al., 1990). Some studies investigate the impacts of movements or volatilities of stock prices on REITs (Ambrose and Bian, 2010; Cotter and Stevenson, 2004, 2006; Devaney, 2001; Stevenson, 2002), but their conclusion regarding the direction of a causal relationship between real estate markets and stock markets tends to be weak.
In Taiwan the “Real Estate Securitization Statute” was promulgated in 2003. As Lee and Stevenson (2005) noted, REITs to some extent provide a hybrid investment form, standing between equities and the fixed-income sector. In addition, the asset maintains strong links with the direct real estate market. These inter-linkages provide such assets with unique characteristics. Real estate in Taiwan is extremely important for people’s belief in the traditional notion of ‘land is wealth.’

With the introduction of this new mechanism, real estate can be transacted in the form of securities, which in turn increases its liquidity. Industries related to real estate in Taiwan have been eager to apply the securitization process for raising funds to liquidate real estate investments. These REITs provide a new alternative for investment in the property market, which is traditionally considered as a secured, scarce, and precious but low-liquid vehicle for most Taiwanese investors. In the Taiwan context, people believe real estate is the most valuable asset, providing an interesting case for the empirical model of REITs.

Prior to the initial public offering (IPO), Taiwan REITs (T-REITs, hereafter) are required to go through an appraisal board meeting held by the government to evaluate the net asset value (NAV) for investor protection. The appraisal meeting helps investors screen the fundamental value of the object’s assets and also limits REITs’ appreciation potential. This special characteristic draws our interest to examine the causal relationship of T-REITs with the equity markets, including the overall stock markets, the financial sector stocks, and the construction sector stocks. The reason to examine the relationship of T-REITs with both the financial and construction sectors is that we want to discover what securitized real estate is like, or which of the following is related: financial vehicles, traditional construction, or direct real property investments.

This paper applies the Granger causality test of Toda and Yamamoto (1995; hereafter TY) to draw conclusions with regard to the causal relationships between T-REITs and weighted stock prices. The TY (1995) method is a modified Wald (MWALD) test in the VAR framework. The concept of causality is basically related to the topic of market integration/segmentation. The hypothesis for determining which direction the causal relationship flows is most likely from stocks to real estate, given the concept that the real estate market is not liquid and may be inactive in prices when compared to the stock market. These movements of asset prices may reflect the behaviors of arbitrageurs and investment managers balancing their portfolios. This information may also benefit investors who consider different prices as a part of their overall investment portfolios. Daily data of the first two issued T-REITs, Fubon No.1 and Cathay No.1, cover the periods March 2005-March 2010 and October 2005-March 2010, respectively, and we examine their causal relationships with the aggregate stock markets, and the financial sector and construction sector in Taiwan. The benefit from using the Granger causality test of TY (1995) is that it does not require knowledge as to the cointegration properties of the system and can be applied in the absence of cointegration (Lee and Chien, 2011).

The above method can also be used when stability and rank requirements are not satisfied. The model estimation procedures are indeed quite simple, particularly in cases where there are more than two cointegrating vectors and when the OLS is valid. This paper also examines the transmission mechanism between these variables by applying the generalized impulse response approach (GIRF) of Pesaran and Shin (1998). The impulse response analysis can trace a variable’s directional responses to a one standard deviation shock in another variable. This achieves both direct and indirect effects of innovations on a variable of interest, thus enabling us to comprehensively estimate the dynamic linkages between T-REITs and the Taiwan Weighted Stock Index.

The remaining part of this paper is organized as follows. Section 2 introduces the development of real estate securitization in Taiwan. Section 3 briefly describes the econometric methodology. Section 4 presents the empirical results. Section 5 offers the conclusion.

2. Real estate securitization in Taiwan

Up until 2009, a few countries in the Asia-Pacific region have implemented a real estate securitization mechanism, including Australia, Malaysia, Japan, Singapore, South Korea, Taiwan, Hong Kong, Philippines and India, while the U.K. and Germany in Europe are on their way towards following the mainstream. The REITs provide these countries with a new alternative for direct investment in the property market, which is traditionally considered as a secured, scarce, and precious, but low-liquid vehicle for most Asian investors.

In Taiwan the “Real Estate Securitization Statute” was promulgated in 2005. There are two types of vehicles for real estate securitization in Taiwan: real estate investment trust (T-REIT) and real estate asset trust (T-REAT). T-REITs are similar to REITs in other countries and involve raising funds first and then acquiring real estate targets. Like stocks, T-REITs have no specific investment period, while the structuring of T-REATs is similar to that of asset securitization. T-REATs are established to first hold defined real estate with rental or operating income for specific periods and then to raise funds in exchange for the particular properties. Capital gains are distributed to investors after the sale of the target properties for T-REATs. Both T-REITs and T-REATs are only allowed to operate as closed-end funds, and at least 75% of the funds must invest in existing properties or related rights that generate steady income as follows: asset-backed securities (ABS), bank deposits and acceptance, short-term commercial papers, and treasury bonds. Real estate development activities, although under discussion, are still prohibited for both portfolios of T-REITs and T-REATs.

