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<th>Volatility and dynamics of public and private real estate market returns in Hong Kong</th>
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<tr>
<td>Author(s)</td>
<td>Chen, Suikang (陳歲康)</td>
</tr>
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Volatility and Dynamics of Public and Private Real Estate Market Returns in Hong Kong
Chen Suikang
City University of Hong Kong

Abstract
This paper attempts to study the volatility and dynamics of public traded equity REITs returns and private real estate market returns using Hong Kong data. Levered and unlevered REITs returns are constructed for public real estate market, while series of private market returns are also constructed as counterpart. The results suggest public real estate returns exhibit higher volatility than private market returns. At the same time, our VAR model using unlevered REITs return and private market return as endogenous variables suggests that returns of private real estate market cannot predict the REITs returns in the subsequent period, while REITs returns have very limited prediction power for the private market.

Keywords: REITs, Private Real Estate, VAR Model
Introduction

Direct real estate investment and public real estate investment trust (REITs) are two major channels for institution investors as well as individual investors to engage in real estate market. Holding private properties provides investors full ownership and rights of the target asset. Investors who purchase publicly traded real estate securities own a share of the portfolio of underlying real estate.

Since the first REIT introduced in the U.S. in the 1960s, REITs including equity and mortgage REITs have seen a rapid growth both in quantity and market capitalization. By the end of 2014, there were 216 REITs in U.S. with a total market capitalization of more than US$ 907 billion. The Asia stock market had not witnessed a REITs until the first one was listed in Japan in 2001. REITs in Asia experienced a rapid growth since then, especially in Japan, Singapore and Hong Kong. By the end of 2013, the aggregate market capitalization of REITs in Asia market approached US$ 140 billion.

In 2003, the enactment of the Hong Kong REIT Code triggered the emerge of REITs in Hong Kong. Since the first REIT (Link REIT) was launched in 2005, 11 REITs have been listed by far. Hong Kong has been well known for high sale price and high rent of real estate. Investing in Hong Kong real estate market is believed to profitable and risky. This paper focuses on the non-domestic real estate in Hong Kong and attempts to examine the returns and vitality of direct real estate and REITs as well as the dynamic relationship between them.

Literature review

The study of real estate has long been marginalized by the mainstream macroeconomics. Many efforts have been spent on the study of the relationship of real estate and the macroeconomics. Clearly, it is beyond the scope of this paper to review the literatures.

When studying asset returns, macroeconomic factors have to be taken into consideration. In terms of the interaction of real estate investment and macroeconomics variables, the influence of changes in monetary policy, interest rate and inflation rate on real estate returns are studied.

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1 Available at https://www.reit.com/data-research/data/us-reit-industry-equity-market-cap
2 Refer to Ken Atchison and Victor S. Yeung, 2014 “The Impact of REITs on Asian Economies”
intensively in the literature. McCue and Kling (1994) adopted an unrestricted vector autoregressive model to explore the link between macroeconomic factor and real estate returns. Employing equity REIT series, they reported that nearly 60% of the variation of real estate returns could be explained by macroeconomic factors, in which nominal interest rate contributed the most. Instead of using VAR model, Glascock et al. (2002) employs a vector error correction model to test the causal relationship between REITs returns and inflation. They found that REITs returns and inflation relationship is fundamentally drove by monetary policy. Leung (2009) introduces a regime-switching model to study the dynamics of asset return in responses to monetary policy and interest rate term structure. This paper documented that a regime-switching model out-performed a linear VAR model in learning the relationship of asset (REITs, housing and stock) returns and monetary policy and term structure.

Many studies have been devoted to the comparison of risk-return characteristics of direct real estate investment and equity REITs. Several recent studies confirm that returns of private and public properties appear to be significant different from the risk-return characteristics. For instance, Riddiough et al. (2005) documented that publicly held real estate investment outperformed private real estate investment by over three percentage points annually on average while returns on private real estate investment show higher volatility than their public counterpart. Using similar methodology, Ling and Naranjo (2015) also reported similar outcome which is returns on investment in REITs is higher than the returns of private real estate portfolio in aggregate level.

