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Estimating Quality Adjusted Commercial Property Price Indexes Using Japanese REIT Data

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Abstract

We propose 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 discount rate) and the numerator (i.e., cash flows from properties) are estimated differs from the traditional method. We estimate the discount 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 rental prices associated only with new rental contracts rather than those associated with all existing contracts. Using a dataset with prices and cash flows for about 500 commercial properties included in Japanese REITs for the period 2003 to 2010, we find that our price index signals turning points much earlier than an appraisal-based price index; specifically, our index peaks in the first quarter of 2007, while the appraisal-based price index exhibits a turnaround only in the third quarter of 2008. Our results suggest that the share prices of REITs provide useful information in constructing commercial property price indexes.

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Keywords: REIT; quality adjusted price index; hedonic regression; 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 real estate price bubbles. For example, it is widely accepted that the collapse of Japan's land/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 U.S. in 2008 and the recent 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.[1] 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 are lagging behind, 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 properties.

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. With these indexes being used, questions have been raised about whether fluctuations in appraisal-based property price indexes diverge from actual market conditions. However, 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.

[1] The Handbook is available online at
`http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/methodology/owner_occupied_housing_hpi/rppi_handbook`.

Given the limited availability of transaction price data, we propose in this paper to employ the present value approach in constructing commercial property price indexes. Employing the present value approach in estimating commercial property prices is not new. In fact, several versions of the present value approach have already been adopted by practitioners, especially by appraisers. However, in our method, the way the denominator (i.e., the discount rate) and the numerator (i.e., cash flow from properties) are estimated differs from the traditional method.

First, we estimate the discount rate using the stock market valuation of the set of properties owned by a real estate investment trust (REIT). Specifically, REITs disclose information on the appraisal value of each property owned by the REIT and on the net operating income (NOI) from it. The capitalization rate (or the cap 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 price but by the share price of the REIT to obtain an alternative measure of the cap rate. Second, as for the numerator (cash flow from properties), we use rental prices associated with new contracts made in a particular year rather than those associated with the entire contracts existing at a particular point in time. It is widely recognized that ongoing rent based on leases agreed in the past deviates from the rent associated with a new contract made today, and that rent indexes using rent data on existing contracts tend to lag behind rent indexes using rent data on new contracts.[2] Therefore, future cash flows from properties can be predicted more precisely by employing rents associated with new contracts.

Using a dataset with prices and cash flows for about 500 commercial properties included in Japanese REITs for the period 2003 to 2010,[3] we find that the discount 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 points earlier than the traditional measure based on appraisal prices: for example, the stock market-based index hits a peak in the first 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

[2]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.

[3]The amount of office investment via REITs for Japan stood at 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.

Table 1: Commercial property price indexes

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.
Moody's/RCA CPPI	Transaction prices	Repeat sales	Monthly	U.S.
FTSE NAREIT PureProperty Index	REIT returns	De-levered regression	Daily	U.S.

related to the estimation of commercial property price indexes. Section 3 then explains our methodology and the data we use. Next, 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 Moody's/RCA Commercial Property Price Index (CPPI) and the MIT/CRE's transaction-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.

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.[4] First, they may not be able to precisely capture turning points in prices ("lagging problem"). Second, they tend to diverge from transaction prices in periods of wild market fluctuation ("valuation error problem"). 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

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

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 ("smoothing problem"), so that they tend to underestimate price volatility. Geltner and Goetzmann (2000) construct a transaction-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.[5]

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 (2007), the quality of buildings changes over time due to aging and renovation, 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 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 biases stemming from quality changes over time.[6]

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

[5] See Quan and Quigley (1991) and Clayton et al. (2001) 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 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 in the construction of an index. Shimizu et al. (2012) argue that this at least partly contributes to excessive smoothness.

[6] 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. (2009), clients may seek to persuade property appraisers to raise the price in an attempt to maintain the property's investment performance.

U.S. They are both quality adjusted by the repeat sales method.[7] 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, the IPD is moving toward the development of a transaction price index which is quality adjusted employing the hedonic method (Devaney and Diaz 2009).

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. 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. Generally, when one tries to collect commercial property transaction prices, it is collected based on registry information. 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 by the hedonic approach.

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 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 United States. 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 will propose in the next section is based on the share prices of REITs, but the way we use stock market information differs from the one employed in the previous studies.

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

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	
TS	Time to the nearest station	Minutes
TT	Travel time to CBD	Minutes
LHD	Leasehold dummy	Leasehold = 1; Owner right = 0
LD_k $(k = 0, \ldots, K)$	Location dummies	

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 2010. 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 an increase in cross-border transactions of 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 prices 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.

