Estimating Quality Adjusted Commercial Property Price Indexes Using Japanese REIT Data

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Abstract

The paper proposes a new method to estimate quality adjusted commercial property price indexes using real estate investment trust (REIT) data. The method is based on the present value approach, but the way in which current operating income and the capitalization rate are estimated differs from the traditional method. The traditional method uses a hedonic regression with appraisal information on properties as the dependent variable in order to estimate the capitalization factor. We compare this method with a method that replaces appraisal information with stock market valuations (adjusted for debt). We also run alternative hedonic regressions, restricting the sample of properties to those which are associated with new rental contracts, which may contain more information on future cash flows from properties. Using a dataset with prices and cash flows for about 400 commercial properties included in Japanese REITs for the period 2001 to 2013, we find that our price index signals turning points much earlier than an appraisal-based price index. Our results suggest that the share prices of REITs provide useful information in constructing commercial property price indexes.

Key Words

Commercial property price indexes, REIT, quality adjusted price index, hedonic regressions, Tobin's q, risk premium.

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1. Introduction

Looking back at the history of economic crises, there are a considerable number of cases where a crisis was triggered by the collapse of a real estate price bubble. For example, it is widely accepted that the collapse of Japan's land and stock price bubble in the early 1990s has played an important role in the subsequent economic stagnation, and in particular the banking crisis that started in the latter half of the 1990s. Similarly, the Nordic banking crisis in the early 1990s also occurred in tandem with a property bubble collapse, while the global financial crisis that began in the United States in 2008 and the European debt crisis were also triggered by the collapse of bubbles in the property and financial markets.

Against this background, the importance of obtaining accurate measures of property prices is widely acknowledged, and active efforts are being made to develop property price indexes. For example, the Handbook on Residential Property Prices Indices published in 2011 jointly by Eurostat and other international organizations provides guidelines for constructing housing price indexes.[5] When it comes to non-residential property price indexes, however, the development of such indexes is an area where both public institutions and the private sector have been lagging, and there are few academic studies. Given this situation, the purpose of the present paper is to propose a new method to construct price indexes for commercial property.

For most industrial countries, including Japan, the U.S., and the U.K., commercial property price indexes have been produced using appraisal prices. For example, in Japan, the government has been conducting the "Land Price Survey" since 1970, which provides price information not only on land for residential use, but also on land for commercial and industrial use. Moreover, the "Urban Land Price Index" has been published by a quasi-public institution since 1926 which provides land prices for 230 major cities in Japan. These indexes are all based on appraisal prices rather than transaction prices. However, there are questions regarding how accurately fluctuations in appraisal-based property price indexes reflect actual market conditions. In most countries, including Japan, transaction volumes are much smaller for commercial properties than for residential properties, so that the availability of transaction price data is extremely limited. This makes it difficult to apply standard methods widely used in constructing residential property indexes, such as the hedonic price method and the repeat sales method, to commercial properties.

Given the limited availability of transaction price data, we propose in this paper to employ the present value approach. Using the present value approach in estimating commercial property prices is not new. In fact, several versions of the present value approach have

[5] The Handbook is available online at:
http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-12-022

already been adopted by practitioners, especially by appraisers. However, in our approach, the way the denominator (i.e., the discount rate or capitalization rate) and the numerator (i.e., cash flow from properties) are estimated differs from the traditional approach.

First, we estimate the capitalization rate, using the stock market valuation of the set of properties owned by a real estate investment trust (REIT). In the case of Japanese REITs (J-REITs), such trusts are allowed to invest in real estate property only, so that the only type of assets in J-REIT balance sheets are property. This means that all the revenue generated by and expenses of J-REITs derive from property. More importantly, J-REITs disclose information on the appraisal value of each property owned by the REIT and on the net operating income (NOI) from it, as well as information on the attributes of individual properties.[6] The capitalization rate is usually calculated by dividing the NOI from properties by the appraisal value of the properties. However, we divide the NOI not by the appraisal value but by the share price of the REIT to obtain an alternative measure of the capitalization rate.

Second, as for the numerator (cash flow from properties), we use not only rental prices associated with all contracts existing at a particular point in time, but also rental prices associated with new contracts made in a particular year. Rental prices associated with all contracts represent actual payments from tenants to property owners, so that they make an obvious candidate for the numerator. On the other hand, it is widely recognized that ongoing rental payments based on leases agreed in the past deviate from rental rates associated with new contracts entered today, and that rent indexes using rent data on existing contracts tend to lag behind rent indexes using rent data on new contracts.[7] This implies that future cash flows from properties can be predicted more precisely by employing rents associated with new contracts. In this paper, we will use rent data on new contracts as an alternative variable for the numerator to construct a better leading indicator of price changes.

Using a dataset with prices and cash flows for about 400 commercial properties included in Japanese REITs for the period 2001 to 2013,[8] we find that the capitalization rate implied by stock market prices exhibits higher volatility than the one estimated using appraisal prices. We also find that the rents associated with new contracts respond more quickly to shocks to the property market. The estimated stock market-based index signals turning

[6] J-REITs differ from REITs in the US and the UK, where individual property information is not disclosed.
[7] See Shimizu et al. (2010a) for details on the discrepancy in rental prices between new contracts and existing contracts in the case of residential properties.
[8] The amount of office investment via REITs for Japan is 4.6 trillion yen, accounting for 49 percent of overall property investments. According to estimates by International Property Databank (IPD), as of March 2012, the corresponding figures were 34 percent for the U.S., 30 percent for the U.K., 52 percent for France, 45 percent for Germany, and 44 percent for Australia. See, for example, Ooi et al. (2006) and Ooi et al. (2011) for more on REIT markets in Japan and other Asian countries.

points earlier than the traditional measure based on appraisal prices: for example, the stock market-based index hits a peak in the second quarter of 2007, while the appraisal price-based index exhibits a turnaround only in the third quarter of 2008.

The rest of the paper is organized as follows. Section 2 provides an overview of issues related to the estimation of commercial property price indexes. Section 3 then explains our methodology and the data we use. Section 4 shows our empirical results. Section 5 concludes the paper.

2. Data sources and quality adjustments of commercial property price indexes

In this section, we provide a brief overview of commercial property price indexes currently available in Japan, the U.S., and the U.K. and discuss some issues related to the construction of these indexes. Table 1 presents a list of the major indexes currently available. Regarding the sources for price data, three different types can be distinguished. The first type of source is appraisal prices, which are used for the Urban Land Price Index in Japan, the NCREIF Property Index in the U.S., and the IPD indexes in the U.K. Note that Japan's Urban Land Price Index is only for land (i.e., it does not cover buildings), while the IPD and NCREIF indexes cover both land and buildings. The second type of source is transaction prices, which are used in the RCA Commercial Property Price Index and the MIT/CRE's transactions-based index (TBI). The third type of source is the share prices of REITs, which are used in the FTSE NAREIT (National Association of Real Estate Investment Trusts) PureProperty Index that started in 2012.

Table 1: Major commercial property price indexes in Japan and the United States

Name	Price data	Estimation method	Frequency	Coverage
Urban Land Price Index	Appraisal prices	Mean	Bi-annually	Japan
IPD Property Index	Appraisal prices	Mean	Monthly	25 countries
NCRIEF Property Index	Appraisal prices	Mean	Quarterly	U.S.
MIT/CRE TBI	Transaction prices	Hedonic	Quarterly	U.S.
RCA CPPI	Transaction prices	Repeat sales	Monthly	U.S.