Apart from examining the risk-return characteristics of private and public real estate investment, a few different angles are presented in the literatures. The correlation of public and private real estate returns over various horizons is tested by Morawski et al. (2008) and Boudry et al. (2012) in which limited correlation in the short run is found while a long-run equilibrium is also documented. The information transmission mechanism is also researched by a number of studies. Li et al. (2009) and Yunus et al. (2012) both find public real estate market leads the market of private real estate over the subsequent periods.

Most of related literatures employ the U.S. real estate market data series as the U.S. owns the most mature private and public real estate market and sufficient data set and long enough time series as well. In terms of public real estate investment, Asian REITs market only rose in the early 20th century. However, with a rapid growth rate, some researches start
to focus on this emerging public real estate market. Apparently, the abundant literatures and rich experience of U.S. real estate market provide excellent examples for both Asian real estate researches and authorities market practices.

In this paper, we attempt to employ Hong Kong real estate market data to examine the return and volatility of direct private investment and REITs. Followed the methodology of Ling and Naranjo (2015), we adopt a two-stage approach to test the performance of private and public real estate investments. In the first stage, we simply compare the performance of private real estate with levered and unlevered REITs in aggregate level. Self-constructed private real estate returns series and two kinds of REITs returns series are presented. The details of data construction will be covered later. In the second stage, an unrestricted vector autoregressive model excluding various fundamental control variables is used to examine the dynamics of information transmission between private and public real estate market.

The remainder of this paper is organized as follows. Section 3 mainly introduces our first stage analysis. Subsections illustrate our data source and how we adjust collected data to compound our own market portfolio and. Section 4 reports the construction of baseline VAR model. The empirical results are documented in subsection. Section 5 compares our results with previous literature using U.S. data and concludes.

Data Construction and Descriptive Analysis

As the first REIT was listed in November, 2005, our sample only consists public and private real estate performance data from the first quarter of 2006 to the second quarter in 2015. Due to the data availability, we construct our own private and public real estate portfolio and calculate the quarterly return data series. To make them more comparable, we construct both levered REITs return and unlevered one as Ling and Naranjo (2015).

Levered REITs Returns Data

Current constituents of the Hong Kong Hang Seng REIT Index

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*See Ong et al. (2008) and the references therein.
* The underlying assets of REITs are mainly commercial real estate, hence we only focus on the commercial real estate market in this paper.
include 10 listed REITs. Table I shows the summary of Hong Kong listed REITs.

<table>
<thead>
<tr>
<th>Stock Code</th>
<th>Stock Name</th>
<th>Listing Date</th>
<th>Focus</th>
<th>Portfolio Location</th>
<th>Index Weighting(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0405.HK</td>
<td>Yuexiu REIT</td>
<td>Dec.21 2005</td>
<td>Office and retail</td>
<td>Guangzhou</td>
<td>14.38</td>
</tr>
<tr>
<td>0435.HK</td>
<td>Sunlight REIT</td>
<td>Dec.21 2006</td>
<td>Office and retail</td>
<td>Hong Kong</td>
<td>8.03</td>
</tr>
<tr>
<td>0778.HK</td>
<td>Fortune REITs</td>
<td>Apr.20 2010</td>
<td>Retail</td>
<td>Hong Kong</td>
<td>14.94</td>
</tr>
<tr>
<td>0808.HK</td>
<td>Prosperity REIT</td>
<td>Dec.16 2005</td>
<td>Office and retail</td>
<td>Hong Kong</td>
<td>6.81</td>
</tr>
<tr>
<td>0823.HK</td>
<td>Link REIT</td>
<td>Nov.25 2005</td>
<td>Retail and car parks</td>
<td>Hong Kong</td>
<td>16.05</td>
</tr>
<tr>
<td>1275.HK</td>
<td>New Century REIT</td>
<td>Jul.10 2013</td>
<td>Hotel</td>
<td>Hong Kong</td>
<td>1.57</td>
</tr>
<tr>
<td>1426.HK</td>
<td>Spring REIT</td>
<td>Dec.5 2013</td>
<td>Office, retail and hotel</td>
<td>Beijing</td>
<td>4.36</td>
</tr>
<tr>
<td>1881.HK</td>
<td>Regal REIT</td>
<td>Mar.30 2007</td>
<td>Hotel</td>
<td>Hong Kong</td>
<td>3.73</td>
</tr>
<tr>
<td>2778.HK</td>
<td>Champion REIT</td>
<td>May.24 2006</td>
<td>Office</td>
<td>Hong Kong</td>
<td>14.46</td>
</tr>
<tr>
<td>87001.HK</td>
<td>Hui Xian REIT</td>
<td>Apr.29 2011</td>
<td>Office and retail</td>
<td>Beijing</td>
<td>15.67</td>
</tr>
</tbody>
</table>