The dataset contains appraisal prices for the properties owned by Japanese REITs, which are updated by appraisers once every six months. 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 Japanese

Table 3: Descriptive statistics on appraisal prices and net operating income

Appraisal prices (Number of observations=4,993)				
	Mean	STD	Min	Max
Price (million yen)	8,428	11,767	323	138,000
Land area (m^2)	2,888	5,767	119	57,177
Floor space (m^2)	18,521	35,170	601	442,150
Rentable floor space (m^2)	7,308	8,455	494	95,697
Price per rentable square meter (million yen)	1.11	0.61	0.16	4.97
Age of building (years)	16.7	8.4	0.1	51.2
Number of stories	11.4	6.9	3	54
Time to the nearest station (minutes)	3.6	2.5	1.0	15.0
Travel time to CBD (minutes)	9.3	7.9	1.0	72.0
Net operating income (Number of observations=4,926)				
	Mean	STD	Min	Max
Net operating income (million yen)	413	501	15	5,268
Income price ratio	0.054	0.012	0.020	0.110
Land area (m^2)	2,894	5,791	119	57,177
Floor space (m^2)	18,556	35,215	601	442,150
Rentable floor space (m^2)	7,339	8,486	494	95,697
Income per rentable square meter (million yen)	0.06	0.02	0.01	0.22
Price per rentable square meter (million yen)	1.12	0.61	0.16	4.97
Age of building (years)	16.7	8.4	0.1	51.2
Number of stories	11.4	6.9	3	54
Time to the nearest station (minutes)	3.6	2.5	1.0	15.0
Travel time to CBD (minutes)	9.3	7.8	1.0	72.0

REITs for which appraisal prices and NOI are all available is 531.

Information available on the attributes of commercial properties includes land area (L: m^2), floor space of building (S: m^2), rentable floor space[8] (RS: m^2), age of building (A: years), number of stories (H: number of stories), nearest station and time required to reach it (TS: minutes), average day-time travel time to the central business district (TT: minutes), 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.

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 flow from property i in period t. We assume that the income flow for property i depends

[8]Rentable floor space refers to the building floor space within the transaction target 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 eliminated from this.

on the property's attributes and is determined as follows:

$$\ln y_{it} = \sum_j \alpha_j Z_{ij} + f_t, \tag{1}$$

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, which is denoted by v_{it}, is given by[9]

$$v_{it} = E_t \sum_{\tau=0}^{\infty} \frac{y_{it+\tau}}{\exp\left(\sum_{s=0}^{\tau-1} r_{t+s}\right)} = y_{it}\phi_t, \tag{2}$$

where r_t is the discount rate in period t, and ϕ_t is defined as

$$\phi_t \equiv E_t \sum_{t=0}^{\infty} \frac{\exp\left(f_{t+\tau} - f_t\right)}{\exp\left(\sum_{s=0}^{\tau-1} r_{t+s}\right)}. \tag{3}$$

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

$$\ln v_{it} = \sum_j \alpha_j Z_{ij} + f_t + \ln \phi_t, \tag{4}$$

indicating that the quality-adjusted price is given by $\exp[f_t + \ln \phi_t]$. Note that equation (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 a 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 work. As an alternative, we propose to use the share prices of individual REITs in constructing a quality-adjusted price index.

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

[9] 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, equation (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.

may change over time. The income flow of REIT r is the sum of income from the properties owned by the REIT, which is given by

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

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

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

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 Japanese REITs have to be in the form of real estate property,[10] and most of REITs' income derives from the properties they own. 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.

Equations (1) and (5) imply

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

Alternatively,

$$\ln Y_{rt} = f_t + \ln \left[\sum_{i \in A_{rt}} \exp \left(\sum_j \alpha_j Z_{ij} \right) \right]. \tag{8}$$

Similarly, equations (4) and (5) imply

$$\ln V_{rt} = f_t + \ln \phi_t + \ln \left[\sum_{i \in A_{rt}} \exp \left(\sum_j \alpha_j Z_{ij} \right) \right]. \tag{9}$$

Finally, subtracting (9) from (8), we obtain

$$\ln Y_{rt} - \ln V_{rt} = -\ln \phi_t. \tag{10}$$

Note that the cap rate for REIT r, i.e., the ratio of Y_{rt} to V_{rt}, is given by ϕ_t^{-1}, and that it does not depend on property attributes at all. The fact that it does not depend on

[10]The Securities Listing Regulations issued by Tokyo Stock Exchange, Inc., state (as of May 10, 2012): "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).

property attributes means that the cap rate is already quality adjusted. We exploit this fact in constructing quality-adjusted price indexes. Specifically, the estimation procedure we employ consists of the following steps. First, we estimate quality-adjusted renal income, i.e., f_t in equation (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 use the data on the income flow and share price for individual REITs to estimate the cap rate, $-\ln\phi_t$ in equation (10), for individual REITs. We then take the simple average of the estimated cap rates across REITs. Finally, we estimate quality-adjusted prices, $f_t + \ln\phi_t$ in equation (9), by subtracting the estimate of $-\ln\phi_t$ obtained in the second step from the estimate of f_t obtained in the first step.