FTSE NAREIT PureProperty Index	REIT returns	De-levered regression	Daily	U.S.

2.1 Appraisal-based commercial property price indexes

As pointed out in a number previous studies, commercial property price indexes based on appraisal prices have several shortcomings.[9] First, they may not be able to precisely capture turning points in prices (the lagging problem). Second, they tend to diverge from transaction prices in periods of wild market fluctuation. For example, Nishimura and Shimizu (2003), Shimizu and Nishimura (2006, 2007), and Shimizu et al. (2012) construct two indexes for the Japanese bubble period in the late 1980s and early 1990s, one based on transaction prices and the other based on appraisal prices, and find that the appraisal price-based index increases 40 percent less than the transaction price-based index during the bubble period, and that the price decline following the burst of the bubble is much smaller for the appraisal price-based index. Third, appraisal price-based indexes tend to smooth out true price changes, so that they tend to underestimate price volatility. Geltner and Goetzmann (2000) construct a transactions-based index using the NCREIF data to show that the NCREIF appraisal price-based index, which is widely used in the U.S., is excessively smooth.[10]

Another issue regarding property price indexes based on appraisal prices is that they do not take quality differences across properties into account. Specifically, appraisal-based indexes, such as the NCREIF and the IPD indexes, collect prices each time for a fixed set of properties, so that they do not conduct any quality adjustment. However, as pointed out by Diewert and Shimizu (2014) and Diewert et al. (2014), the quality of buildings changes over time due to aging (or depreciation) and renovation (or capital expenditure), so that even if indexes are based on observations for a fixed set of real estate properties, appropriate quality adjustment is necessary. Moreover, the population from which the data used to create the indexes is extracted changes over time. Since the purpose of these indexes is to capture changes in the investment values of properties, they are estimated by taking investment properties as the population. As a result, if a given property is sold off and is no longer an investment target, it is removed from the index; if a property becomes a new investment target, it becomes part of the index. In other words, the properties which are the target of the index change over time. In this sense, these indexes are not free from

[9] See Geltner and Pollakowski (2007) for a survey on this issue.

[10] See Quan and Quigley (1991), Geltner and Kluger (1996), Clayton et al. (2001), and Francke and Vos (2004) for discussions of the sources of valuation errors and excessive smoothness of appraisal price-based indexes. According to these studies, property appraisers fail to acquire price data in a timely manner. Also, they tend to update prices only with a lag due to their slow decision-making process. In a related context, Shimizu et al. (2012) point out that appraisers tend to regard large price changes as outliers and therefore tend to exclude them. Shimizu et al. (2012) argue that this at least partly contributes to excessive smoothness.

biases stemming from quality changes over time.[11]

2.2 Transaction-based commercial price indexes

To address the above mentioned issues associated with appraisal-based indexes, some of the indexes use transaction prices. For example, the Moody's/REAL CPPI, which was launched in 2007, and its successor, the Moody's/RCA CPPI, are constructed using about 17,000 transaction prices in the U.S.. They are both quality adjusted using the repeat sales method.[12] On the other hand, the MIT/CRE TBI is based on transaction prices but is quality-adjusted using the hedonic method. Specifically, the TBI employs the NCREIF dataset, which contains not only transaction prices for properties but also various attributes of the properties, including location, size, building age, and transport connections. Note that such information regarding property attributes is collected mainly to provide information to price appraisers. Using a similar dataset, IPD is moving toward the development of a transaction price index which is quality adjusted employing the hedonic method.

To estimate a property price index using the repeat sales method, a sufficiently large number of properties that are bought and sold more than once is required. Given the small transaction volumes in commercial property, meeting this requirement is difficult in most countries (see, for example, Francke (2010)). On the other hand, to employ the hedonic method, considerable amounts of data on property-related attributes in addition to property prices themselves need to be collected. Commercial property transaction prices are generally collected based on registry information, which, however, only includes the price, address, floor space, and transaction date, so that gathering information on additional property characteristics will involve considerable time and expense. Practically speaking, this makes it very costly to construct transaction-based commercial property price indexes which are quality-adjusted using the hedonic approach. Devaney and Diaz (2011) is an attempt to apply hedonic regression to transaction prices using property attribute information provided by appraisers.

2.3 Stock market-based commercial property price indexes

Given that appraisal price-based indexes have some serious shortcomings and that transaction price-based indexes are not easy to construct due to data limitations, some scholars and practitioners have started to use information from stock markets to construct

[11] An additional systemic factor in appraisals of investment properties is that price appraisals may be subject to interference from the client. As highlighted by Crosby et al. (2003) and Crosby et al. (2010), clients may seek to persuade property appraisers to raise the price in an attempt to maintain the property's investment performance.

[12] See Diewert (2007) and Shimizu et al. (2010b) for some estimation issues associated with the repeat sales method, including the change of building quality over time due to depreciation and renovation.

property price indexes. For example, Fisher et al. (1994) and Geltner (1997) have employed the share prices of REITs to construct property price indexes for the U.S.. Moreover, in June 2012, the FTSE Group launched a new index, the FTSE NAREIT PureProperty Index, which tracks, at a daily frequency, price changes of commercial properties held by U.S. REITs as revealed by changes in the stock market valuation of the REIT constituents (see Geltner et al. (2010) and Bokhari and Geltner (2012) for more on this). The method we propose in the next section is based on the share prices of REITs, but the way we use stock market information differs from those employed in the previous studies.

3. Data and Methodology

3.1. Data

We construct a dataset based on published information for J-REITs holding office properties in the Tokyo area. The sample period is from the second quarter of 2001 to the fourth quarter of 2013. This includes the period when property prices, which had been on a sustained downward trend following the collapse of the 1980s bubble, were heading toward recovery. Moreover, from the start of the 2000s, with further advances in financial technologies and the increase in cross-border transactions by investment funds, money flowed into the J-REIT market, giving rise to a mini-bubble in property prices, particularly in large urban areas, dubbed the "fund bubble." However, the failure of Lehman Brothers in 2008 triggered a reversal in both fund and property prices. In this sense, the period covers a boom-bust cycle, from a downward phase in property prices to a period of increasing prices and then to a downward phase again following the collapse of the fund bubble.

Table 2: List of property attribute variables

Attribute variable	Definition	Description
v^A	Appraisal price	Million yen
y	Net operating income	Rent income less operating expenditure, million yen
c	Capitalization rate	Rent income divided by appraisal price
L	Land area	Square meters
S	Floor space	Square meters
RS	Rentable floor space	Square meters
A	Age of building	Years
H	Number of stories	
DS	Distance to the nearest station	Meters
DC	Distance to CBD	Meters
LHD	Leasehold dummy	Leasehold = 1; Owner managed = 0

$LD_k(k=0, \dots, K)$	Location dummies

The dataset contains appraisal prices for the properties owned by Japanese REITs, which are updated by appraisers once every six months.[13] In addition, the dataset contains rental income, the corresponding expenses such as property taxes and damage insurance premiums, and the net income after these expenses (net operating income or NOI). Note that in the documents that the J-REITs disclose, taxes and public dues for the year the property is acquired are not recorded as expenses. Therefore, for the year that a property is acquired, we calculate the NOI using taxes and public dues from accounting data for the year following the acquisition. The number of commercial properties owned by J-REITs for which appraisal prices and NOI are all available is 414.

