Reitaku Institute of Political Economics and Social Studies

RIPESS

Working Paper No.49

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平成24年10月15日

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Oct 15, 2012

Abstract

While fluctuations in commercial property prices have an enormous impact on economic systems, the development of related statistics that can capture these fluctuations is one of the areas that is lagging the furthest behind. The reasons for this are that, in comparison to housing, commercial property has a high level of heterogeneity and there are extremely significant data limitations. Focusing on the Tokyo office market, this study estimated commercial property price indexes using the data available in the property market, and clarified discrepancies in commercial property price indexes based on differences in the method used to create them. Specifically, we estimated a quality-adjusted price index with the hedonic price method using property appraisal prices and transaction prices available for the J-REIT market. In addition, we attempted to estimate a price index based on a present value model using revenues arising from property and discount rates. Here, along with the discount rates underlying the determination of property appraisal prices and transaction prices, we obtained discount rates using enterprise values that can be acquired from the J-REIT investment market, and estimated the respective risk premiums. First, the findings showed that, compared to risk premiums formed by the stock market, risk premiums when determining property appraisal prices change only relatively gradually, with the adjustment speed being especially slow while the market is contracting. As a result, these prices decline only slowly. They also showed that until the Lehman Shock, property market risk premiums formed by the stock market were at a lower level than risk premiums set when determining property appraisal prices and transaction prices, but following the Lehman Shock, the respective risk premiums converged toward the same level.

Key Words :quality adjusted price index; hedonic approach; discout rate; heterogeneity; Tobin's q; Risk premium

JEL Classification : E3; G19

*This paper was presented at "the International Conference on Commercial Property Price Indicators", organized by Eurostat, ECB, IMF and BIS, OECD (5/10-11,2012,Frankfurt- Germany). We would like to thank Bert Balk, Mick Silver and David Geltner for discussions and comments. The third author's contribution was mostly made before he joined the Policy Board. This research is a part of the project on "The Evolution of the Property Price Indexes" funded by a JSPS Grant-in-Aid for Scientific Research (B 23330084).

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1 Introduction

Looking back at the history of economic crises, there are more than a few cases where a crisis was triggered by the collapse of financial market prices. It is recognized that the collapse of Japan's 1980s' land/stock price bubble in the early 1990s was closely related to the subsequent economic stagnation, and in particular the banking crisis that started in the latter half of the 1990s. Moreover, the 1990s' crisis in Scandinavia also occurred in tandem with a property bubble collapse. The global financial crisis that began in the U.S. in 2008 and the recent European debt crisis were triggered by the collapse of bubbles in the property and financial markets as well. Examples of bubble collapses becoming the trigger for an economic crisis are not limited to advanced nations; it has been widely observed in emerging nations as well, such as Asian countries.

In the case of Japan's property bubble, which of all these is said to be the greatest bubble of the 20th century, subsequent research has made clear that it was triggered by escalating commercial property prices in central Tokyo, beginning in 1983.

Japan experienced three property bubbles in the 20th century: the post-war escalation of land prices centered on land for industrial purposes during the early 1960s' era of rapid economic growth; the escalation of housing prices in the early 1970s accompanying the progress of urbanization; and the property bubble beginning with the escalation of commercial property in the 1980s accompanying the growth of the financial market.

The first two property bubbles occurred while the industrial structure was being rapidly transformed under conditions of strong economic growth. As a result, the economic slowdown triggered by the property bubble's collapse and the impact on individual companies/financial institutions was able to be absorbed by the residual momentum of the overall economy's strong growth. However, with regard to the commercial property-centered bubble that occurred in the 1980s, not only did it occur on a large scale, but since its incidence was linked to the vulnerability of the financial system, its collapse had an enormous impact on economic activity.

As can be understood from the Japanese experience, it is extremely important for fluctuations in commercial property prices to be built into economic policy. In particular, investment in office buildings has a large weight in the property investment market that has been growing rapidly in recent years. As a result of this, observing fluctuations in commercial property prices is becoming even more important from a policy perspective.[1]In this context, the importance of the commercial property market in the management of economic policy is increasing; even so, the preparation of data that makes it possible to grasp changes in this market is one of the areas that is lagging the furthest behind in each country. We believe there are several reasons for this.

First, there is the problem of the weak relationship to other economic statistics. Commer-

[1]The amount of office investment via J-REITs for Japan as a whole is ¥4.6 trillion, representing 48.8% of overall property investment value. In addition, according to estimates by the company IPD, the figures are 34.3% for the U.S. (investment amount: US$39.2 billion), 29.5% for the U.K. (investment amount: US$54.8 billion), 52.1% for France (investment amount: US$74.0 billion), 44.8% for Germany (investment amount: US$27.3 billion), and 43.5% for Australia (investment amount: US$49.1 billion), as of March 2012.

cial property prices have a weak relationship to SNA statistics and consumer price statistics, which occupy a position as the most important economic statistics in economic policy, so there are few related statistics.

The second reason is that the areas where commercial property accumulates are concentrated in large urban regions. As a result, in official statistics, where it is common to measure the size of the economy and level of economic activity for the country as a whole, the creation of statistics that are limited to only some areas is not necessarily a high priority.

Third, and closely related to the above reason, commercial property prices are a low priority in terms of economic policy. Since the objective of economic policy such as fiscal policy is to address problems occurring on a nation-wide level, such as price rises and unemployment, policy measures in response to problems occurring in specific markets of specific regions are a low priority. It is deemed that many of the problems that occur in the commercial property market are limited to large urban areas, and the owners (investors) are also limited to certain companies or individuals.

The fourth reason is the difficulty in developing the statistics. Compared to other goods/services, housing, etc., commercial property has a high level of heterogeneity, and there are extremely significant data limitations. As a result, there is an extremely high level of technical difficulty involved in preparing these statistics, and the cost of producing data is high.

Moreover, the fact various commercial property-related indexes are supplied by the private sector is also a factor behind the lag in preparing commercial property-related statistics in the public sector.

Looking first at commercial property-related statistics from public or quasi-public organizations, there is Japan's "Urban Land Price Indexes" – one of the oldest published commercial property price indexes among advanced nations. Surveying for Urban Land Price Indexes began on a trial basis in 1926, and from 1955 onward, indexes have been created covering 230 cities throughout Japan.[2] What's more, in Japan, a Land Price Survey covering the whole country was initiated by the former National Land Agency (now the Ministry of Land, Infrastructure, Transport and Tourism) in 1970. Not only does the Land Price Survey publish price levels by location for commercial land in addition to residential and industrial land, its also publishes indexes comparing the rate of change to the same period in the previous year. It is necessary to note, however, these indexes are not commercial property price indexes including buildings and land; rather, they are land price indexes limited to land only.

In Germany as well, federal and state statistical agencies have published a transaction price index (Kaufwert für Bauland) since 1961.[3] However, this survey is a simple aggregate

[2]It has been prepared since 1926 when one includes the organization previously responsible for producing it. This index was created by Nippon Kangyo Bank, predecessor of the Japan Real Estate Institute. Since Nippon Kangyo Bank was a state-run bank, its index played the role of an official index. This survey published not only a commercial land price index but also a housing land price index and an industrial land price index.