Sources: Hang Seng Index and Annual Reports of Corresponding REITs

Apparently, those REITs that focus other than office and retail, and whose portfolio is located other than Hong Kong are out of scope and have to be excluded from our construction of REITs return. The REITs excluded are shaded in Table I. Five REITs that are included in our construction (including Sunlight REIT, Fortune REIT, Prosperity REIT, Link REIT and Champion REIT) account for more than 60% of current Hang Seng REIT Index. Note that quarter returns are applied in the whole paper.

Our construction follows the methodology of Ling and Naranjo (2015). Historical prices down to the listing day are obtained from Bloomberg Database. We assume a quarterly “buy and hold” strategy, by which investors purchase the REITs stock at the beginning of each quarter of our sample period and sell the stock at the last day of each quarter. The

---

* As of December 1, 2015.
* Fortune REIT is dual-listed in Singapore.
trading prices are set to be the close price of each trading day. Therefore, we can denote the return of each REIT in each quarter \( t \) as \( r_{i,t}^e \), then we construct an REIT index return of each quarter by weighting the return of each REIT at quarter \( t \) by the market capitalization of each REIT at the end of quarter \( t-1 \). The weight of each REIT at quarter \( t \) is denoted as:

\[
w_{i,t}^e = \frac{mcap_{i,t-1}^e}{\sum_{i=1}^{N^e} mcap_{i,t-1}^e}
\]

where \( mcap_{i,t-1}^e \) is the market capitalization of REIT \( i \) at the end of each quarter \( t-1 \), \( N^e \) is the number of REITs at quarter \( t \).

Eventually, the levered returns of our REIT index in each quarter is denoted as:

\[
R_{t}^e = \sum_{i=1}^{N^e} w_{i,t}^e r_{i,t}^e
\]

A time-series levered return data of REIT is constructed.

Figure I illustrates the levered returns of self-constructed REIT index and five index constituents. High volatilities of the return series are displayed in the figure. Detail statistics of mean returns and standard deviations are reported in Table II.
Unlevered REITs Return Data

The methodology of de-leverage of REITs returns is simple. Unlevered return is interpreted as total asset return. Since levered return only consists equity return, we have to take debt return into consideration and construct our unlevered return series. The unlevered REITs returns in each quarter is expressed in the following way:

$$ r_{i,t}^{TA} = \theta_{i,t}^e r_{i,t}^e + \theta_{i,t}^d r_{i,t}^d $$

where $ r_{i,t}^{TA} $ denotes the unlevered return (total asset return), $ r_{i,t}^e $ is the equity return we introduced before and $ r_{i,t}^d $ represents return on debt. $ \theta_{i,t}^e $ and $ \theta_{i,t}^d $ are the corresponding weight of equity return and debt return. Following expressions show how these two weights are calculated.
\[ \theta_t^i = \frac{mcap_{i,t}}{TA_{i,t}} \]
\[ \delta_t^d = \frac{dvl_{i,t}}{TA_{i,t}} \]

where \( TA_{i,t} \) is total asset book value of REIT \( i \) in quarter \( t \), \( dvl_{i,t} \) is the total debt book value and \( mcap_{i,t} \) is the market capitalization.

Apparently,
\[ TA_{i,t} = dvl_{i,t} + mcap_{i,t} \]

We collect the following firm-level financial figures from the interim reports and annual reports of each REITs: current liabilities, long-term debt, interest expenses and total assets. Based on these figures and the formulas above, we create a counterpart of levered REITs return, which is unlevered REITs return, denoted as \( R^T_{i,t} \), constructed by

\[ R^T_{i,t} = \sum_{i=1}^{N_t} w^T_{i,t} r^T_{i,t} \]

where
\[ w^T_{i,t} = \frac{TA_{i,t-1}}{\sum_{i=1}^{N_t} TA_{i,t-1}} \]

The weight of each REIT is determined by the total asset of each REIT in last period divided by total asset of all listed REITs last period.