Information available on the attributes of commercial properties includes the land area (L: m^2), the floor space of the building (S: m^2), the rentable floor space[14] (RS: m^2), the age of the building (A: years), the number of stories (H: number of stories), the distance to the nearest station (DS: meters), the distance to the central business district (DC: meters), the leasehold type (LHD: standard leasehold or fixed-term leasehold). A full list of attributes is provided in Table 2, while descriptive statistics are presented in Table 3.

Table 3: Descriptive statistics on prices and attributes for REITs and for individual properties owned by REITs

REITs (Number of observations=573)	Mean	Std. dev.	Min	Max
Stock market value (million yen)	137,467	148,293	13,847	833,841
Appraisal value (million yen)	130,577	130,130	14,860	622,670
Stock market value per rentable floor space (million yen/m^2)	1.226	0.355	0.458	2.58
Appraisal value per rentable floor space (million yen/m^2)	1.202	0.316	0.683	2.738
Income (million yen)	5,855	5,334	708	25,376
Income price ratio based on stock market value	0.047	0.01	0.027	0.116
Income price ratio based on appraisal value	0.047	0.008	0.024	0.073
Income per rentable floor space (million yen/m^2)	0.055	0.01	0.033	0.103

[13] Appraisal prices of properties owned by J-REITs must follow a set of rules set by the government, which is referred to as the "Securitized Property Appraisal Standard". It requires REITs to employ the DCF (discounted cash flow) method. Details on the procedure to calculate revenues and expenses are also specified in the standard.

[14] Rentable floor space refers to the building floor space within a building that represents a source of income. Shared areas such as the entrance as well as areas of the building not included in the transaction are not included in rentable floor space.

Land area*(m^2)	2,132	1,761	430	8,721
Floor space * (m^2)	12,358	9,426	2,429	47,152
Rentable floor space* (m^2)	8,722	7,509	1,897	40,007
Age of buildings* (years)	19	6	5	36
Distance to the nearest stations* (meters)	290	79	105	569
Distance to CBD* (meters)	4,810	1,721	2,168	11,141

Individual properties owned by REITs (Number of observations=9,120)	Mean	Std. dev.	Min	Max
Price (million yen)	8,204	11,234	389	116,200
Land area (m^2)	2,128	3,837	79	42,509
Floor space (m^2)	13,946	28,108	535	287,350
Rentable floor space (m^2)	6,674	7,901	491	95,697
Price per rentable square meter (million yen/m2)	1.178	0.557	0.277	4.797
Age of building (years)	19	10	0	54
Number of stories	11.4	6.9	3	54
Distance to the nearest station (meters)	266	148	20	868
Distance to CBD (meters)	4,150	2,569	357	14,193

Note: The variables with * represent the average across properties owned by a REIT.

3.2. Methodology

3.2.1. Present value approach based on the share prices of REITs

This section presents the present value approach based on the share prices of REITs that we use for the construction of our property price index. Let y_{it} denote the rental income per rentable floor space from property i in period t. We assume that the income flow for property i depends on the property's attributes and is determined as follows:

$$\ln y_{it} = \sum_j \alpha_j Z_{ij} + f_t, \qquad \text{(eq 1)}$$

where Z_{ij} represents attribute j of property i, α_j is the parameter associated with attribute j, and f_t is the time-varying component of the income flow. Note that the quality-adjusted income flow is given by $\exp(f_t)$. Following Gordon's (1959) valuation model, the price of property i per rentable floor space, which is denoted by v_{it} is given by[15]

$$v_{it} = E_t \sum_{r=0}^{\infty} \frac{y_{it+r}}{\exp\left(\sum_{s=0}^{r-1} r_{i,t+s}\right)} = y_{it}\phi_{it},$$

(eq 2)

where r_{it} is the capitalization rate in period t, and ϕ_{it} is defined as

$$\phi_{it} \equiv E_t \sum_{r=0}^{\infty} \frac{\exp(f_{t+r} - f_t)}{\exp\left(\sum_{s=0}^{r-1} r_{i,t+s}\right)}.$$

(eq 3)

Note that we allow the possibility that discount rates may differ across properties and that it may be correlated with property attributes.[16] For example, older buildings are closer to the point of redevelopment than newer buildings, so that they are exposed to higher vacancy and redevelopment risks. Therefore, older buildings may be associated with higher required returns. Also, note that we use the fact that $\ln y_{it+\tau} - \ln y_{it} = f_{t+\tau} - f_t$, which results from (1), in obtaining (2) and (3). Inserting (1) into (2), we obtain

$$\ln v_{it} = \sum_j \alpha_j Z_{ij} + f_t + \ln\phi_{it},$$

(eq 4)

indicating that the quality-adjusted price is given by $\exp(f_t + \ln\phi_{it})$. Note that eq. (4) is a hedonic equation and that one may be able to obtain an estimate of quality-adjusted prices by running a hedonic regression. To do so, we need a price measure for individual properties. Our dataset contains appraisal prices for individual properties owned by REITs, which may be used in conducting such a hedonic regression. We will do that as part of our empirical exercise in the next section. However, as pointed out in previous studies, appraisal prices may contain some serious measurement errors, so a simple hedonic regression using (4) may not provide a precise estimate. As an alternative, we propose to use the share prices of individual REITs in constructing a quality-adjusted price index.

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[15] Equation (2) defines the fundamental value of property i. However, we can easily incorporate the possibility of property bubbles into the model. As an extended version of (2), let us assume that the price of property i consists of the fundamental component and a bubble component, and that the bubble component depends only on t but not on i. Then, eq. (2) changes to $v_{it} = y_{it}\phi_t + b_t$, where b_t represents the bubble component. The methodology developed in this section basically remains unchanged even in that case. See Diewert and Shimizu (2013) for more on this.

[16] The relationship between required rate of returns and firm characteristics has been discussed in the asset pricing literature. For example, Chordia et al. (2012) shows that a appreciable portion of cross sectional variations in stock prices can be accounted for by firm characteristics.

Consider a REIT r and denote the set of properties owned by it in period t by A_{rt}. Note that the reason for using subscript t is that the set of properties owned by a REIT may change over time. The income flow of REIT r is the sum of income from the properties owned by the REIT. Denoting the fraction of property i in REIT r in terms of rentable floor space by ω_{it}, where ω_{it} satisfies $\sum_{i \in A_{rt}} \omega_{it} = 1$, the income flow of REIT r is given by

$$Y_{rt} \equiv \sum_{i \in A_{rt}} \omega_{it} y_{it}, \tag{eq 5}$$

while the asset value of the properties owned by the REIT is given by

$$V_{rt} \equiv \sum_{i \in A_{rt}} \omega_{it} v_{it}. \tag{eq 6}$$

Note that V_{rt} can be estimated based on the share price of the REIT. Specifically, the liability side of the balance sheet of a REIT consists of debts and issued share capital, while the asset side consists of properties owned by the REIT. By law, 90 percent or more of the assets of J-REITs have to be in the form of real estate property, and most of REITs' income derives from the properties they own.[17] Given this balance sheet structure, we can estimate the asset value of the properties owned by a REIT by adding the value of short- and long-term debts to its share value.