[3]The transaction price index is implemented based on a land price survey stipulated in Article 2-5 and Article 7 of a price statistics-related law (Gesetz über die Preisstatistik) enacted in 1958. Each state's statistical agency began surveying transaction examples of building plots which had not yet been used for construction within municipal urban planning areas, and after conducting the survey on a trial basis in the

of land on which there has not yet been any construction, and the use to which it will be put – such as whether it will be built up as commercial property, developed as housing, or left as is without any construction – is unclear. In this sense, it cannot be treated as a commercial property price index in the strict meaning of the term.

With regard to this, in recent years, in tandem with the growth of the property investment market, "property investment indexes" have come to be created by private-sector companies/organizations. Leading indexes include the U.S. NCREIF and the index produced by IPD, a U.K.-based company. Moreover, in the U.S., the MIT/CRE Transaction Based Index (TBI) and Moody's/REAL Commercial Property Price Index (CPPI) have come to be published.[4] Compared to the Urban Land Price Indexes, Land Price Survey, and NCREIF and IPD land price indexes, which are appraisal-based property price indexes, these indexes are distinct in the sense they are based on transaction prices. In addition, they are quality adjusted: the TBI based on the hedonic approach and the CPPI based on the repeat sales price method.

Changes in needs with respect to property price indexes for economic markets, advancements in quality-adjustment techniques, and changes in the collectable data are underlying factors that may have led to the appearance of these new property price indexes. The growth of the property investment market is behind the birth of property investment indexes. And the advancement of index creation techniques is behind the use of the hedonic method and repeat sales price method as quality-adjustment methods. Moreover, due to the growth of the property investment market, it has been become possible for the private sector to obtain not only transaction price data but also property appraisal prices, and it has also become possible to use income and the like corresponding to them.

The aim of this paper is to outline the methods used to generate previously created property price indexes and related issues, and then, looking at the case of the Tokyo market in Japan, outline the possibility of estimating a commercial property price index using publicly disclosed J-REIT market data and related issues。

2 Issues in Commercial Property Price Index Estimation

2.1 Types of Commercial Property Price Indexes and Related Issues

In this section, we will outline commercial property price index data sources and estimation methods.

Japan's Urban Land Price Indexes and Land Price Survey, the U.S. NCREIF, and the index produced by the U.K.-based IPD are appraisal-based property price indexes. Among

third quarter of 1961, the federal statistics agency has been publishing quarterly and annual building land price statistics since 1962.

[4]Each of these indexes is created and published by MIT's Center for Real Estate. Refer to http://mit.edu/cre/research/credl/rca.html for details.

these, Japan's Urban Land Price Indexes and Land Price Survey are appraisal-based property price indexes for land prices only, which do not include building prices. On the other hand, the IPD and NCREIF indexes are appraisal-based property price indexes which also include building prices. In contrast to these, the German property price index, Moody's/REAL Commercial Property Price Index (CPPI), and MIT commercial property index (TBI) are transaction-based property price indexes.

Next, we will look at differences in estimation methods. When estimating property price indexes, it is necessary to perform quality adjustment, as indicated in the Residential Property Price Index Handbook. Since properties have a high level of individuality, it is not possible to assume the homogeneity of assets, which is a premise of index theory.

Since indexes created based on property appraisals are, as a general rule, fixed-point surveys of the same property, they are estimated based on straightforward averages (or weighted averages). With regard to indexes using transaction prices, the German property price index is created with straightforward average values without performing quality adjustment. In contrast, the Moody's/REAL Commercial Property Price Index (CPPI) and MIT commercial property price index (TBI) are indexes for which quality adjustment is performed. The Moody's/REAL Commercial Property Price Index (CPPI) is estimated based on the repeat sales price method and the MIT commercial property price index (TBI) based on the hedonic price method.[5]

If one looks at them from the perspective of quality adjustment, there are problems with these indexes. First, with regard to the NCREIF and IPD indexes using property appraisals, the populations from which the data used to create the indexes is extracted changes on a continuous basis. Since the purpose of these indexes is to capture changes in property investment market investment values, 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 targets of index creation change continuously. In this case, although there is no problem in terms of measuring investment values, in the case of trying to capture changes in quality-adjusted prices, a bias occurs with the indexes.

Next, we will consider cases using transaction prices. First, if one tries to apply the repeat sales price method, there needs to be enough transactions to meet the prerequisites. However, when attempting to estimate commercial property price indexes, in many countries it is often difficult to collect sufficient transaction price data. In addition, with the repeat sales price method, one also faces the depreciation problem and renovation problem (Diewert, 2007; Shimizu, Nishimura, and Watanabe, 2010).

Problems likewise occur with the NCREIF and IPD indexes that use property appraisals. With regard to property appraisal prices, since prices are surveyed at different times, as a building ages, it will be evaluated at a lower price in accordance with its aging, while if

[5] Each of these indexes is created and published by MIT's Center for Real Estate. Refer to http://mit.edu/cre/research/credl/rca.html for details.

additional investment is made; it will be evaluated at a higher price in accordance with that investment. Both depreciation and increases/decreases in capital expenditure are factored in.

Meanwhile, if one attempts to estimate using the hedonic price method, it is necessary to collect considerable property price-related attribute data. Generally, when one tries to collect commercial property transaction prices, it is collected based on registry information. Since registry information only includes the price, address, floor space, and transaction date, if one tries to collect property characteristics that include other building attributes, one can expect that it will involve considerable time and expense.

In order to tackle these problems, Shimizu and Nishimura (2006, 2007) and Shimizu, Diewert, Nishimura, and Watanabe (2012) eliminated building prices from commercial property transaction prices and restricted themselves to land prices only, then estimated using the hedonic price method. In this case, since there is no longer any need to collect building-related characteristics, quality adjustment can be performed with land-related characteristics only. However, in this case, one is faced with the problem of how to eliminate building prices.

Meanwhile, the MIT commercial property price index (TBI) is estimated using the hedonic price method using NCREIF data. The NCREIF data-set includes detailed data relating to property appraisals. Since property-related characteristics (position, size, building age, transportation accessibility, etc.) are provided in the property appraisal data, it includes enough information to apply the hedonic method. Moreover, IPD, which has a similar database, also employs the hedonic method, and is moving forward with the development of a transaction price index (S. Devaney and R.M. Diaz, 2009).

However, with regard to using this kind of information, it can only be used in countries where a property investment market exists and, in addition, the information is disclosed.

2.2 Previous Research

Many of the problems surrounding the estimation of commercial property price indexes are problems which are shared with residential property price index estimation. Many of these issues have been outlined in Diewert (2007) and the Residential Property Price Index (RPPI) Handbook.