An alternative to our approach would be to apply a hedonic regression to Y_{rt}. Specifically, the Taylor series of $\sum_{i\in A_{rt}} \exp\left(\sum_j \alpha_j Z_{ij}\right)$ in equation (8) is given by

$$\sum_{i\in A_{rt}} \left(\sum_j \alpha_j Z_{ij}\right) + \text{higher-order terms} \tag{11}$$

Using this approximation, equation (8) can be rewritten as

$$\ln Y_{rt} \approx f_t + \ln\left[\sum_{i\in A_{rt}} \left(\sum_j \alpha_j Z_{ij}\right)\right] = f_t + \ln\left[\sum_j \alpha_j \left(\sum_{i\in A_{rt}} Z_{ij}\right)\right] \tag{12}$$

Note that $\sum_{i\in A_{rt}} Z_{ij}$ in the final term is the average value of a particular attribute (e.g., the floor space of a property) across properties owned by REIT r. Applying a hedonic regression to (12) would provide an estimate of α_j for $j = 1, 2, \ldots$ as well as the estimate of f_t, which is a type of quality-adjusted price index. In fact, this is close to the approach advocated by Geltner and Kluger (1996) and Horrigan et al. (2009).[11] Note that (12) is an approximation to (8), so that whether a hedonic regression works or not crucially depends on the precision of this approximation. More importantly, it is highly likely that $\sum_{i\in A_{rt}} Z_{ij}$ does not vary much across r at least for some attributes. For example, let us assume that REIT r owns properties with small, medium, and large floor spaces in order to diversify its

[11] 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: delevered return$_{rt} = \sum_j b_{jt} x_{jrt}$, 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. The regression coefficient b_{jt} represents the return for market segment j.

real estate portfolio, so that the variation in floor space across properties owned by REIT r is very large. The same must be true for REIT r'. However, if one compares the average floor space for the properties owned by REIT r and for the properties owned by REIT r', the difference will not be particularly large. If variation in $\sum_{i\in A_{rt}} Z_{ij}$ across r for some property attributes is small, this will make the estimates of α_j less reliable, meaning that the estimated quality-adjusted price index will be less precise.

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

$$\sum_i \ln y_{it} = (1-\lambda)\sum_i \ln y_{it}^N + \lambda \sum_i \ln y_{it-1}, \tag{13}$$

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 analysis.[12] Equation (13) can be rewritten as

$$\sum_i \ln y_{it} = (1-\lambda)\sum_{\tau=0}^{\infty} \lambda^\tau \left(\sum_i \ln y_{it-\tau}^N\right), \tag{14}$$

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 equation (1) for y_{it} and the corresponding one, denoted by f_t^N, for y_{it}^N. We then estimate two kinds of quality adjusted prices: $f_t + \ln\phi_t$ and $f_t^N + \ln\phi_t$.

4 Empirical Results

4.1 Hedonic regressions

We run hedonic regressions for income (NOI) and appraisal prices to conduct quality adjustments. We denote the appraisal price of a property i in period t by v_{it}^A. The hedonic

[12]Shimizu et al. (2010a) apply a Calvo model to rental prices of residential properties to find that an equation like (13) fits the data well.

equations for y and v^A are given by

$$\ln y_{it} = \alpha_0 + \sum_j^J \alpha_j Z_{ijt} + \sum_t^T \nu_t D_t + \epsilon_{yit} \tag{15}$$

$$\ln v_{it}^A = \beta_0 + \sum_j^J \beta_j Z_{ijt} + \sum_t^T \xi_t D_t + \epsilon_{vit}, \tag{16}$$

where Z_{ijt} represents attribute j of property i ($j = 1, \ldots, J$) and D_t represents time dummies ($t = 1, \ldots, T$). Note that the corresponding cap rate, c_{it}^A, which is defined by $c_{it}^A \equiv y_{it}/v_{it}^A$, is given by

$$\ln c_{it}^A = (\alpha_0 - \beta_0) + \sum_j^J (\alpha_j - \beta_j) Z_{ijt} + \sum_t^T (\nu_t - \xi_t) D_t + (\epsilon_{yit} - \epsilon_{vit}) \tag{17}$$

The quality-adjusted values for price, income, and the cap rate, which are denoted by $\hat{y}_t$, $\hat{v}_t^A$, and $\hat{c}_t^A$, are given by

$$\hat{y}_t = \exp(\nu_t); \quad \hat{v}_t^A = \exp(\xi_t); \quad \hat{c}_t^A = \exp(\nu_t - \xi_t). \tag{18}$$

Table 4 presents the regression results for equations (15) and (16). The regression result for (15) 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 equation (16). However, more interesting are the results reported in the final column of the table, which shows the difference between the coefficients in the two regressions. As we saw in the last section, the coefficients associated with each attribute should be identical between the two regressions (i.e., the regressions for income and for prices), as shown in equations (1) and (4). However, the final column of the table shows that the estimated coefficients are significantly different. For example, if the age of a building increases by one year, $\hat{y}$ decreases by 0.6 percent, while $\hat{v}^A$ decreases by 0.9 percent, and consequently $\hat{c}$ increases by 0.3 percent. In other words, the result indicates that the cap rate for a particular property depends on its age, which is clearly inconsistent with the theoretical argument in the previous section. However, 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 two regressions.