Eqs. (1) and (5) imply

$$\ln Y_{rt} = f_t + \ln\left[\sum_{i \in A_{rt}} \omega_{it} \exp\left(\sum_j \alpha_j Z_{ij}\right)\right]. \tag{eq 7}$$

Similarly, eqs. (4) and (6) imply

[17] The Securities Listing Regulations of the Tokyo Stock Exchange (as of May 10, 2012) state: "The ratio of the amount of real estate, etc., to the total amount of the working assets, etc., is expected to reach 70 percent or more" (Rule 1205 (1) a) and "the ratio of the total amount of real estate, etc., real estate-related assets and current assets to the total amount of the working assets, etc., is expected to reach 95 percent or more by the time of listing" (Rule 1205 (1) b). In this respect, J-REITs differ from REITs in the U.S. and the U.K., where REITs are allowed to own not only properties themselves but also other assets, including the shares of real estate companies.

$$\ln V_{rt} = f_t + \ln \phi_{it} + \ln\left[\sum_{i\in A_{rt}} \omega_{it} \exp\left(\sum_j \alpha_j Z_{ij}\right)\right].$$

(eq 8)

We assume that ϕ_{it} consist of the component associated with property characteristics and the time varying component; that is,

$$\ln \phi_{it} = \sum_j \beta_j Z_{ij} + g_t$$

(eq 9)

Plugging (9) into (8), we obtain

$$\ln V_{rt} = (f_t + g_t) + \ln\left[\sum_{i\in A_{rt}} \omega_{it} \exp\left(\sum_j (\alpha_j + \beta_j) Z_{ij}\right)\right].$$

(eq 10)

Finally, the capitalization rate for REIT r is given by

$$\ln Y_{rt} - \ln V_{rt} = -g_t + \ln\left[\sum_{i\in A_{rt}} \omega_{it} \exp\left(\sum_j \alpha_j Z_{ij}\right)\right] - \ln\left[\sum_{i\in A_{rt}} \omega_{it} \exp\left(\sum_j (\alpha_j + \beta_j) Z_{ij}\right)\right]$$

(eq 11)

Note that, if the discount rate does not depend on i, eq. (11) reduces to $\ln Y_{rt} - \ln V_{rt} = -g_t$, implying that the capitalization rate for REIT r does not depend on the characteristics of properties owned by REIT r. However, in more general cases, it depends on property characteristics.

The empirical strategy we employ in the next section consists of the following steps. First, we estimate quality-adjusted rental income, i.e., f_t in eq. (1), by applying a hedonic regression to the data on the income flow for individual properties owned by REITs. Note that, at this stage, we use the income data for individual properties, y_{it}, rather than the income data for individual REITs, Y_{rt}. Next, we estimate quality-adjusted prices, $f_t + g_t$ in eq. (10), by applying a non-linear hedonic regression given by (10) to the REIT level data. Finally, we use the estimates on income and prices to estimate quality adjusted capitalization rates, $-g_t$ in eq. (11).

An alternative to our approach would be to estimate individual property prices that are consistent with stock market valuation, and then apply a hedonic regression to them. Specifically, we define the estimate of v_{it}, denoted by $\tilde{v}_{it}$, as follows

$$\tilde{v}_{it} \equiv \frac{v_{it}^{A}}{\sum_{j \in A_{rt}} v_{jt}^{A}} V_{rt} \quad \text{for } i \in A_{rt}$$

(eq 12)

where v_{it}^{A} represents the appraisal price of a property i. We then apply a hedonic regression to $y_{it}/\tilde{v}_{it}$ to estimate quality adjusted capitalization rates. Note that this approach is eclectic in the sense that we use both appraisal and stock market information.[18] We know from eqs. (4) and (9) that

$$\ln v_{it} = (f_t + g_t) + \sum_{j} (\alpha_j + \beta_j) Z_{ij}.$$

(eq 13)

so that $\tilde{v}_{it} = v_{it}$ holds if α_i's and β_i's used by appraisers coincide with their true values. Put differently, this eclectic approach gives us precise estimates of quality adjusted prices if the deviations of appraisal prices from true prices mainly come from the wrong estimates of ft + g_t. In the next section, we will compare the outcomes from the two approaches.

3.2.2. Alternative measure of income flows

Next, we introduce an alternative measure of y_{it}. The variable y_{it} represents actual rent payments. However, rent payments are often based on leases agreed in the past, so that they could diverge from current market rents. Specifically, let us assume, following Calvo (1983), that rental contracts are stochastically renewed each period with a constant probability. Then the rents associated with all contracts existing at time t (i.e., y_{it}), and the rents associated with new contracts made at time t, denoted by y_{it}^{N}, satisfy

$$\sum_{i} \ln y_{it} = (1 - \lambda) \sum_{i} \ln y_{it}^{N} + \lambda \sum_{i} y_{it-1},$$

[18] This eclectic approach is similar to the one advocated by Geltner and Kluger (1996) and Horrigan et al. (2009). Geltner and Kluger (1996) and Horrigan et al. (2009) propose a method in which REIT returns are delevered and then regressed against property attribute data. Specifically, they first calculate delevered returns for REIT r as a weighted average of REIT returns (i.e., the growth rates of the share price of REIT r) and the debt interest rate with weights given by e and 1 - e, where e represents the fraction of equity in total assets. They then estimate an equation of the following form: $\text{delevered return}_{rt} = \sum_j \theta_{jt} x_{jrt}$, where x_{jrt} represents REIT r's percentage of total assets in various market segments (j) such as the apartment, industrial, retail, and hotel market segments. Note that the dollar value of assets in a REIT's portfolio is unknown, so that they use proxies for property value such as rental income or floor space. The regression coefficient θ_{jt} represents the return for market segment j.

(eq 14)

where λ represents the probability of contract renewal. Note that λ is the so-called Calvo parameter, which is widely used as a measure of price stickiness in New Keynesian macroeconomic.[19] Eq. (14) can be rewritten as

$$\sum_i \ln y_{it} = (1-\lambda)\sum_{r=0}^{\infty}\lambda^r\left(\sum_i \ln y_{it-r}^N\right),$$

(eq 15)

implying that the rents associated with all existing contracts lag behind the rents associated with new contracts. Put differently, y_{it}^N contains more useful information than y_{it} in predicting the future values of income flows. In our empirical exercise, we will run a hedonic regression for both y_{it} and y_{it}^N to obtain quality-adjusted income indexes, which are f_t in eq. (1) for y_{it} and the corresponding one, denoted by f_t^N, for y_{it}^N.