Unlike the U.S. and Japan, Taiwan only allows the operation of an investment trust (special-purpose trust) instead of an investment corporation (special-purpose corporation). The minimum capital requirement for establishing a T-REIT is NT$1 billion and for a T-REAT is NT$300 million. (US$1 = NT$30 in 2010 on average). For both T-REITs and T-REATs, any five certificate holders cannot own more than 50% of the total value of the issued certificates. The T-REIT is allowed to leverage financially for the purpose of operation or dividend payout, but the maximum percentage has not been regulated. The income of T-REITs is only required to be distributed within six months after every fiscal year, but the ratio is not specifically regulated.

After the enactment of the “Real Estate Securitization Statute” in 2003, Taiwan introduced the first case of REIT to the public market in early 2005. Up through 2010, the accumulated market capitalization of T-REITs has reached US$1.8 billion, indicating the popular trend of real estate securitization for both investors and issuers in Taiwan. As stated above, T-REITs are required to go through an appraisal board meeting prior to IPO for evaluating the NAV for investor protection. The appraisal meeting helps investors screen the objective assets with the objective assets’ fundamental value and also limits REITs’ appreciation potential. Therefore, the price fluctuation of T-REITs is smaller than those in the U.S. or in Japan. The low-risk and low-return characteristics of T-REITs also provide investors a secured vehicle in Taiwan, together with the tax-free incentive for the dividends of T-REIT investors. The incentives above have resulted in over 60% of investors being individuals, according to Fubon No.1, the first T-REIT introduced to the markets.

The trend of real estate securitization indicates that REITs have successfully drawn investors’ interests in this region, where real estate is

---

1 According to the census of Taiwan’s Ministry of Interior in 2006, the average home ownership rate is over 87% and the average housing unit vacancy rate is 17.6%. These figures are far above the average of other countries (Lee and Chien, 2011; Chen et al., 2011).

2 There are some papers discussing the volatility of REITs and stock prices. Most of these papers aim to utilize the GARCH model to analyze the volatility dynamics of REITs, including Devaney (2001), Stevenson (2002), and Cotter and Stevenson (2004, 2006). A few of them utilize data on REITs to examine the role of stock market volatility on earnings management (Ambrose and Bian, 2010). However, the aim of this paper is to examine the characteristics of T-REITs that lead or lag the stock price index. We focus on the price relationships of these two markets, not the volatility linkages, and the volatility in daily stock market index data is not discussed herein.
traditionally considered as an asset that appreciates in the long run. Despite the popularity of the REIT mechanism in Asia, some unique characteristics of Asian REITs are worth noting. First, most REITs in Asia do not allow funds to invest in properties abroad. This restriction may lead these REITs to become less regional diversified and eventually encounter significant concentration risk and currency risk as the domestic macro economy declines. Second, the economic scale of the Asian REITs, which are relatively smaller than those in the U.S., might face liquidity limitations in the future, especially as real estate markets stagnate or the rental or operating income streams shrink. Third, most of these countries have no regulations upon the minimum lease term of the properties for REIT investment. The uncertainty over continuity in rent periods for the properties. Relative to the experience in the U.S. and Australia, these features may lead to limited liquidity and marketability of REITs. International investors or researchers will need to take into account the basic differences of REITs among various countries for assessing potential risks.

3. Methodology

In line with Toda and Yamamoto (1995), we consider the n-vector time series \( Z_t \) generated by the \( k \)-th order VAR model:

\[
Z_t = \phi_0 + \phi_1 t + \phi_2 t^2 + \phi_3 t^3 + \Pi_1 Z_{t-1} + \ldots + \Pi_k Z_{t-k} + E_t, \quad t = 1, \ldots, T, \quad (1)
\]

where \( E_t \sim N(0, \Omega) \), \( Z_t = (\text{REIT}_t, \text{SP}_t, \ldots) \), where REIT, and SP, represent T-REIT and stock price, respectively; and \( t \) represents a deterministic time trend. Economic hypotheses can be expressed as restrictions on the coefficients in the model in accordance with the following:

\[
H_0: F(\pi) = 0,
\]

where \( \pi = \text{vec}(P) \) is a vector of the parameters in Eq. (1); \( P = (\Pi_1, \ldots, \Pi_k) \); and \( F(\cdot) \) is a twice continuously differentiable \( m \)-vector valued function.