Table 4: Hedonic regressions of income and appraisal prices

	Appraisal price equation		Income equation		Difference
	Coefficient	Std. error	Coefficient	Std. error	
Constant	13.614***	0.117	11.057***	0.130	2.557***
Floor space (m^2)	0.002	0.003	0.006*	0.003	-0.005**
Age of building (years)	-0.009***	0.001	-0.006***	0.001	-0.003***
Number of stories	0.006***	0.002	-0.001	0.002	0.007***
Time to the nearest station (minutes)	-0.018***	0.004	-0.004	0.005	-0.014***
Travel time to CBD (minutes)	-0.023***	0.005	-0.015***	0.006	-0.008***
LD_k $(k = 0, \dots, K)$	Yes		Yes		
Adjusted R-squared	0.889		0.773		
Number of observations	4,926		4,926		

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

Figure 1 displays the trends 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 third 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 cap rate. The figure also shows that the decline of $\hat{v}^A$ since the end of 2008 was also accompanied by a decline in $\hat{y}$ and a rise in $\hat{c}^A$.

4.2 Stock market-based measure of the cap rate

As stated in the previous section, for a typical Japanese REIT, the properties it owns account for 90 percent or more of its total assets and the rental income from the properties accounts for most its total income. Given this balance sheet structure, we estimate the value of properties owned by a REIT by adding the value of short- and long-term debts to its share value. We then calculate the cap rate of a REIT by dividing its annual income (NOI) by the sum of the share price and the value of short- and long-term debts. The cap rate for REIT r at period t is given by

$$c_{rt}^R \equiv \frac{\sum_{i \in A_{rt}} y_{it}}{Share_{rt} + Debt_{rt}} \tag{19}$$

where $Share_{rt}$ is the share price of REIT r at period t and $Debt_{rt}$ represents the sum of short- and long-term debts.

In our empirical exercises, we focus on four J-REITs: Nippon Building Fund, Japan Real Estate Investment Corporation, Global One, and Nomura Real Estate Office Fund. The main reason we focus on these four REITs is that they are homogeneous in the sense that all of them specialize in investing in office buildings only and, more importantly, most of those office buildings are located in Tokyo. Moreover, the parent companies of these four J-REITs (Mitsui Fudosan, Mitsubishi Estate, Nomura Real Estate Development, and Meiji Life Insurance) all have a high credit rating, so that the market values of the four J-REITs do not depend much on factors other than the performance of their investments in commercial properties.

Figure 2 compares the developments in two different estimates of the cap rate, namely, $\hat{c}_t^A$ and c_t^R. Note that the c_t^R shown in the figure is the simple average of the estimated cap rates for the four REITs. We see that the stock market-based cap rate, c^R, is much lower than the cap rate based on appraisal prices, $\hat{c}^A$. Specifically, at the beginning of 2003, c^R is about 2 percent lower than $\hat{c}^A$ and the difference between the two does not change much between 2003 and 2008, when both c^R and $\hat{c}^A$ exhibit a significant decline. Note that $c^R < \hat{c}^A$ means that Tobin's q, which is defined as the ratio of the stock market valuation of the properties to the appraisal valuation, is greater than unity.[13] However, c^R and $\hat{c}^A$ display very different trends from the first half of 2007. Specifically, c^R exhibits a sharp rise from 2007 to 2009, while $\hat{c}^A$ continues to decline until the second quarter of 2008, when it starts to gradually rise again. Next, we convert the cap rates into risk premiums, defined as the cap rate plus the expected growth rate of NOI minus the risk free rate. The result is shown in Figure 3.[14] The pattern we observe is very similar to that in Figure 2 for the cap rates.

To see where the difference between c^R and $\hat{c}^A$ comes from, we estimate Tobin's q for individual REITs. The results are presented in Figure 4. 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.

A 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

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

[14]As for the expected growth rate of income from property investments, we assume perfect foresight and calculate the growth rate over eight quarters. We use the return on 10-year Japanese government bonds as the risk free rate.

"too smooth" in the sense that they failed to capture the wild price fluctuations during this period.[15] Another possible reason for the deviation of Tobin's q from unity may be a lack of price arbitrage between the stock market and the property market. Specifically, when Tobin's q is greater than unity for a REIT, it would be possible to make a profit by acquiring properties via the stock market by purchasing the shares of a REIT and selling the properties in the actual property market. However, for certain (unknown) reasons such arbitrage transactions may not have taken place. In fact, as highlighted by Lamont and Thaler (2003), there are cases in financial markets in which a lack of price arbitrage is observed; for example, the prices of closed-end mutual funds sometimes deviate from the underlying value of the asset they own. We cannot rule out the possibility that such "mispricing" occurred in the J-REIT market during this period.

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 3,985 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 5. Location dummies are included in order to make the result comparable to those reported in Table 4. In Figure 5, 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.