4. Empirical Results

4.1. Hedonic regressions for income and appraisal prices

We begin by running hedonic regressions for income, y_{it}, and appraisal prices, v_{it}^A, to conduct quality adjustments. The hedonic equations for the two variables are given by

$$\ln y_{it} = a_0 + \sum_j^J a_j Z_{ij} + \sum_t^T v_t D_t + \epsilon_{yit}$$

(eq 16)

$$\ln v_{it}^A = b_0 + \sum_j^J b_j Z_{ij} + \sum_t^T \xi_t D_t + \epsilon_{vit},$$

(eq 17)

where D_t represents time dummies. Note that the corresponding capitalization rate, which is defined by $c_{it}^A \equiv y_{it}/v_{it}^A$, is given by

[19] Shimizu et al. (2010a) apply a Calvo model to rental prices of residential properties to find that an equation like (14) fits the data well.

$$\ln c_{it}^{A} = (a_0 - b_0) + \sum_{j}^{J} (a_j - b_j) Z_{ijt} + \sum_{t}^{T} (\nu_t - \xi_t) D_t + (\epsilon_{yit} - \epsilon_{vit})$$

(eq 18)

The quality-adjusted values for income, appraisal prices and capitalization rates, which are denoted by $\hat{y}_t$, $\hat{v}_t^A$, and $\hat{c}_t^A$, are given by

$$\hat{y}_t = \exp(\nu_t);\ \ \hat{v}_t^A = \exp(\xi_t);\ \ \hat{c}_t^A = \exp(\nu_t - \xi_t).$$

(eq 19)

Table 4 presents the regression results for eqs. (16), (17), and (18). The regression result for (16) shows that prices tend to be higher for properties that are built more recently, are more conveniently located, and have larger floor space. We see similar results for the estimated coefficients for eq. (17). However, more interesting are the results reported in the final column of the table, which shows the regression result for eq. (18). As we discussed in the last section, if the discount rates do not depend on property attributes at all, the coefficients associated with each attribute should be identical between the regressions for income and for prices, so that the capitalization rates do not depend on property attributes. However, the final column of the table shows that the estimated coefficients are significantly different from zero. For example, if the age of a building increases by one year, $\hat{y}$ decreases by 0.48 percent, while $\hat{v}^A$ decreases by 0.57 percent, and consequently $\hat{c}^A$ increases by 0.09 percent. In other words, the result indicates that the capitalization rate for a particular property depends on its age, suggesting that discount rates depend on property characteristics. However, it should be noted that this may be due to measurement errors contained in appraisal prices. Given that the y_{it}'s are not estimates but actual values reported in REITs' financial statements, there is little reason to doubt the precision of the estimated coefficient on age in the income equation. On the other hand, v_{it}^A is not a transaction price but an appraisal price, so potentially it may contain some measurement errors. Specifically, it may be the case that the age profile of prices assumed by appraisers in valuing a property may be imprecise, resulting in the inconsistency between the age coefficients in the income and price regressions.

Table4: Hedonic regressions of income, appraisal prices, and capitalization rates

	Income		Appraisal prices		Capitalization rates	
	Coef.	*t*-value	Coef.	*t*-value	Coef.	*t*-value
Constant	-3.157	-26.878***	-0.295	-2.529*	-2.862	-38.004***
Floor space	0.002	15.166***	0.003	23.112***	-0.001	-12.104***
Age of building	-4.759	-12.084***	-5.718	-14.637***	0.96	3.801***
Distance to the nearest station	-0.52	-19.563***	-0.561	-21.256***	0.041	2.376*
Distance to CBD	-0.005	-1.261***	-0.021	-4.840***	0.015	5.520***

LD_k (k=0,…,K)	Yes	Yes	Yes
Adjusted R-squared	0.2162	0.3059	0.2210
Number of observations	9,120	9,120	9,120

Notes: The dependent variable is the log of appraisal prices per rentable floor space, the log of income per rentable floor space, and the log of capitalizations, respectively. The estimated coefficients are multiplied by 1000 except for the constant terms. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Figure 1 shows fluctuations in $\hat{v}^A$, $\hat{y}$, and $\hat{c}^A$ on a quarterly basis. We see that $\hat{v}^A$ shows a significant increase from the first quarter of 2004 through the third quarter of 2008. This happened partly due to an increase in $\hat{y}$ during the corresponding period, but it was also supported by a decline in the capitalization rate. The figure also shows that the decline in $\hat{v}^A$ since the end of 2008 was also accompanied by a decline in $\hat{y}$ and a rise in $\hat{c}^A$.

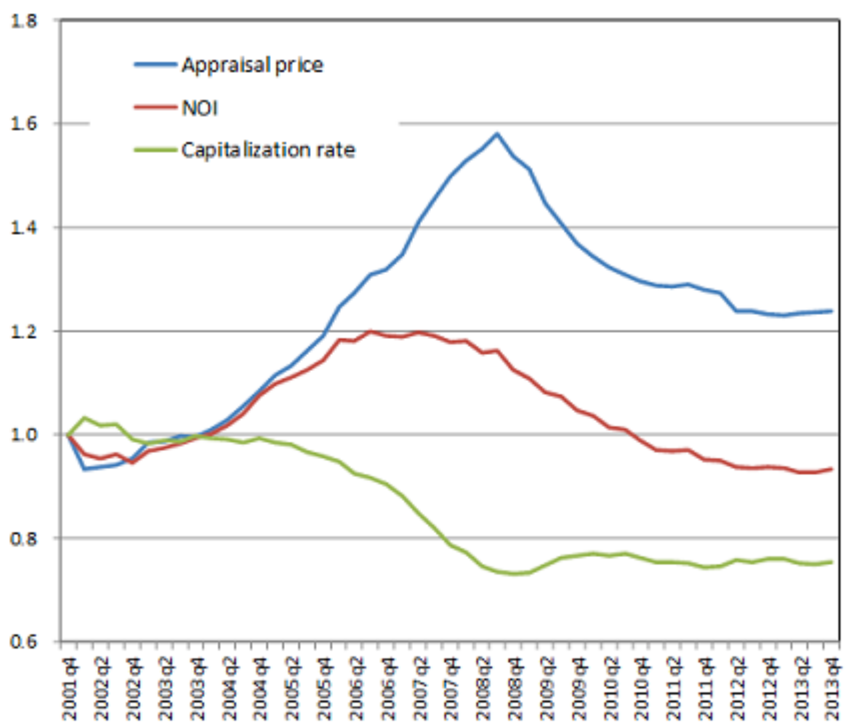

Figure 1: Hedonic estimates of appraisal price, NOI, and the capitalization rate

4.2. Stock market-based measure of the capitalization rate

We estimate the value of properties owned by a REIT by adding the value of short- and long-term debts to its share value. That is,

$$V_{rt} \equiv \text{Share}_{rt} + \text{Debt}_{rt} \tag{eq 20}$$

where Share_{rt} is the share price of REIT r in period t and Debt_{rt} represents the sum of short- and long-term debts in book values. We then run a non-linear hedonic regression at the REIT level, which is given by eq. (10), to estimate quality adjusted prices. The regression result is presented in Table 5. The estimated coefficients are with the correct signs and statistically significant, except for the coefficient on the distance to the nearest station, which is not significantly different from zero. We also apply a hedonic regression to individual property prices that are calculated using appraisal and stock market information (see eq. (12)). The regression result is presented in Table 6.