However, in comparison to research relating to housing price index estimation, which has emphasized estimation methods, research relating to commercial property price indexes has emphasized problems in the selection of data for the purpose of creating indexes.[6] In terms of differences from the housing market, two broad points have been outlined with regard to the commercial property market's characteristics. The first is, compared to housing, the number of transactions in the commercial property market is extremely limited, meaning it

[6]Problems surrounding the estimation of commercial property price indexes are comprehensively outlined by Geltner and Pollakowski (2007). As well, problems surrounding data selection for the estimation of housing price indexes are addressed by Shimizu, Nishimura, and Watanabe (2011). Here, the focus is on the relationship between offer prices and transaction prices. Data source problems surrounding commercial property relate to the selection of property appraisal prices and transaction prices.

is an extremely "thin" market. The second is, compared to housing, which is a relatively homogeneous market, the commercial property market is strongly heterogeneous.

In order to overcome these property price index-related characteristics (problems) in the commercial property market, the focus has come to center on appraisal-based property price indexes.[7] Since property appraisal prices are not prices transacted on the market but rather prices determined by property appraisers, they may diverge from the actual market conditions. As a result, various discussions have developed surrounding the precision/accuracy of these property appraisal prices.

Specifically, the following points have become issues of discussion: Are indexes based on property appraisal prices able to precisely capture market turning points? (The problem of there in fact being a lag has been pointed out; this is known as the "lagging problem.") Do property appraisal prices diverge from market prices? (They in fact diverge considerably in periods of market fluctuation; this is known as the "valuation error problem.") Are they able to precisely capture market volatility (the amount of risk)? (It has been reported that these values smooth out market changes; this is known as the "smoothing problem.")

For example, Geltner, Graff, and Young (1994) have clarified the aggregation bias mechanism in the NCREIF index, the leading U.S. appraisal-based property price index, while Geltner and Goetzmann (2000) have estimated an index with transaction prices and clarified the extent of appraisal evaluation errors and smoothing for NCREIF property appraisal prices. These problems are not just problems with the NCREIF appraisal-based property index: they relate to the creation of all appraisal-based property indexes, including IPD's.

In addition, focusing on Japan's bubble period, Nishimura and Shimizu (2003), Shimizu and Nishimura (2006, 2007), and Shimizu et al. (2012) estimated a transaction price index for commercial property and housing and a hedonic price index for appraisal prices, and statistically clarified the differences between the two. Looking at the estimation results made it clear that during the bubble period, when there was an especially large increase in property prices, appraisal-based property price indexes could not sufficiently keep pace with transaction prices, and they also could not keep up with the rate of decline during the period when prices dropped. For commercial property prices, the results showed that because property prices increased at a rapid rate in the bubble period, property appraisal prices at the bubble's peak were only able to reach 60% of transaction prices at the bubble's peak. As well, it was shown that they could not keep pace with the rate of decline during the bubble's collapse, remaining at a level approximately 20% higher than transaction prices.

Much research has also been conducted that attempts to elucidate the mechanisms causing the likes of the lagging problem, valuation error problem, and smoothing problem (Shimizu et al., 2012).

Quan and Quigley (1991) and Clayton et al. (2001) are examples of studies that attempted to clarify the micro structure of these problems. They have shown that due to the lag in

[7] For housing price index estimation as well, indexes using property appraisal values are estimated with the SPAR (Sale Price Appraisal Ratio method). However, since they are used in combination with transaction prices, no significant discussion has arisen regarding the precision/accuracy or characteristics of property appraisal values.

data acquired by property appraisers, the data selection method, and the existence of a lag mechanism until a decision is made, property appraisal prices have a structural smoothing problem.[8] As well, property appraisals for investment properties involve an additional systemic factor: the problem of interference from the client. This problem differs in nature from the problem of property valuation errors or the smoothing problem. Specifically, it is a problem involving the property appraisal client inducing the property appraiser to raise the price in an attempt to maintain the property's investment performance (Crosby et al., 2003; Crosby, Lizieri, and McAllister, 2009). As a result of these inherent property appraisal technical and systemic factors, property appraisal prices end up diverging from actual market conditions.

Given this, efforts have been made to clarify the property price fluctuation mechanism and level of smoothing using data such as property equity determined by the stock market and price (share value) of investments in real estate investment trusts (Fisher, Geltner, and Webb, 1994; Geltner, 1997).

Moreover, attempts have also been made to create commercial property price indexes using actual transaction prices. In terms of methods of estimating quality-adjusted property price indexes using transaction prices, the hedonic price method and repeat sales price method are the leading estimation methods. In the case of attempting to estimate a price index using the hedonic price method, considerable property-related characteristic data is needed. Since commercial property in particular has a high level of heterogeneity, many more variables are needed in comparison to housing, etc.[9] Fisher et al. (2003) and Fisher, Geltner, and Pollakowski (2007) have estimated transaction price indexes based on the hedonic method using NCREIF transaction price data. This is because the NCREIF database provides property characteristic-related data, since it includes property appraisal price-related data. Geltner and Goetzmann (2000) have estimated a transaction price index based on the repeat sales price method using transaction price data.

When attempting to estimate transaction price indexes using these kinds of methods, since the commercial property market is a thin market in terms of transactions, besides the problem of applicable methods, the problems of spatial aggregation unit (can the index be estimated for the whole country or by region?) and estimation frequency (is an annual, quarterly, or monthly index possible?) have also become significant points of discussion (Bokhari and Geltner, 2010).

[8]This problem is also outlined in Shimizu et al. (2012). With regard to the selection of transaction comparables when the property appraiser is determining the price, there is a strong possibility that examples that diverge significantly from past conditions will be treated as outliers. If prices diverge from market fluctuations as a result, there will be a lag. This problem is equivalent to problems in the creation of consumer price indexes, such as the selection of survey stores and products, the handling of sales, etc.

[9]As pointed out by Ekeland, Heckman, and Nesheim (2004), in hedonic function estimation, if explanatory variables are lacking, the index estimation-related problem known as omitted variables bias will occur.

3 Commercial Property Price Index Estimation Model

3.1 Data[10]

As can be understood from previous research, the main points of discussion regarding commercial property price indexes are what kind of biases exist with appraisal-based property price indexes (which are used for most commercial property price indexes) and what estimation method is preferable in terms of quality adjustment.

In this study, we will estimate a commercial property price index using published J-REIT market data for the Tokyo-area office market. This data includes the transaction price (V^T) when an investment company listed on the J-REIT market makes a purchase or sale and the property appraisal price(V^A) evaluated once every six months.

In addition, along with property appraisal prices, we calculated rental income (Y^A), corresponding expenses such as property tax and damage insurance premiums (O), and net income after expenses (y^A=Y^A-O: Net Operating Income).[11]

In terms of property-related characteristic data, land area (L : m^2), floor space of building (S : m^2), rentable floor space representing a source of income (RS : m^2)[12] Cage of building (A: years), number of stories (H: number of stories), nearest station and time required to reach it (TS: minutes), leasehold format (LHD: right of ownership, standard leasehold, or fixed-term leasehold), and so forth are surveyed by property appraisers.[13] In addition, since the nearest station is surveyed, we added the average day-time travel time to the central business district (Tokyo Station) using train network data (TT: minutes).[14]

This data may be considered as having the same characteristics as U.S. NCREIF or U.K. IPD data. An overview of the data is provided in Table1.

3.2 Theoretical Framework

If one follows traditional economic theory, property prices may be determined as the discounted cash flow of income generated from property. Based on this type of economic theory, there are two broad methods of estimating property price indexes.