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 1.1, or 10 percent below and above the initial level, while the index for new contracts ranges from 0.8 to 1.2. As shown in equation (14), 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 in (13) and (14), we run a regression of the form

$$\hat{y}_t = (1-\lambda)\hat{y}_t^N + \lambda \hat{y}_{t-1}, \tag{20}$$

[15] Crosby et al. (2009) 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 company 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.

Table 5: Hedonic regression of new rental prices

	Coefficient	Std. error
Constant	9.854***	0.091
Floor space (m^2)	0.000***	0.000
Age of building (years)	-0.007***	0.000
Number of stories	0.013***	0.002
Time to the nearest station (minutes)	-0.018***	0.002
Travel time to CBD (minutes)	-0.001	0.001
LD_k $(k = 0, \ldots, K)$	Yes	
Adjusted R-squared=0.556		
Number of observations=3,985		

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

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 $\lambda = 0.874$ with a standard error of 0.050 (adjusted R-squared=0.892). This estimate indicates that 12.6 percent of rental prices are updated every quarter, implying that the average length of rental contracts is about eight quarters (i.e., $1/(1 - 0.874) = 7.936$).[16]

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 fall into the second quarter of 2003, while the trough for the index for existing contracts falls in the fourth quarter of 2004, indicating the presence of a six-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 6 shows the estimates of three price indexes based on different combinations of using new and existing contracts and the stock market-based cap rate and the appraisal-based cap rate. Specifically, it shows the index when using new contracts and the stock market-based cap rate ($\hat{y}_t^N/c_t^R$), the index when using existing contracts and the stock market-based cap rate ($\hat{y}_t/c_t^R$), and the index when using existing contracts and the appraisal-based cap rate ($\hat{y}_t/c_t^A$)

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

First, we see that each of the three indexes rise 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 cap rate), 3.2 percent for $\hat{y}_t/c_t^R$ (Rent income from existing contracts/stock market-based cap rate), and 2.0 percent for $\hat{y}_t^N/c_t^R$ (Rent income from new contracts/stock market-based cap 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, $\hat{y}_t/c_t^R$ and $\hat{y}_t^N/c_t^R$ peaks in the first quarter of 2007, while $\hat{y}_t/\hat{c}_t^A$ peaks in the third quarter of 2008, indicating the presence of a six-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

With regard to the estimation of commercial property price indexes, appraisal-based property price indexes have been published for many years in several countries such as Japan, the U.S., and the U.K. Yet, although such indexes are widely used, questions have been raised as to whether appraisal-based property indexes adequately reflect market conditions. At the same time, using transaction prices for the estimation of indexes has faced considerable difficulties in many countries, including Japan, 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.

In this paper, 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 discount rate) and the numerator (i.e., cash flows from properties) are estimated differs from the traditional approach. We estimate the discount 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 rental prices associated only with new rental contracts rather than those associated with all existing contracts.

Using a dataset with prices and cash flows for about 500 commercial properties included in Japanese REITs for the period 2003 to 2010, we found that our price index signals turning points much earlier than an appraisal-based price index; specifically, our index peaks in the first 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. We also found 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 2004-2005 but started to rise quickly in the latter half of 2006, eventually reaching over 1.8 in 2007. We argued that the deviation of Tobin's q from unity may be due to measurement errors in appraisal prices or may stem from a lack of price arbitrage between the stock market and the property market.

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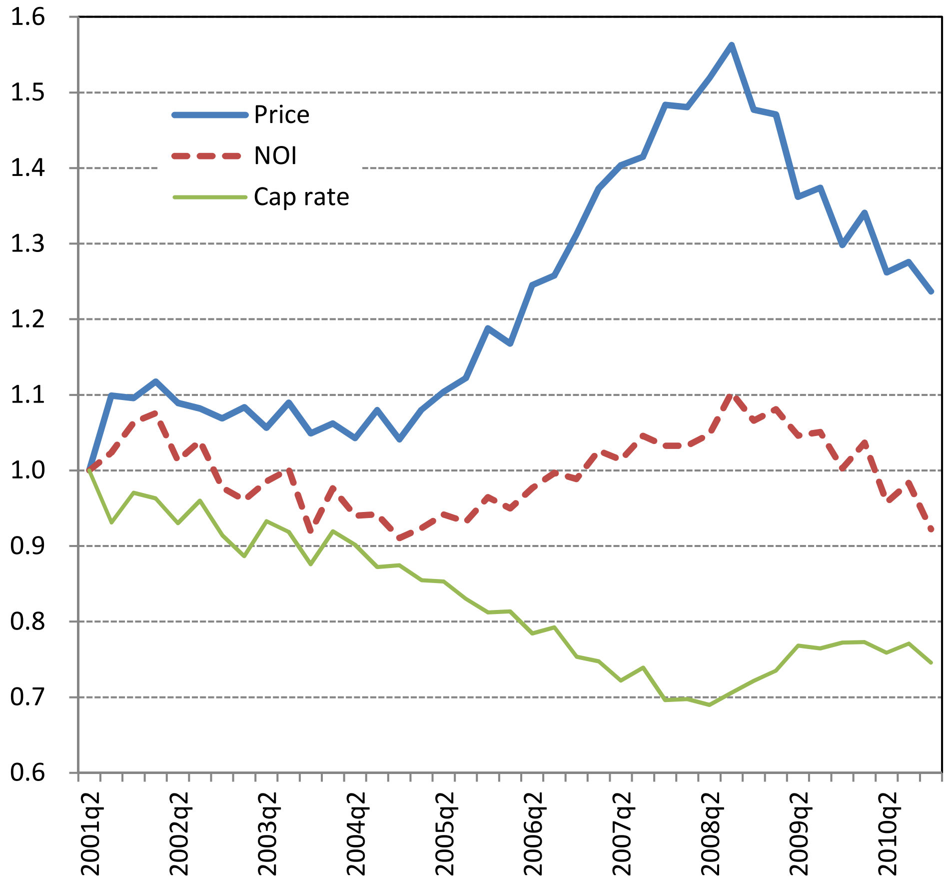