Table 5: Hedonic regression of stock market-based prices

	Coefficient	Std. error	t-value
Constant	0.209	0.239	0.875
Floor space	0.026	0.004	6.970***
Age of building	-0.013	0.002	-5.391***
Distance to the nearest station	0.237	0.173	1.368
Distance to CBD	-0.038	0.007	-5.205***
LD_k (k=0,…,K)		Yes	
Log likelihood=51.139			
Number of observations=573			

Notes: The dependent variable is the log price. *,**, and *** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Table 6: Hedonic price regression based on the eclectic approach

	Coefficient	Std. error	t-value
Constant	-0.425	0.130	-3.281**
Floor space	0.004	0.000	28.139***
Age of building	-6.517	0.434	-15.007***
Distance to the nearest station	-0.555	0.029	-18.912***
Distance to CBD	-0.016	0.005	-3.362***
LD_k (k=0,…,K)		Yes	
Adjusted R-squared=0.3424			

Number of observations=9,120

Notes: The dependent variable is the log of individual prices per rentable floor space, which is defined by eq. (12). The estimated coefficients and standard errors are multiplied by 1000 except for the constant terms. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Figure 2 compares three different estimates of the capitalization rate, namely, $\hat{c}_t^A$, $\hat{c}_t^R$, and $\tilde{c}_t^R$, where $\hat{c}_t^R$ and $\tilde{c}_t^R$ are computed by dividing $\hat{y}_t$ by the quality adjusted prices obtained in Table 5 and Table 6, respectively. We see some substantial differences between the stock market-based and the appraisal-based capitalization rates. First, the stock market-based capitalization rate exhibits a sharp decline in 2006 and 2007, while the appraisal based capitalization rate declines only gradually during the same period. Second, the stock market-based capitalization rate starts to rise sharply in the second quarter of 2007, which continues until the first quarter of 2009. However, the appraisal-based capitalization rate continues to decline until the first quarter of 2009, when it starts to rise but only slightly. Finally, the stock market-based capitalization rate starts to decline again in the fourth quarter of 2012, when the government announced a new economic policy package, referred to as "Abenomics", including quantitative easing conducted by the Japanese central bank. In contrast, the appraisal-based capitalization rate remains unchanged during the same period.

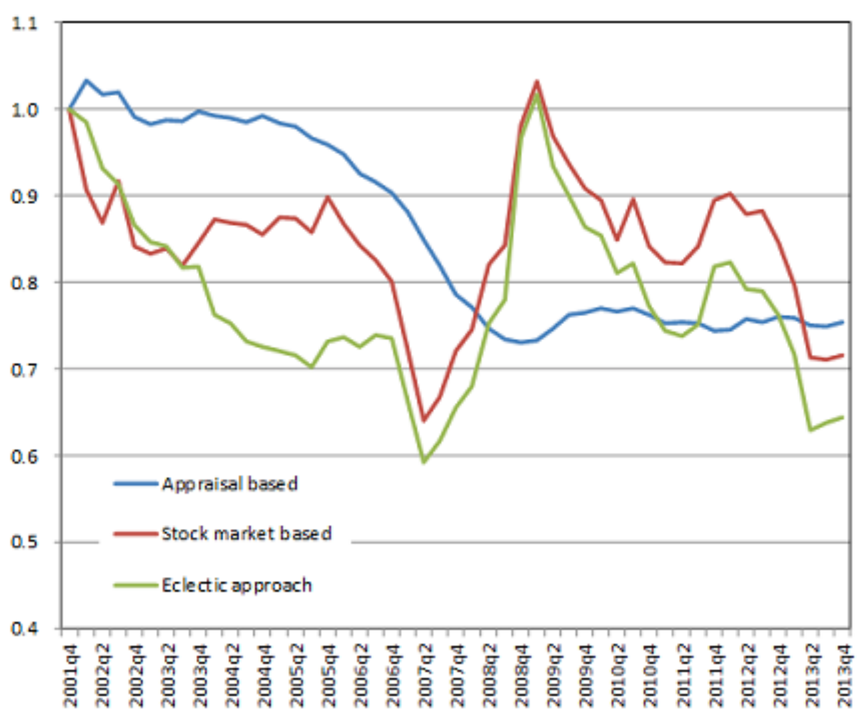

Figure 2: Capitalization rates

To see where the difference between $\hat{c}^R$ and $\hat{c}^A$ comes from, we estimate Tobin's q for individual REITs.[20] We focus on four representative J-REITs for which the data is available for a longer period: Nippon Building Fund, Japan Real Estate Investment Corporation, Global One, and Nomura Real Estate Office Fund.[21] In neoclassical investment theory, Tobin's q is defined as the ratio of the market value to the replacement value. In the case of REITs, the replacement value can be measured by the value of properties owned by a REIT. We compute Tobin's q by dividing the stock market value of a REIT by the sum of the appraisal values of properties owned by the REIT. The results are presented in Figure 3. The sample mean of Tobin's q is 1.08 and the standard deviation is 0.25, implying that Tobin's q is, on average, close to unity but it often deviates from unity.[22] The figure shows that Tobin's q for each REIT is slightly higher than unity in 2004-2005, but the values start to rise quickly in the latter half of 2006, eventually reaching more than 1.8 in the first half of 2007. Importantly, there is strong comovement in Tobin's q among the four REITs in 2006-2008, suggesting that the divergence between stock market-based prices and appraisal-prices was not caused by idiosyncratic factors but by common factors.

[20] See Tobin (1969) and Hayashi (1982). Hayashi and Inoue (1991) estimate Tobin's q for Japanese firms by explicitly accounting for the value of properties owned by firms.

[21] These four REITs specialize in investing in office buildings only and, more importantly, most of those office buildings are located in Tokyo. Moreover, the parent companies of the four J-REITs (Mitsui Fudosan, Mitsubishi Estate, Nomura Real Estate Development, and Meiji Life Insurance) all have a high credit rating, so that the stock prices of the four J-REITs do not depend much on factors other than the performance of their investments in commercial properties.

[22] According to Gentry and Mayer (2010), the mean and the standard deviation of Tobin's q in U.S. REITs in 1992-2002 are 1.04 and 0.12, respectively.