The first method is to estimate the index using data on property prices transacted on the

[10]With regard to the data used in this study, the Nikkei Inc.'s R-Square was used. Nikkei Digital Media and Sound-F collaborated in supplying the data.

[11]In published information on J-REITs, taxes and public dues for the year the property is acquired are not recorded as expenses in order to balance taxes and public dues paid when the property is acquired. Accordingly, in the data-set used in this analysis, we obtained the actual value of taxes and public dues from accounting data for the year following the property's acquisition, and calculated NOI by using this data as a substitute for the taxes and public dues in the year the property was acquired.

[12]Rentable floor space refers to the amount of the building floor space within the transaction target building that represents a source of generating income. Shared areas such as the entrance and areas of the building which were not covered by the transaction are eliminated from this.

[13]These property characteristics are surveyed by property appraisers for the purpose of performing property appraisal. Building-related data is surveyed separately in the form of building engineering reports by research organizations aimed at architects and the like.

[14]This data is calculated as the day-time average travel time and excludes the time during morning and evening commutes. It is updated once per six months based on changes in transportation schedules. The present data was created by Val Laboratory.

Table 1: List of Variables

Symbols	Variables	Contents	Unit
V^A	Appraisal price	Appraisal price by Certidied Appraiser (Value)	million yen
V^T	Transaction Price	Purchase & Sales price (Value)	million yen
y	Net Operating Income	Rent income (Y) - Operating Expenditure(O)	million yen
r	Rent-Price ratio	Rent income (y) $\div$ Appraisal price(V^A)	%
L	Land area	Land area of building	m^2
S	Floor space	Floor space of building.	m^2
RS	Rentable floor space	Rentable floor space of Building	m^2
A	Age of building at the time of transaction.	Age of building at the time of transaction/appraisal	year
H	Number of stories	Number of stories in the building	stories
TS	Time to the nearest station	Time distance to the nearest station.	minute
TT	Travel time to central business district	Minimum railway riding time in daytime to one of the seven major business district stations.	minute
LHD	Leasehold dummy	Leasehold in Lnad = 1, Owner right = 0.	(0,1)
LD_k (k=0,…,K)	Location dummy	*k th aare* =1, other *district* =0.	(0,1)
D_t (t=0,…,T)	Time dummy (quartertly)	*t th quarter* =1, other *quarter* =0.	(0,1)

market. Attempts to estimate property price indexes based on this kind of method have been reported in many studies focusing on housing price indexes and the like.

The second method is to obtain the discounted cash flow of income generated by property. This kind of value is known as the fundamental value and is based on basic capital theory formulae.

Here,V_v^t is the initial asset value for the period t, for which v years have elapsed since production, and y_v^t is the income corresponding to this. In addition, the asset's lifetime is assumed to be m years. Then, the expenses paid at the end of the period t for an asset for which v years have elapsed since production is O_v^t, and r^t is the expected nominal discount (interest) rate for period t (i.e., the expected interest rate determined as a result of comparison with other alternative assets). Here, the expected value is considered to be the value determined at the start of period t. Based on this kind of hypothesis, the asset value for the period t may be formulated as follows (Diewert and Nakamura, 2009; Jorgenson, 1963; LeRoy and Porter, 1981).

$$\begin{aligned} V_v^t = & \frac{y_v^t}{1+r^t} + \frac{y_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} + \ldots + \frac{y_{m-1}^{t+m-v-1}}{\Pi_{i=t}^{t+m-v-1}(1+r^i)} \\ & - \frac{O_v^t}{1+r^t} - \frac{O_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} - \ldots - \frac{O_{m-1}^{t+m-v-1}}{\Pi_{i=t}^{t+m-v-1}(1+r^i)} \end{aligned} \quad (1)$$

In other words, the asset value is the discounted cash flow of income to be generated in future.

3.3 Estimation Model

In terms of estimation methods for commercial property price indexes, there are the following methods: estimating from the property price, corresponding to the left side of formula1, and estimating from the income(y) and discount rate(r), as on the right side.[15] Specifically, the method of estimating the property price index by directly using V_v^t and the method of converting the price index into the discounted cash flow based on the discount rate(r) after estimating the index from the rent, which is the income generated by property, are possible.

In this study, along with estimating a commercial property price index using property price(V), we obtained the new discounted cash flow, as well as explicitly estimating the relationship between property price(V), property income(y), and the income/price ratio (hereafter referred to as the discount rate(r)).[16]

[15] With regard to determining property prices in actual property appraisals, they are obtained either by the method of determining the price through extrapolation from transaction prices (the sales comparison approach) or the method of dividing the income generated by the property by the discount rate (the capitalization method).

[16] Commercial property appraisals are generally determined according to the capitalization method based on the right side of formula eq(1). The reason for this is based on experience showing that it is difficult to reach an accurate appraisal price with the sales comparison approach based on the formula's left side. This practical experience is important, and it must be referred to in estimating property price indexes as well. In such a case, it is necessary to properly understand the determent or mechanism of property appraisal price. In order to do so, it is necessary to clarify the relationship between the property price

In order to estimate a price index using property prices and income, it is necessary to perform quality adjustment, since prices and income vary based on the characteristics(X) of the property. Variation of rent and price based on the time to the central business district, regional differences in amenities such as the availability of commercial districts and facilities like parks in the vicinity, etc., is a phenomenon that may be viewed as common to all countries. In addition, even when the location is the same, rent and price vary if the building age and size differ.

Accordingly, under the assumption that these kinds of differences in characteristics change rents and prices, we specified a model that would estimate these three parameters. Taking the income(y_{it}) with expenses removed generated by property j for the period t and the corresponding property price(V_{it}), and considering j characteristics vectors $X_{ijt} = (X_{i1t}, \ldots, X_{iJt})$ for the property and the "time dummy" assimilating time effects as $(D_t : t = 1 \ldots, T)$, it is possible to express property income and property price as shown in Formula 2 and 3.

$$\ln y_{it} = \alpha_0 + \sum_J \alpha_j X_{ij} + \sum_T \nu_t D_t + \nu_{1i} \tag{2}$$

$$\ln V_{it} = \beta_0 + \sum_J \beta_j X_{ij} + \sum_T \xi_t D_t + \nu_{2i} \tag{3}$$

In this case, the discount rate(r_{it}) converting net income(y_{it}) into the property's price(V_{it}) may be expressed as follows.

$$\ln(y_{it}/V_{it}) = (\alpha_0 - \beta_0) + \sum_J (\alpha_j - \beta_j)X_{ij} + \sum_T (\nu_t - \xi_t)D_t + (\nu_{1i} - \nu_{2i}) \tag{4}$$

$$\ln r_{it} = (\alpha_0 - \beta_0) + \sum_J (\alpha_j - \beta_j)X_{ij} + \sum_T (\nu_t - \xi_t)D_t + \varepsilon_i \tag{5}$$

$$\alpha_{jt} = \partial \ln y_{it} / \partial X_{ij} \tag{6}$$

$$\beta_{jt} = \partial \ln p_{it} / \partial X_{ij}$$

$$(\alpha_j - \beta_j) = \frac{\partial \ln y_{it}}{\partial x_{ij}} - \frac{\partial \ln p_{it}}{\partial x_{ij}} \tag{7}$$

In other words,ν_t estimated with Formula(2) is a quality-adjusted rent index, while ξ_t estimated with Formula (3) is a quality-adjusted property price index.In addition, for the discount rate (r) converting income generated by the property into price, one can understand that $(\alpha_j - \beta_j)$, accompanying changes based on property characteristics and related quality-adjusted temporal changes may be estimated as $(\nu_t - \xi_t)$.