Figure 1: Hedonic estimates of appraisal price, NOI, and the cap rate

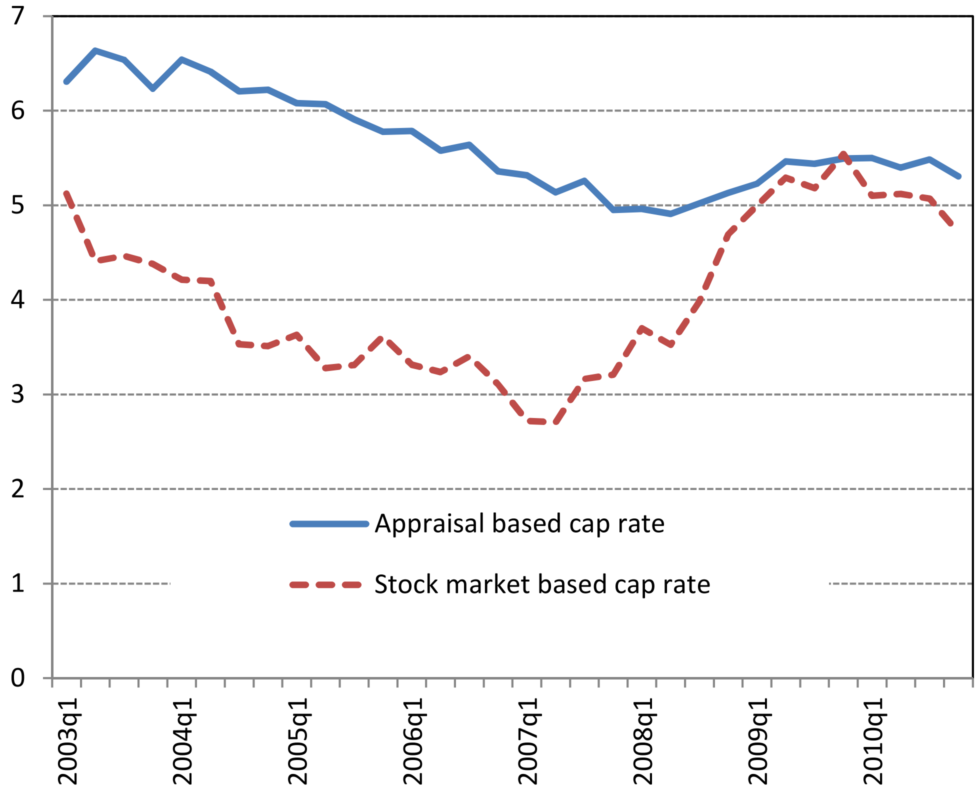

Figure 2: Cap rates

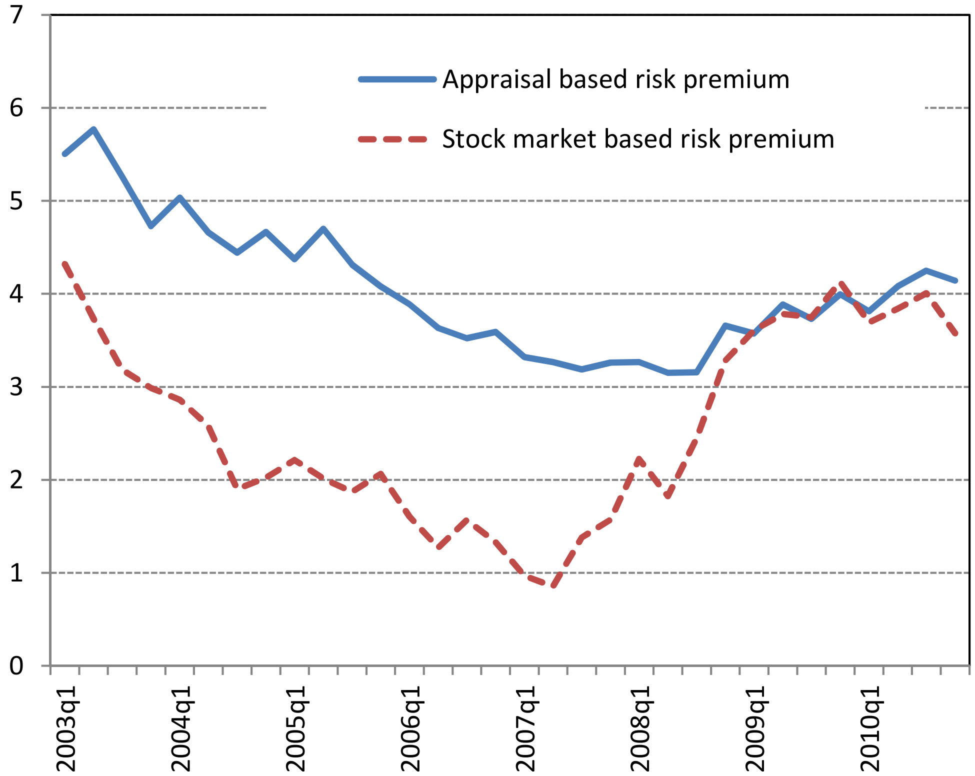