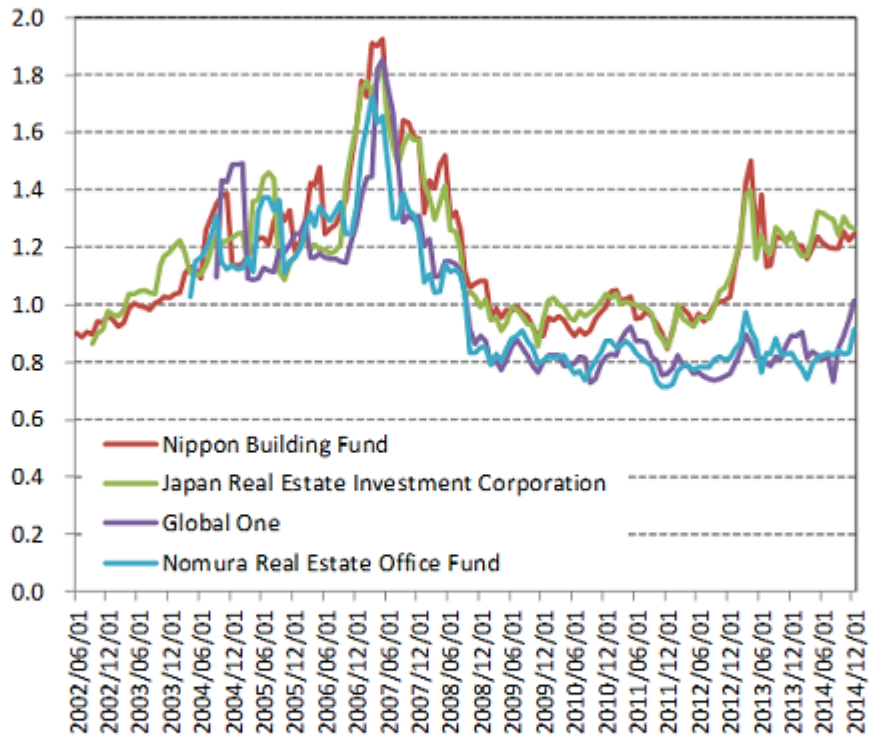

Figure 3: Estimates of Tobin's q for individual REITs

According to the investment theory, firms cannot adjust capital stocks immediately to the optimal level due to the presence of adjustment costs. For example, firms have to not run some of their machines while they install new machines. Gentry and Mayer (2010) shows that Tobin's q for U.S. REITs often deviates from unity, arguing that this is because REITs have to incur similar adjustment costs when they adjust their asset sizes, including the direct cost of selling/buying properties, as well as indirect costs associated with the difficulties of selling/buying a property when the existing owner has more information about the property than an outside buyer would have.[23] The deviation of Tobin's q from unity observed in the Japanese data may be due to the presence of similar adjustment costs. Note that, according to a rule set by the government, the amount of investment by a J-REIT is not allowed to exceed a ceiling, which is proportional to the appraisal value of its total assets. Therefore, it is possible that, even when the stock price of a REIT increases, the REIT may not be able to increase its investment if the appraisal value remains unchanged. This regulation may be another source of adjustment costs.

[23] Gentry and Mayer (2010) shows that REITs tend to increase investment, which is defined as the percentage change in total assets during the year, when Tobin's q is greater than unity. Specifically, their regression result indicates that a REIT whose q rises from 1.0 to 1.1 increases its assets by 4.3 percent in the next year. It is our future task to compare the sensitivity of REIT investment to q between U.S. and Japanese REITs.

Another possible reason for the deviation of Tobin's q from unity is measurement error in appraisal prices. That is, it seems likely that the share prices of the REITs accurately capture the hike in property prices in central Tokyo in 2006-2007, which is sometimes referred to as the "fund bubble", as well as the rapid drop in property prices on the back of the global financial crisis in 2008. On the other hand, appraisal prices may have been "too smooth" in the sense that they failed to capture the wild price fluctuations during this period.[24]

4.3. Existing versus new contracts

Next, we compare rents and prices based on existing contracts with those based on new contracts. To this end, we construct a separate dataset consisting of new rental contracts for 4,911 commercial properties. The underlying data were collected by a major brokerage company in Tokyo and we adjust rents by quality using hedonic regression. The regression result is presented in Table 7. Location dummies are included in order to make the result comparable to those reported in Table 4. In Figure 4, we compare the rent index based on new contracts only with the rent index estimated before. The two indexes exhibit basically similar ups and downs over the observation period as a whole, but they differ in some important respects.

Table7: Hedonic regression of new rental prices

	Coefficient	Std. error	t-value
Constant	8.875	0.074	119.635***
Floor space	0.004	0.000	80.743***
Age of building	-7.539	0.141	-53.679***
Distance to the nearest station	-0.271	0.009	-30.847***
Distance to CBD	-0.042	0.002	-25.788***
LD_k (k=0,…,K)		Yes	
Adjusted R-squared=0.5168			
Number of observations=26,933			

[24] Crosby et al. (2010) argue that investment companies that manage REITs have different incentives to update property valuations depending on whether prices are rising or falling. That is, during periods when the property market is heating up, investment companies have an incentive to increase property prices appropriately in accordance with changes in the market. On the other hand, when the market is falling, investment companies have an incentive to urge property appraisers not to lower property appraisal prices in order to maintain their loan-to-value ratio within a certain range. Our finding that appraisal prices were not updated fully when property prices were on an upward trend is inconsistent with this story.

Notes: The dependent variable is the log of rental prices per rentable floor space. The estimated coefficients and standard errors are multiplied by 1000 except for the constant terms. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

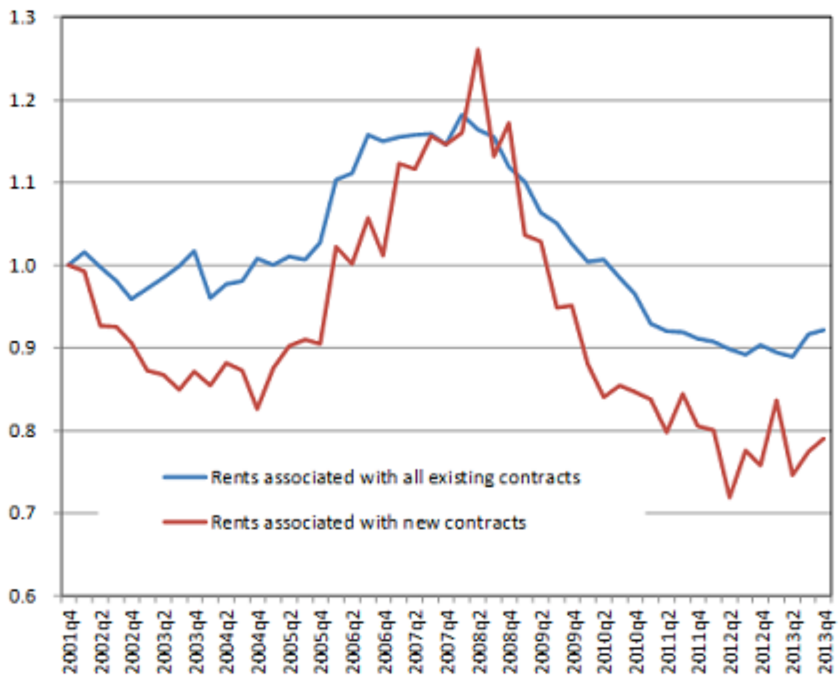

Figure 4: Hedonic estimates of rent indexes

First, the index for new contracts is about twice as volatile as the index for existing contracts. Specifically, setting the level for the second quarter of 2001 to 1, the index for existing contracts moves in a range between 0.9 and 1.2, while the index for new contracts ranges from 0.7 to 1.3. As shown in eq. (15), the index for existing contracts is a moving average of the index for new contracts, so that the lower volatility of the index for existing contracts is not very surprising. To estimate the Calvo parameter λ, we run a regression of the form

$$\hat{y}_t = (1-\lambda)\hat{y}_t^N + \lambda\hat{y}_{t-1}, \qquad \text{(eq 21)}$$

where $\hat{y}_t$ and $\hat{y}_t^N$ are the quality-adjusted rent indexes for all existing contracts and for new contracts. We find that λ = 0.966 with a standard error of 0.030 (adjusted R-squared=0.933). This estimate indicates that 3.4 percent of rental prices are updated every quarter, implying that the average length of rental contracts is about 29 quarters (i.e., 1/(1 - 0.966) = 29.411).[25] The finding that the average length of rental contracts is about 29 quarters suggests the presence of very high stickiness in rental prices.

Second, the index for new contracts precedes the index for existing contracts at the turning points. Specifically, the trough for the index for new contracts falls into the third quarter of 2003, while the trough for the index for existing contracts falls in the first quarter of 2004, indicating the presence of a two-quarter delay. Similarly, when the two indexes start to decline in 2008 in response to the global financial crisis, the index for new contracts precedes the index for existing contracts by a few quarters. This is consistent with the finding by Shimizu et al. (2010a) for residential property prices.