Figure II displays the returns of self-constructed unlevered REIT index and five constituents. Comparison of levered and unlevered REITs return is presented in Figure III. Unlevered REIT returns exhibit similar trend and volatility as levered ones.

\[ \text{Since Hong Kong listed corporations are not required to disclose quarterly reports, we have no access to the exact figures (except for Fortune REIT which is dual-listed in Singapore), instead, we estimate these quarterly figures by taking average. For example, the first quarter figure is estimated to be the average of last year-ended figure and interim figure current year. Similarly, the third quarter figure is estimated to be the average of interim figure this year and current year-end figure.} \]
Private Real Estate Return Data

When constructing our private market index, we gather quarterly transaction volume and average prices data from the Rating and Valuation Department of the Government of the Hong Kong Special Administrative Region. The same quarterly “buy and hold” strategy applies here. To be comparable to our REITs indexes, we focus only on two types of commercial real estate, which are office and retail. Quarterly sales data and prices data in our sample period are obtained and our private real estate market return index is constructed as follows:

\[ R_t^p = w_t^{rt} r_t^{rt} + w_t^{of} r_t^{of} \]

where \( R_t^p \) denotes the return of private market at time \( t \), \( r_t^{rt} \) and \( r_t^{of} \) are return of retail and office respectively. Their corresponding weight in the index is calculated as

\[ w_t^{rt} = \frac{tsc_t^{rt}}{tsc_t^{rt} + tsc_t^{of}} \]
\[ w_t^{of} = \frac{tsc_t^{of}}{tsc_t^{rt} + tsc_t^{of}} \]

where \( tsc_t^{rt} \) and \( tsc_t^{of} \) are the transaction considerations of retail properties and offices respectively.

Figure III shows the returns of self-constructed private index, office and retail respectively. Figure V illustrates the return and volatility characteristics of unlevered REIT returns and private market returns. Detailed statistics are reported in Table II.
Figure IV. Private Market Returns

Figure V. Unlevered REIT Index Return vs. Private Market Return
It is clearly that, over our sample period, public real estate market returns show higher volatility than private market returns. However, the mean returns of public market are significantly lower than private ones. Private market provides a relatively stable mean return of 3.67%, while levered and unlevered aggregate returns are only 2.12% and 2.06% respectively.
The dynamics of information transmission

**Empirical VAR Model**

Follow the methodology of Ling and Naranjo (2015), we employ a vector autoregressive model to study the dynamics of information transmission between private and publics real estate market. Generally, an unrestricted $p$th-order VAR model can be expressed as

$$Y_t = C + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots + \Phi_p Y_{t-p} + \epsilon_t$$

where $Y_t$ is n-dimensional endogenous variable, $C$ is n-dimensional constant term and error term $\epsilon_t \sim NID(0, \Omega)$.

In our simple bivariate regression, estimates of $\Phi$ can be obtained by OLS. And according to the selection of lag by various criterions shown in Table III, we choose the 2-length lags in the VAR system.

<table>
<thead>
<tr>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NA</td>
<td>702.007</td>
<td>12.229</td>
<td>12.319</td>
<td>12.260</td>
</tr>
<tr>
<td>1</td>
<td>30.737</td>
<td>329.845</td>
<td>11.473</td>
<td>11.743*</td>
<td>11.565</td>
</tr>
<tr>
<td>2</td>
<td>9.976*</td>
<td>296.872*</td>
<td>11.365*</td>
<td>11.814</td>
<td>11.517*</td>
</tr>
<tr>
<td>3</td>
<td>3.969</td>
<td>326.755</td>
<td>11.453</td>
<td>12.081</td>
<td>11.667</td>
</tr>
<tr>
<td>4</td>
<td>4.271</td>
<td>353.377</td>
<td>11.517</td>
<td>12.325</td>
<td>11.793</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion.

LR: sequential modified LR (Likelihood Ratio) test statistics (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Likelihood ratio, Final prediction error, Akaike information criterion and Hannan-Quinn information criterion all suggest that lags of our VAR model should be 2 periods (2 quarters).
**Unit Root Tests**

At the very beginning, a relatively reliable VAR model requires the stationary time-series. In general, non-stationary time series conducted by basic time-series techniques may lead to inaccurate hypothesis testing and other related statistics. Table IV presents the outcomes of various unit root tests.