Figure 3: Estimates of risk premiums

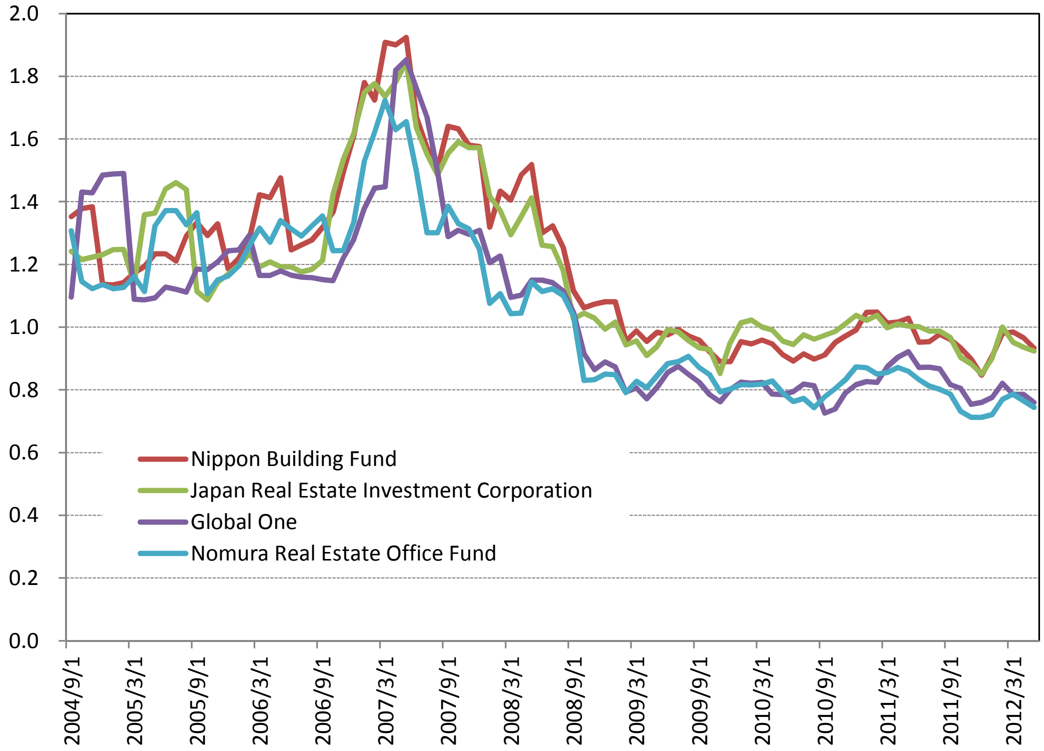

Figure 4: Estimates of Tobin's q for individual REITs