4 Empirical Analysis Results

4.1 Quality-Adjusted Commercial Property Price Index Estimation

Data-Sets Prior to estimating the quality-adjusted commercial property price index, we will provide an overview of the data for analysis.

In this study, based on published J-REIT data, three broad data-sets were created covering the period from the second quarter of 2001 to the fourth quarter of 2010 for the Tokyo-area office market. The three data-sets are: a property appraisal price data-set, a transaction price data-set, and a data-set with which property appraisal prices (V^A)property transaction prices (V^T), and corresponding net income (y^A) can all be obtained.

This period includes a period when property prices, which had been in a sustained downward phase accompanying the collapse of the 1990s bubble, headed toward recovery. What's more, from the start of the 2000s, with the development of financial technologies and increase in cross-border transactions of investment funds, investment funds flowed into the property investment market and a mini-bubble dubbed the "fund bubble" occurred, which was centered on large urban areas. Then, the Lehman Shock triggered a reversal in the increase in property prices accompanying this fund bubble. In this sense, the period covers one property price cycle, from the downward phase in property prices to the period of increasing prices and then to the downward period following the fund bubble's collapse.

We were able to collect 4,993 items for the property appraisal price data-set, 559 items for the transaction price data-set, and 4,926 items for the data-set with which property appraisal prices and transaction prices, including net income, can all be observed.[17] The summary statistics for these are outlined in Table2.

Appraisal-Based Property Price Index Estimation Using the property appraisal (V^A) database, we estimated a quality-adjusted property price index with the hedonic method, based on Formula8. In addition, in the following series of estimations, for both property price and income, the unit price per rentable floor space (RS) and unit income logarithmic variable were considered as explained variables. Here, the property appraisal price(V^A) is per rentable floor space (RS).

$$\ln V^A{,}_{it} = \beta_0 + \sum_J \beta_j \ln X_{ij} + \sum_T \xi_t D_t + \nu_{it} \tag{8}$$

[17]The reason why the 4,993 items in the property appraisal price data-set are reduced to 4,926 items in the shared data-set is due to a deficiency in y (NOI). NOI was calculated as the aggregate value for the past 12 months. It was calculated based on the past record since it was deemed that it would be difficult to fully predict future income. There is a lack of theoretical consistency as a result, but it is possible to be consistent with actual property appraisals. In other words, since it is difficult to predict the future at the time of property appraisal, the present and future income was set based on actual past values. As a result, at the time of the property's purchase or when the property appraisal was conducted within less than one year, cumulative past data does not exist, so such properties were eliminated from this database.

Table 2: Summary Statistics of Commercial Property

Appraisal price

	Mean	Std.Dev	Min	Max
	Appraisal price (4,993 Observations)			
V^A: Appraisal price (million yen)	8,428.35	11,767.37	323.00	138,000.00
L: Land area (m^2)	2,888.27	5,767.79	119.16	57,177.66
S: Floor space (m^2)	18,521.30	35,170.09	601.63	442,150.70
RS: Rentable floor space (m^2)	7,308.29	8,455.45	494.14	95,697.03
V_1/RS (million yen)	1.11	0.61	0.16	4.97
A: Age of Building (years)	16.74	8.48	0.05	51.26
H: Number of stories (stories)	11.45	6.90	3.00	54.00
TS: Time to the nearest station: (mimutes)	3.68	2.52	1.00	15.00
TT: Travel Time to Central Business District (minutes)	9.38	7.91	1.00	72.00

Transaction price

	Mean	Std.Dev	Min	Max
	Transaction data (559 Observations)			
V^T: Transaction price (million yen)	7,229.37	11,110.93	324.00	110,000.00
L: Land area (m^2)	2,575.49	5,666.67	119.16	57,177.66
S: Floor space (m^2)	17,313.45	39,162.05	652.06	442,150.70
RS: Rentable floor space (m^2)	6,538.95	9,061.04	526.43	95,697.03
V_2/RS (million yen)	1.08	0.60	0.25	4.94
A: Age of Building (years)	14.91	8.42	0.04	46.36
H: Number of stories (stories)	10.98	6.82	3.00	54.00
TS: Time to the nearest station: (mimutes)	3.68	2.50	1.00	15.00
TT: Travel Time to Central Business District (minutes)	9.31	7.64	1.00	72.00

Rent, Price & Rent-Price ratio

	Mean	Std.Dev	Min	Max
	NOI, Appraisal price and NOI Price ratio (4,926 Observations)			
y^A: Net Operating Income (Rent - Operating Expenditure)	413.06	501.45	15.68	5,268.89
V^A: Appraisal price (million yen)	8,472.32	11,816.94	323.00	138,000.00
r^A : y / V^A ratio	5.40	1.18	2.02	11.04
L: Land area (m^2)	2,894.39	5,791.05	119.16	57,177.66
S: Floor space (m^2)	18,556.59	35,215.52	601.63	442,150.70
RS: Rentable floor space (m^2)	7,339.47	8,486.40	494.14	95,697.03
y/RS (million yen)	0.06	0.02	0.01	0.22
V^A/RS (million yen)	1.12	0.61	0.16	4.97
A: Age of Building (years)	16.75	8.47	0.05	51.26
H: Number of stories (stories)	11.46	6.91	3.00	54.00
TS: Time to the nearest station: (mimutes)	3.67	2.50	1.00	15.00
TT: Travel Time to Central Business District (minutes)	9.37	7.85	1.00	72.00

Table 3: Estimation Result of Hedonic Equation: Transaction Price Model

	Model.V_{A1}			Model.V_{A2}		
	Coef	std err		Coef	std err	
Constant	13.622	0.117	***	13.945	0.092	***
S: Floor space (m^2)	0.001	0.003		0.011	0.002	***
A: Age of Building (years)	-0.009	0.001	***	-0.007	0.001	***
H: Number of stories (stories)	0.006	0.002	***	0.010	0.001	***
TS: Time to the nearest station: (mimutes)	-0.020	0.004	***	-0.043	0.002	***
TT: Travel Time to Central Business District (minutes)	-0.023	0.005	***	-0.017	0.002	***
LD_k $(k=0,\ldots,K)$	Yes: Census			Yes: Municipalities		
TD_q $(q=0,\ldots,Q)$	Yes			Yes		
Adjusted R-square=	0.889			0.569		
Number of Observations=	4,993			4,993		

*P<.01, **P<.0.05, ***<.0.01

Note: The dependent variable in each case is the log of the price.