TY (1995) set up a simple procedure to facilitate testing for Granger non-causality in level VARs, which is estimated by the OLS with integrated variables. The test essentially involves two stages. First, the augmented \((k + d)\) VARs are estimated, where \( d \) is the maximal order of integration. Second, we apply the Wald test to the first \( k \) VAR coefficient matrix to test for Granger causality. For testing the null hypothesis, TY (1995) confirmed that the Wald statistic converges in distribution to a \( \chi^2 \) random variable with \( m \) degrees of freedom regardless of whether the process \( Z_t \) is stationary, possibly around a linear trend, or whether it is cointegrated. This methodology minimizes the risks perhaps associated with misidentifying the orders of integration of the series, or the presence of cointegration, while additionally it minimizes the possibility of distorting the test size that frequently results from pretesting.

This paper applies the advanced generalized impulse response techniques of Pesaran and Shin (1998) to examine the relationships between T-REITs and the aggregate equity markets and segmented industries. The results are expected to draw interests from investors and academia. We consider the two-dimensional VAR model as follows:

\[
Z_t = A \sum_{i=1}^{p} \psi_i Z_{t-1} + e_t, \quad (2)
\]

where \( Z_t \) is a \((2 \times 1)\) vector of jointly determined endogenous variables; \( \psi_i \) through \( \psi_p \) are \((2 \times 2)\) coefficient matrices; \( A \) is a vector of constants; and \( e_t \) is a \((2 \times 1)\) vector of well-behaved disturbances with covariance \( \Sigma = \psi_0 (I_2, I_2) \). The generalized impulse response of \( Z_{t+n} \) with respect to a unit shock to the \( j \)-th variable at time \( t \) is represented by \( (G_t \Sigma_t)^{-1} \), where \( G_t = \psi_t G_{t-1} + \psi_t G_{t-2} + \ldots + \psi G_{t-p} \), \( n = 1, 2, \ldots \), \( G_0 = I \), \( G_0 = 0 \) for \( n < 0 \), and \( \psi_j \) is a \((2 \times 1)\) selection vector with unity as its \( j \)-th element and zero elsewhere.

Our methodology has two advantages over the standard impulse response analysis (Chen et al., forthcoming). First, it does not presuppose any ordering that has theoretical implications. Second, the methodology provides a meaningful interpretation of the initial impact of shocks - a feature that is missing in the traditional methodology, but might be important in the analysis of Taiwan Real Estate Investment Trusts where information is transmitted quickly.

4. Empirical investigations

We use two different stock prices of T-REITs’ data, including Fubon No.1 and Cathay No.1 for empirical analysis. Properties in the portfolios of these two T-REITs are all located in Taipei City, and both T-REITs are ranked over twA. Fubon No. 1, market capitalization of US $0.25 billion, includes three office buildings and one commercial building that are 10 years old or newer. Cathay No. 1, market capitalization of US $0.43 billion, has two office buildings and one hotel, all of which are over 40 years old. The sample period for Fubon No.1 is from March 10, 2005 to March 15, 2010. The sample data of Cathay No.1 covers the period from October 3, 2005 to March 15, 2010. Other data are daily prices for three different weighted indices: the Taiwan Weighted Stock Index (SPT), the Weighted Price Index of the Financial Sector (SPF), and the Weighted Price Index of the Construction Sector (SPC). All the data are collected from the Taiwan Economic Journal (TEJ) database. All of the variables used are in natural logarithms.

Figs. 1–5 present the price movements of Fubon No.1, Cathay No. 1, and the SPT, SPF, and SPC series, respectively. The figures show that these prices are non-stationary and exhibit similar patterns. In Fig. 1 the price of Fubon No.1 shows more variation since March 2007 and seems to be breaking around April 2007 and June 2008. As to Cathay No. 1, its price also presents more variations after July 2007 and is breaking around April 2009.

4.1. Case 1 — REIT of Fubon No.1

For a comparison, we apply the unit-root tests, including the ADF (Dickey and Fuller, 1979), the PP (Phillips and Perron, 1988), the KPSS (Kwiatkowski et al., 1992), the DF-GLS (Elliott et al., 1996), and the NP (Ng and Perron, 2001), from March 10, 2005 to March 15, 2010 to detect stationarity of these variables. Table 1 presents the results of the classic unit-root tests. We follow the determining rule of Doldado et al. (1990) to establish the appropriate model for the unit-root tests. Aside from this, we adopt the newly-developed Modified Akaike’s Information Criterion (MAIC) suggested by Ng and Perron (2001) to select the optimal number of lags based on the principle of parsimony. The results in Table 1 clearly indicate that all series are integrated of order one \((I(1))\) at the 5% level of significance for all unit-root tests without structural breaks.