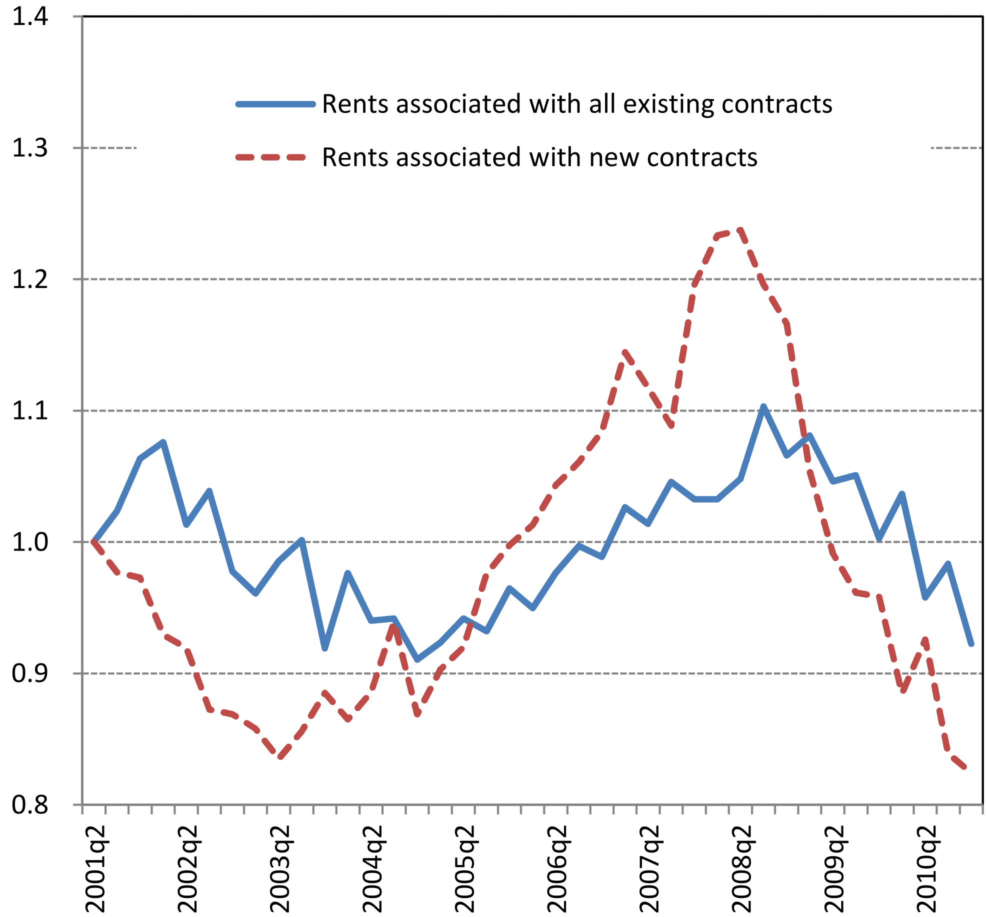

Figure 5: Hedonic estimates of rent indexes

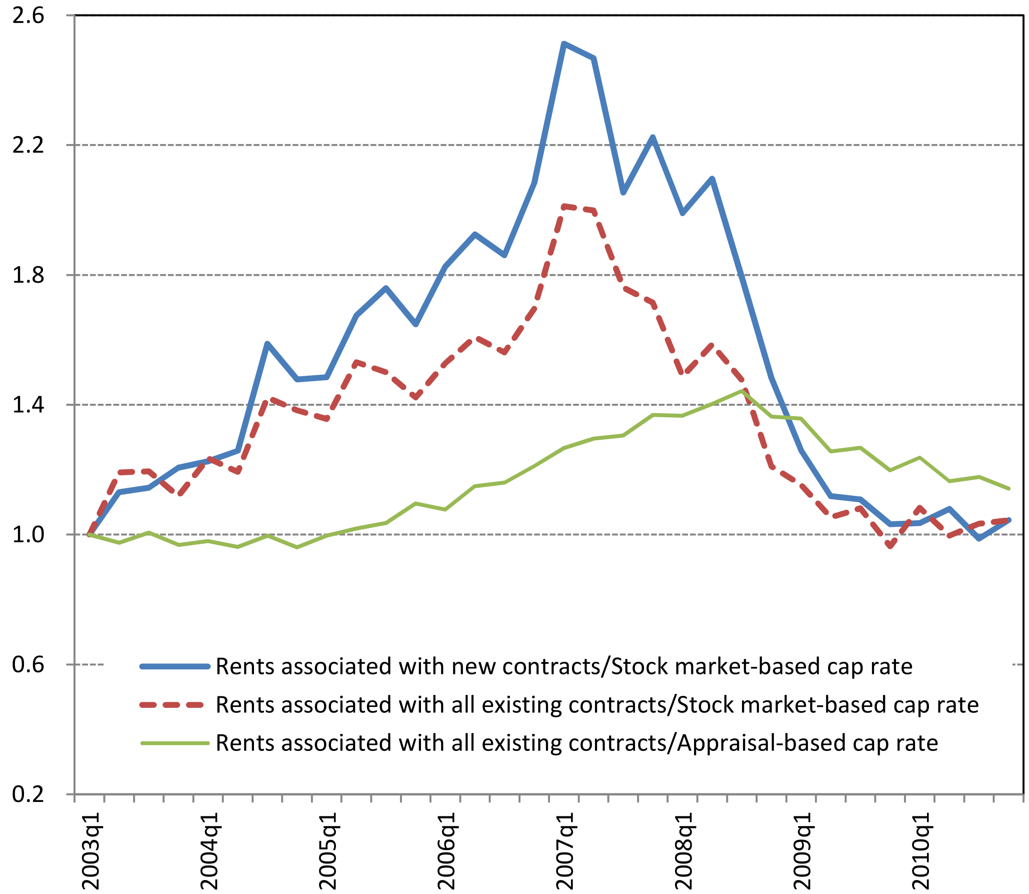

Figure 6: Estimates of property price indexes