In estimating the hedonic function, along with the land area (L), total building floor space (S), rentable floor space representing a source of income (RS), age of building (A), number of stories (H), nearest station and distance to it (TS), leasehold form (LHD), and average day-time travel time to the central business district (Tokyo Station) (TT), quality was adjusted based on a location dummy (LD). The estimation results are shown in Table3.[18]

If location differences can be assimilated based on time to the central business district (TT) and time to the nearest station (TS), there is no need to use a location dummy. However, in many cases, it is difficult to assimilate location differences with these variables only. Accordingly, in terms of the location dummy, we performed estimates for two cases: one in which a location dummy was input using census survey areas with Model.V_{A1}, and one in which a location dummy was input using municipalities with Model.V_{A2}[19]

What's more, the time dummy (D_t) was treated as quarterly. Given the limitations of the data, it would be easier to perform estimates annually or semi-annually, but in view of the purpose for which the index is to be used we deemed it would be difficult to achieve this purpose with annual or semi-annual estimates.

The estimation results are outlined in Table3.

When one compares Model.V_{A1} and Model.V_{A2} , one can see the explanatory power is significantly higher with Model.V_{A1}. When one compares the price indexes based on the respective estimation results with simple average values (Figure1), Model.V_{A2} moves in

[18]Based on the variable selection, since land area has a strong correlation to building floor space, the problem of multicollinearity occurred. As a result, it was eliminated from the model. As well, a standard leasehold dummy and fixed-term leasehold dummy were input as land leasehold forms, but since no significant results could be obtained, they were eliminated.

[19]With Model.V

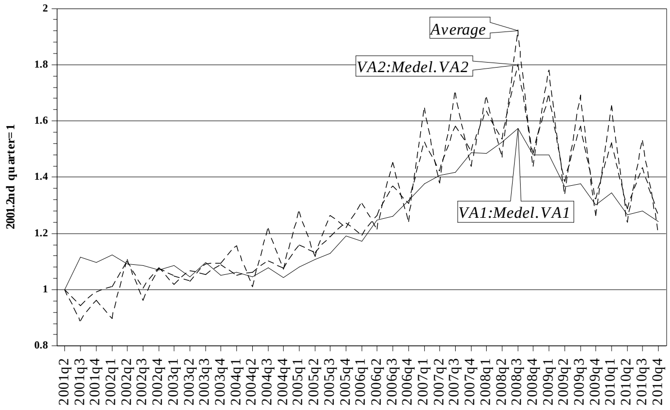

Figure 1: Trend of Appraisal Based Indexes

tandem with the average values, so one can understand that quality differences have not been sufficiently adjusted. While previous research focusing on the Tokyo housing market (Diewert and Shimizu, 2012; Shimizu, Nishimura, and Watanabe, 2010) showed that location differences were able to be assimilated using municipality dummies, this kind of unit is insufficient for the commercial property market. This is because the commercial property market is strongly heterogeneous compared to the housing market and is differentiated across highly detailed spatial units.

Transaction Price-Based Index Estimation Transaction price index estimation was performed based on the following two models.

$$\ln V^{M}{,}_{it} = \beta_0 + \sum_{J} \beta_j \ln X_{ijt} + \sum_{T} \xi_t D_{it} + \nu_{it} \tag{9}$$

$$\ln V^{A,M}{,}_{it} = \beta_0 + \sum_{J} \beta_j \ln X_{ij} + TrnsD + \sum_{T} \xi_t D_t + \sum_{T} \tau_t TrnsD \times D_t + \nu_{it} \tag{10}$$

Compared to Formula (9), (ξ_{Mt}) focusing on the transaction price (V^M), Formula (10) pools property appraisal prices and transaction prices and estimates an appraisal-based property price index (ξ_{At}) while also estimating a transaction price index ($\xi_{At} + \tau_t$) using a cross term with a transaction price dummy (considered as 1 if the transaction price and 0 otherwise). With respect to the location dummy, as in the property appraisal price model (Model. V_{A1}), it was input using national census survey areas. The estimation results are outlined in Table4, and Table5 outlines the estimated values and their reliability by number of samples and time dummy for each time period.

Table 4: Estimation Result of Hedonic Equation: Transaction Price Model

	Model. V_{M1}			Model. V_{M2}		
	Coef	std err		Coef	std err	
Constant	13.707	0.526	***	13.601	0.107	***
S: Floor space (m^2)	-0.010	0.003	***	-0.009	0.001	
A: Age of Building (years)	-0.011	0.012		0.000	0.003	***
H: Number of stories (stories)	0.008	0.009		0.007	0.002	***
TS: Time to the nearest station: (mimutes)	-0.024	0.019		-0.021	0.004	***
TT: Travel Time to Central Business District (minutes)	-0.023	0.022		-0.022	0.005	***
TrnsD: Transaction Dummy	-			-0.014	0.049	
LD_k $(k=0,\ldots,K)$	Yes:Census			Yes:Census		
TD_q $(q=0,\ldots,Q)$	Yes			Yes		
$TD_q \times TrnsD$	-			Yes		
Adjusted R-square=	0.897			0.886		
Number of Observations=	559			5,552		

*P<.01, **P<0.05, ***<.0.01

Note: The dependent variable in each case is the log of the price.

Looking at the estimation results, the adjusted R-square is 0.897 and 0.886 respectively, so both have a high explanatory power. Here, we combined the transaction price index (V_{T1}: ξ_{Mt}) estimated with Model. V_{M1} and appraisal-based price index (V_{A3}:ξ_{At}) estimated with Model. V_{M2} with the number of transactions and compared them (Figure2). We observed changes in the transaction price index (V_{T1}: ξ_{Mt}) in combination with the confidence interval (95% confidence interval).

As can be understood from these results, the variability of the transaction price index is extremely high. It can be seen this fluctuation is not a true (real) fluctuation but rather is caused by significant estimation error. Looking at changes in the number of transactions, in the third quarter of 2003 there is only one transaction. After the Lehman Shock, there are only two transactions in both the second and third quarter of 2009. In the subsequent period, one can see that there are some periods in which there are no more than five transactions.

Here, we will focus on Table5. During periods in which there are few transactions, the apparent confidence interval of the estimated parameters becomes small. This means for such estimated parameters, even though the reliability of the estimated values seems high at first glance, they actually have no significance. In addition, it can be understood that even if the samples are sufficient for distinguishing temporal changes, there are periods with significant errors in the estimated values.

That being the case, it can be understood that it is necessary to think carefully about using the transaction price index ($\xi_{M,t}$) estimated using Model. V_{M1} based on the data limitations.