All of the above unit-root tests are not appropriate for testing the stationarity of a series that encounters a structural change. Thus, we further take the structural break into account when employing the unit-root test. Ever since the renowned paper offered by Perron (1989), previous literature has been aware of the importance of allowing for a structural break when testing for a unit root. Interestingly, subsequent
studies changed the test to allow for one unknown break point that is determined endogenously from the data. Without allowing for structural breaks, traditional ADF type tests could cause a wrong decision when the null hypothesis is not rejected. To improve the default of ADF type tests without allowing for possible breaks in the series, Perron (1989) proposed allowing for one known, or “exogenous,” structural break in the ADF unit-root test. Following Perron (1989), Zivot and Andrews (1992) offered to determine the break point “endogenously” from the data.

A structural break essentially corresponds to an intermittent shock with a permanent effect on the series (Hendry, 1996). The opposite can also happen if the break occurs at the beginning of the sample (Leybourne et al., 1998). In order to take this possible regime shift in the unit-root tests into account, Zivot and Andrews (1992, hereafter ZA) developed a new category of tests that allow for a structural break.

A potential problem common to the ADF-type endogenous break unit-root tests is that they derive their critical values assuming no break(s) under the null. This assumption leads to size distortions in the presence of a unit root with a break as Nunes et al. (1997) showed. As Lee and Strazicich (2004) suggested, if we lose the power from ignoring one break, then it may let us extend that the query has a similar loss of power from ignoring two or more breaks in the one-break test (Smyth and Inder, 2004). To avoid problems of bias and spurious rejections, Lee and Strazicich (2003) derived the endogenous two-break LM unit-root test.

Lee and Strazicich (2003) held that the two-break LM unit-root test statistic can be estimated by regression according to the LM (score) principle as follows:

\[ \Delta y_t = \eta' \Delta R_t + \varphi \tilde{S}_{t-1} + u_t, \]  

where \( \tilde{S}_t \) is a de-trended series, \( \tilde{S}_t = y_t - \bar{y} \), \( i \), \( t = 2, \ldots, T \); \( \bar{y} \) is a vector of coefficients in the regression of \( \Delta y_t \) on \( \Delta R_t \); \( \eta' \) is given by \( \eta_1 - \bar{R}_1 \); and \( y_1 \) and \( R_1 \) denote the first observations of \( y_t \) and \( R_t \), respectively. Corrections for autocorrelated errors are accomplished.

---

**Fig. 1.** Price movement of the REIT of Fubon No. 1 (March 10, 2005–March 15, 2010).

**Fig. 2.** Price movement of the REIT of Cathay No. 1 (October 8, 2005–March 15, 2010).
via augmented terms $\Delta S_{t-j}, j=1,\ldots,k$, in Eq. (3), as with the ADF test. For Model C, where $B_j = \Delta D_j$ and $BT_j = \Delta DT_j^\prime$ ($j=1,2$), the unit-root null hypothesis is described by $\varphi = 0$ (implying a unit root with two breaks), and the LM test statistics are given by:

$$\hat{\tau} = t_{\text{statistic for the null hypothesis } \varphi = 0}.$$

From this, the LM unit-root test can endogenously determine the two breaks by utilizing a grid search as follows:

$$LM = \inf_\lambda \hat{\tau}(\lambda).$$

There is a repeated procedure at each combination of break points, $\lambda_j = T_j/T, j=1,2$. As shown in Lee and Strazicich (2003), the critical values for Models A and C depend on the location of the breaks ($\lambda$). Therefore, we utilize critical values that correspond to the location of the breaks.

We list the null and alternative hypotheses of Model C as:

$$\begin{align*}
\text{Null : } & y_t = \mu_0 + d_i B_{1t} + y_{t-1} + v_{1t} \\
\text{Alternative : } & y_t = \mu_1 + \gamma t + d_i D_{1t} + \omega_i DT_{1t} + y_{t-1} + v_{2t}
\end{align*}$$

However, if the vector of exogenous variables shows $R = [1, t]'$, then the DGP is the same as that shown in the no break LM unit-root test of Schmidt and Phillips (1992).

Tables 2 and 3 respectively present the results of the ZA (1992) tests and Lee and Strazicich’s (2003) unit-root tests. Both these two tests show that all series carry a unit root in the level and reject the null of “non-stationarity” in the first difference. This insures the I(1) type series for all series considered. The results of the ZA test and Lee and Strazicich’s (2003) tests indicate that the estimated break
References