<table>
<thead>
<tr>
<th>Series</th>
<th>Augmented DF</th>
<th>DF-GLS</th>
<th>Phillips-Perron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlevered Equity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REIT Return</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate REIT Index</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Sunlight REIT</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Fortune REIT</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Prosperity REIT</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Link REIT</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Champion REIT</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Private Market Returns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate Private Index</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>Office</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Retail</td>
<td>(0.00)</td>
<td>(0.01)</td>
<td>(0.22)</td>
</tr>
</tbody>
</table>

Notes: This table presents Augmented Dickey-Fuller, DF-GLS and Phillips-Perron unit root tests on the series employed. P-values are reported in parentheses.

Augmented Dickey-Fuller, DF-GLS and Phillips-Perron unit root tests are conducted to show the stationarity of series we constructed. The null hypothesis that a unit root exists is rejected at 1% significance level by almost all tests, which indicates that error correction is not necessary for our stationary series.

**Dynamic Relations Between REITs Returns and Private Market Returns**

Table V summarizes our unrestricted VAR results using unlevered REITs returns and private market returns as endogenous variables. Lagged private market returns are not able to predict the returns of unlevered REITs returns in the subsequent period. Meanwhile,
unlevered REITs returns have very limited power to predict the return of private market returns.

Table V. VAR Results: Unlevered REIT Index Return and Private Market Return

<table>
<thead>
<tr>
<th>Variables</th>
<th>PUBLIC</th>
<th>PRIVATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUBLIC(-1)</td>
<td>0.065</td>
<td>0.216*</td>
</tr>
<tr>
<td>(0.212)</td>
<td>(0.116)</td>
<td></td>
</tr>
<tr>
<td>PUBLIC(-2)</td>
<td>0.179</td>
<td>-0.026</td>
</tr>
<tr>
<td>(0.214)</td>
<td>(0.117)</td>
<td></td>
</tr>
<tr>
<td>PRIVATE(-1)</td>
<td>0.265</td>
<td>0.780***</td>
</tr>
<tr>
<td>(0.376)</td>
<td>(0.205)</td>
<td></td>
</tr>
<tr>
<td>PRIVATE(-2)</td>
<td>-0.634**</td>
<td>-0.453***</td>
</tr>
<tr>
<td>(0.271)</td>
<td>(0.148)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>2.888**</td>
<td>2.142***</td>
</tr>
<tr>
<td>(1.288)</td>
<td>(0.704)</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R-square

0.085

0.590

Notes: Standard errors are reported in parentheses. 10%, 5% and 1% significance level are represented by *, ** and *** respectively.

Impulse Response Functions

Impulse response functions evaluate the effects shocks to residual value on the value of endogenous variables. As shown in Figure VI, responses of unlevered REITs returns to shocks in private market are not significantly different from zero, while responses of private market returns are significantly different from zero in the subsequent periods. This finding is consistent with our findings in VAR model results.
This short paper attempts to study the volatility and dynamics of public traded equity REITs returns and private real estate market returns using Hong Kong data. Levered and unlevered REITs returns are constructed for public real estate market, while series of private market returns are also constructed as counterpart of public REITs returns. As Ling and Naranjo (2015), a two-stage methodology is adopted in which a simple comparison of public and private real estate returns are presented in the first stage and an unrestricted VAR model is established to study the dynamics of public and private market in the second stage.

Consistent to previous studies (e.g. Riddiough et. al 2005 and Ling and Naranjo 2015), public real estate returns exhibit higher volatility than private market returns. However, our study documents that public real estate market doesn’t offer higher average returns in our sample period, which is not in line with previous studies. At the same time, our VAR model using unlevered REITs return and private market return as endogenous variables suggests that returns of private real estate market cannot predict the REITs returns in the subsequent period, while REITs...
returns have very limited prediction power for the private market.

Data insufficiency limits our studies for Hong Kong real estate market, especially for public real estate market. Only 10 REITs are contained in Hang Seng REIT Index and the history of Hong Kong REITs are not long enough. Due to the availability of return data, we have to assume a quarterly “buy and hold” strategy for both public and private market to calculate the quarterly returns, which may not realistic for private real estate market. Nevertheless, our VAR model exclude several important control variables such as asset pricing factors.
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Atchison K. and Yeung E.S.. 2014. The Impact of REITs on Asian Economics. *Asia Pacific Real Estate Association Limited.*