However, that does not necessarily mean that a transaction price index estimated in this way has no significance whatsoever. While the price increase in the period prior to the

Table 5: Estimation Result of Hedonic Equation: Time Dummy

Time	Model. V_{M1}		Model. V_{M2}		
	ξ^M: Coef.	Number of obs	ξ^A: Coef.	Number of obs	τ^M: Coef.
2001q2	-	12	-	12	-
2001q3	0.070	12	0.116 *	12	0.017
2001q4	0.052	27	0.101 ***	40	0.010
2002q1	0.172	7	0.126 **	20	0.017
2002q2	0.015	3	0.093 *	26	-0.030
2002q3	-0.044	13	0.090 **	53	-0.086 **
2002q4	0.477	3	0.075 *	29	-0.028
2003q1	-0.131	7	0.092 **	51	-0.142
2003q2	0.835 ***	1	0.052	38	0.399 ***
2003q3	0.108	13	0.100 ***	60	-0.034
2003q4	0.217	13	0.059 *	53	0.051
2004q1	-0.052	11	0.069 *	78	-0.081
2004q2	0.084	14	0.053 *	76	0.040
2004q3	0.246	7	0.085 **	79	0.057
2004q4	-0.013	15	0.051	86	-0.038
2005q1	0.027	14	0.086 **	91	0.018
2005q2	0.219	7	0.110 ***	89	0.060
2005q3	0.167	23	0.130 ***	101	0.026
2005q4	0.239	27	0.185 ***	130	0.039
2006q1	0.109	44	0.165 ***	118	-0.010
2006q2	0.188	46	0.231 ***	186	-0.016
2006q3	0.213	31	0.241 ***	108	0.005
2006q4	0.319 *	9	0.283 ***	217	-0.023
2007q1	0.495 ***	16	0.328 ***	121	0.071 *
2007q2	0.443 ***	20	0.350 ***	242	0.052 *
2007q3	0.287	12	0.357 ***	120	0.030
2007q4	0.421 **	19	0.406 ***	257	0.042
2008q1	0.471 ***	42	0.404 ***	154	0.060
2008q2	0.462 **	15	0.431 ***	280	0.016
2008q3	0.659 ***	10	0.462 ***	130	0.126
2008q4	0.495	5	0.400 ***	280	0.047
2009q1	0.215	14	0.401 ***	136	-0.200 ***
2009q2	1.272 ***	2	0.322 ***	280	0.301
2009q3	0.018	2	0.329 ***	123	-0.290 ***
2009q4	0.128	10	0.273 ***	286	-0.094 **
2010q1	0.363 **	16	0.305 ***	131	0.016
2010q2	0.325	5	0.246 ***	283	0.138
2010q3	0.329	5	0.258 ***	130	0.038
2010q4	0.206	7	0.226 ***	290	-0.062

*P<.01, **P<.0.05, ***<.0.01

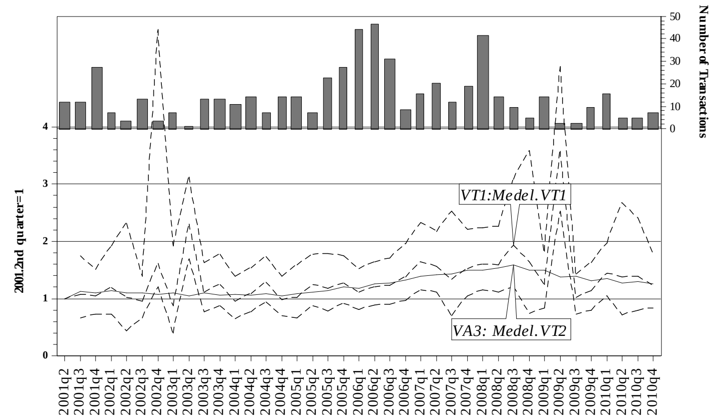

Figure 2: Error of Estimated Transaction Based Index

Lehman Shock dubbed the "mini-bubble" and the subsequent decline cannot be observed with the appraisal-based price index, these changes are able to be captured at a reliable level with the transaction price index.

That being the case, it is important to consider, as proposed by Devaney and Diaz (2009), the question of how an appraisal-based price index and transaction price index could be integrated.

In Model. V_{M2}, the property appraisal price (V^A) and property transaction price (V^T) were pooled and a hedonic price index was estimated. For the estimate values ($\xi_{A,t}$) for time dummies distinguishing temporal changes in property appraisal price, estimation is performed with a fixed reliability, but for the cross term (τ_t :Cross term effect) with transaction prices, as with Model. V_{M1}, there are periods for which insufficient samples exist and periods in which the reliability of the estimated parameters (τ_t) is low.

Accordingly, using the appraisal-based price index ($\xi_{A,t}$) as a base, we combined it with the cross term of the transaction price dummy (τ_t) using the following rules. First, we eliminated periods for which there were less than five sample transactions when estimating the transaction price index (τ_t). This is because the estimated values have no significance in periods when there are few sample transactions. Moreover, even when there was a sufficient number of transactions, those with a significance probability of less than 10% were eliminated.

Applying these two rules, we obtained a transaction price index ($\xi_{A,t} + \tau_t$) by revising the appraisal-based price index.[20]

Figure(3) depicts trends in the appraisal-based property price index (V_{A3}: $\xi_{A,t}$) estimated using Model. V_{M2} and the transaction price index (V_{M3}: $\xi_{A,t}+\tau_t$) obtained by revising the

[20]The remaining periods for

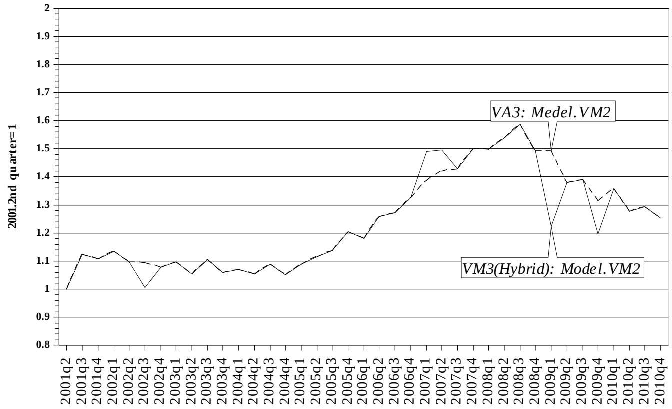

Figure 3: Trend of Adjusted Transaction Based Index

appraisal-based property price index.

The transaction price index is distinguished by the fact that it increases more than the appraisal-based property price index in the first and second quarters of 2007 (the period dubbed the mini-bubble), as well as decreasing more than the appraisal-based property price index in the first quarter of 2009 after the Lehman Shock.

4.2 Estimation Based on Discounted Cash Flow Model

Property Appraisal Price Decision-Making Mechanism The above line of analysis showed that since sufficient transaction price data does not exist for Japan's REIT market, when attempting to estimate a quality-adjusted price index using the hedonic price method, it is necessary to estimate it using property appraisal price as a base. Here, focusing on the right side of Formula(1), we will clarify the mechanism by which property appraisal prices are determined and explore the possible of estimating a property price index based on a present value model.

There are two reasons for focusing on the decision-making mechanism for property appraisal prices. Of the various property appraisal methods, commercial property appraisals are determined based on the approach known as the capitalization method. As a result, when seeking to observe the micro structure of the commercial property price index based on property appraisal prices analyzed in the previous section, it is necessary to clarify the mechanisms of its constituent factors: property income (y) and discount rate (r).

Secondly, there is an extremely strong possibility the transaction price is dependent on the appraisal price. In Japan's REIT market, the companies from which an investment company purchases property are often developers, life insurance companies, or the like with capital ties to it. As a result, in order to eliminate conflict-of-interest transactions, it is not unusual for the transaction to be conducted within a fixed range of the property appraisal price. In various other countries as well, capitalized value methods such as the DCF method are often used to determine investment amount in the property investment market. In such cases, the transaction price, despite its name, is highly dependent on the property appraisal price.