Finally, Figure 5 shows the estimates of three price indexes based on different combinations of using new and existing contracts and the stock market-based capitalization rate and the appraisal-based capitalization rate. Specifically, it shows the index when using new contracts and the stock market-based capitalization rate ($\hat{y}_t^N/\hat{c}_t^R$), the index when using existing contracts and the stock market-based capitalization rate ($\hat{y}_t/\hat{c}_t^R$), and the index when using existing contracts and the appraisal-based capitalization rate ($\hat{y}_t/\hat{c}_t^A$).

[25] It is assumed in the Calvo model that price adjustment follows a Poisson process. Specifically, a typical rental contract is renewed with probability 1 - λ, so that the probability that a contract survives exactly τ periods is equal to $\lambda^{-1}(1 - \lambda)$. Thus, the expected lifetime of a contract can be computed as $\sum_{\tau=1}^{\infty} \tau \times \lambda^{\tau-1}(1-\lambda) = 1/(1-\lambda)$.

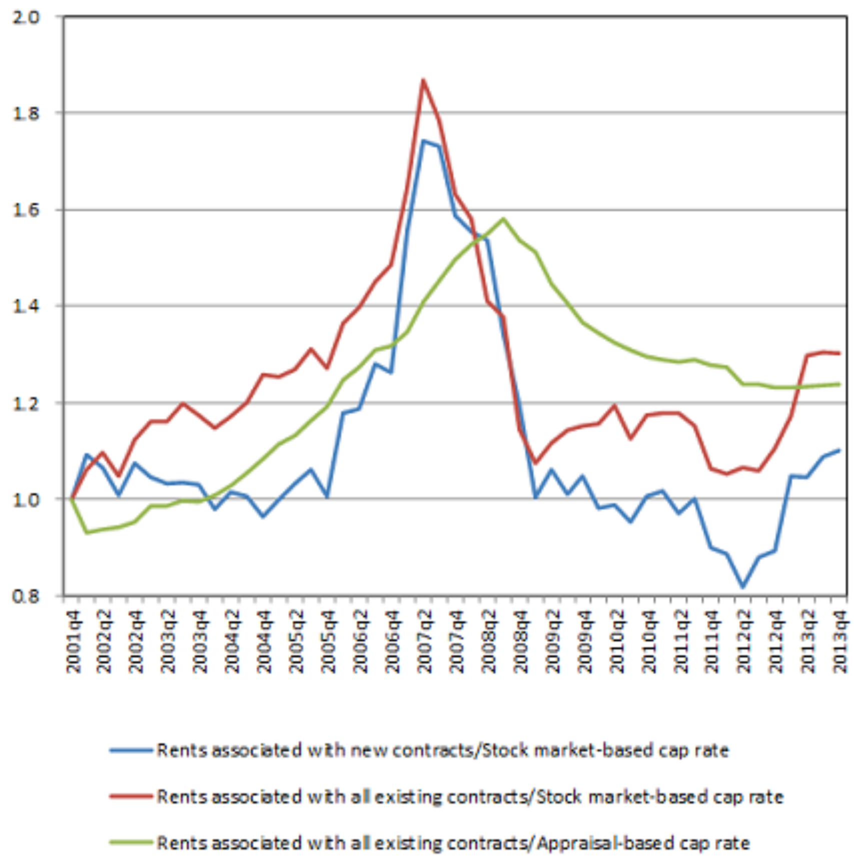

Figure 5: Estimates of property price indexes

First, we see that each of the three indexes rises from 2003 to 2007, but their growth rates differ substantially. The average annual growth rate during this period is 5.9 percent for $\hat{y}_t/\hat{c}_t^A$ (rent income from existing contracts/appraisal-based capitalization rate), 3.2 percent for $\hat{y}_t/\hat{c}_t^R$ (rent income from existing contracts/stock market-based capitalization rate), and 2.0 percent for $\hat{y}_t^N/\hat{c}_t^R$ (rent income from new contracts/stock market-based capitalization rate). The considerable difference in growth rates is mainly due to the sticky (and therefore less volatile) movement of the existing rent index. Second, the timing of the peaks differs substantially. That is, $\hat{y}_t/\hat{c}_t^R$ and $\hat{y}_t^N/\hat{c}_t^R$ peak in the second quarter of 2007, while $\hat{y}_t/\hat{c}_t^A$ peaks in the third quarter of 2008, indicating the presence of a five-quarter lag. This suggests that we may be able to detect a market turning point much earlier by utilizing information from the REIT market.

5. Conclusion

This study sought to reconsider the estimation of commercial property price indexes. While appraisal-based property price indexes are widely used in countries such as Japan, the U.S., and the U.K., questions have been raised as to whether they adequately reflect market conditions. At the same time, it has generally been difficult to use transaction prices for the estimation of commercial property price indexes because of a lack of sufficient transaction price data. A further complication is that commercial properties tend to be considerably more heterogeneous than residential properties, so that rigorous quality adjustments are necessary.

Against this background, we sought to develop a new method to estimate quality adjusted commercial property price indexes using real estate investment trust (REIT) data. Our method is based on the present value approach, but the way the denominator (i.e., the capitalization rate) and the numerator (i.e., cash flows from properties) are estimated differs from the traditional approach. We estimate the capitalization rate based on the share prices of REITs, which can be regarded as the stock market's valuation of the set of properties owned by the REITs. As for the numerator, we use not only rental prices associated with all contracts existing at a particular point in time, but also rental prices associated with new contracts made in a particular year. Rental prices associated with all contracts represent actual payments from tenants to property owners, so that they make an obvious candidate for the numerator. However, ongoing rental payments based on leases agreed in the past deviate from rental rates associated with new contracts entered today, meaning that rent indexes using rent data on existing contracts tend to lag behind rent indexes using rent data on new contracts. This implies that future cash flows from properties can be predicted more precisely by employing rents associated with new contracts. We used rent data on new contracts as an alternative variable for the numerator to construct a better leading indicator of price changes.

Using a dataset with prices and cash flows for about 400 commercial properties included in Japanese REITs for the period 2001 to 2013, we found that our price index signals turning points much earlier than an appraisal-based price index; specifically, our index peaks in the second quarter of 2007, while the appraisal-based price index exhibits a turnaround only in the third quarter of 2008. This suggests that the share prices of REITs provide useful information in constructing commercial property price indexes. Although the empirical analysis in this paper demonstrated the usefulness of our approach, there still remain some issues that were not fully addressed here. First, we showed that Tobin's q, i.e., the ratio of the stock market valuation of the properties owned by REITs to the appraisal valuation, was close to unity in 2002-2005 but deviated from unity in 2006 and 2007. Our explanation was that the deviation from unity occurred due to the presence of adjustment costs associated with the increasing/decreasing size of assets held by a REIT. However, this raises a number of questions such as where these adjustment costs come from; whether they are related with institutional arrangements regarding REITs, and if so, how; and how quickly (or slowly)

REITs adjust the size of their assets when q deviates from unity. Addressing these questions would be an important step to deepening our understanding on the relationship between the stock price of a REIT and the transaction/appraisal value of the set of properties owned by the REIT. Second, we need to make sure that our empirical results are robust to changes in the econometric methodology and data employed. Specifically, the hedonic regressions we ran in this paper contain only a minimum set of attribute variables, such as the size, age, and location of a property. We need to check the robustness of our results to the inclusion of additional attribute variables such as time since negotiation in the appraisal price equation. Another important task is to see how our empirical results would change if we allow for the possibility of structural breaks. For example, there may well have been a structural break after the global financial crisis. These issues are left for future research.

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