Accordingly, we will explicitly clarify the relationship between property price (V) and its constituent factors, property income (y) and discount rate (r) converting property income into property price.

First, based on Formula(2), (3) and (5), using the data-set with which it is possible to observe property appraisal price (V^A),the property income(y^A) upon which its valuation is premised, and the discount rate (r^A: income/price ratio), we estimated a property income function, property price function, and discount rate function. The estimation results are outlined in Table6.

Looking at the estimated results, one can see, as shown in Formula(5), the coefficient of regression estimated with the discount rate function (Model.r^A) is estimated as the differential($\alpha - \beta$) of the coefficient of regression estimated based on the property income function (α) and the coefficient of regression estimated based on the property price function (β). In other words, one can understand that the property price, property income, and discount rate change depending on the property's characteristics (X).

For example, if the building's age (A) increases by one year, the income decreases by 0.006 with the property income model (Model.y_A) and the price decreases by 0.009 with the property price model (Model.V_{A3}). As a result of this, with the discount rate model (Model.r_A), the discount rate increases by 0.003(-.006-(-.009)) due to the one-year increase.

Based on models estimated in this way, it is possible to obtain a quality-adjusted price index, quality-adjusted income index, and their discount rate index. The estimated indexes are shown in Figure4.

Looking at the estimated indexes, one can see that the increase in property prices from the third quarter of 2004 through the third quarter of 2008 occurred due to a property income increase and discount rate decrease. The subsequent decline in property prices was caused by a decrease in income and increase in discount rate. Looking carefully at this situation, one can see since property income decreases occurred only gradually, the discount rate increase contributed greatly to the decline in property prices.

Discount rate) and Risk premium In the present value model, price is determined based on income (y) and discount rate (r), and it is known that the discount rate has a major effect on this determination. Since exact actual values are used in the calculation of income, there is no significant difference in the calculation result, no matter what organization makes the calculations.[21] In such a case, differences in property appraisal price and transaction price are caused by the discount rate.

[21] Present and past income are not random variables but fixed variables. In Japanese property appraisal standards, precise definitions are indicated for the calculation of income and expenses.

Table 6: Estimation result of hedonic equation: Income, Price and Discount rate

	Model.y_A			Model.V_{A3}			Model.r_A			$\alpha-\beta$
	α : Coef	std err		β : Coef	std err		Coef	std err		
Constant	11.057	0.130	***	13.614	0.117	***	-2.557	0.078	***	-2.557
S : Floor space (m^2)	0.006	0.003	*	0.002	0.003		0.005	0.002	**	0.005
A : Age of Building (years)	-0.006	0.001	***	-0.009	0.001	***	0.003	0.001	***	0.003
H : Number of stories (stories)	-0.001	0.002		0.006	0.002	***	-0.007	0.001	***	-0.007
TS : Time to the nearest station: (mimutes)	-0.004	0.005		-0.018	0.004	***	0.014	0.003	***	0.014
TT : Travel Time to Central Business District (minutes)	-0.015	0.006	***	-0.023	0.005	***	0.008	0.003	***	0.008
LD_k $(k=0,\ldots,K)$	Yes: Census			Yes: Census			Yes: Census			-
TD_q $(q=0,\ldots,Q)$	Yes			Yes			Yes			-
	0.773			0.889			0.672			
	4,926			4,926			4,926			

*P<.01, **P<.0.05, ***<.0.01

Note: The dependent variable in each case is the log of the price.

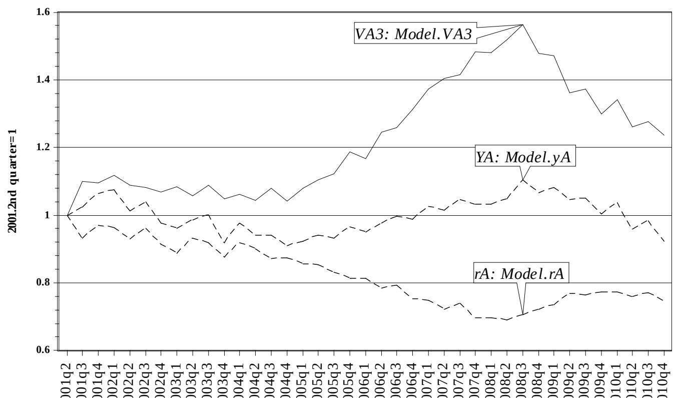

Figure 4: Appraisal Price, Rent and Discount Rate

The discount rate used with the present value model is weighed against property, stocks, and bonds, and determined as part of this process.

In that case, property discount rates should have a certain relationship to stock market changes, but as is clear from Figure4, they move only gradually.

As well, among financial markets, the stock market is said to be one of the most efficient markets, in which case it may be worthwhile to investigate the possibility of factoring in stock market data into property price determination. In this context, Geltner (1997) has investigated the possibility of changes in property shares or listed share prices of REITs.

In this study, we focus on listed investment prices (share prices) of REITs on the stock market and the relevant investment company's Tobin's q. Tobin's q is the value obtained by dividing the enterprise value (EV) estimated on the stock market by the capital reacquisition price ($\sum V_{it}$).[22] For J-REIT investment companies, since they are more or less identical in the sense of all their facilities being property, the property price for the investment company as a whole is calculated based on total share value and total liabilities. This being the case, the conditions under which Tobin's q is 1 are when the total share value and liabilities for investment unit matches the total property value.

In other words, we obtained discount rates – the discount rates (r_A) and (r_T) obtained by dividing the property income (y) estimated in the series of analyses by the property appraisal price (V_{Ait}) or property transaction price(V_{Tit}), and the discount rate (r_M)[23] that may be obtained through dividing the total property income for all property held by the investment company ($\sum y_{it}$) by the enterprise value (EV)[24] , which was estimated based on property income y and enterprise value (EV). Along with the fact that they specialize in offices only, we restricted ourselves here to these four investment companies based on the fact that the operators' parent companies (Mitsui Fudosan, Mitsubishi Estate, Nomura Real Estate Development, and Meiji Life Insurance) are enterprises with high credit-worthiness, with our aim being to eliminate share price fluctuations due to factors other than property market income/risk caused by the operator having low credit-worthiness. As well, since these investment companies make investments focusing on the Tokyo area, they largely corresponded to the region covered in this study's analysis.
In actual property investment, this is known as the implied cap rate. – of three kinds.[25]

Based on Gordon (1959), the discount rates obtained in this way may be analyzed as:

$$r = i + \rho - \delta \tag{11}$$

[22]Ignoring minor costs, this is the ratio of the enterprise value – comprised of the total value of shares estimated by the stock market and total value of liabilities, assuming the enterprise is dissolved and ownership changed completely at the present time – to the total amount of all costs involved in replacing the capital currently owned by the company (Tobin, 1969). Hayashi and Inoue (1991) measured Tobin's q by expressly introducing property market values using Japanese company data.

[23]

[24]29Here, we restricted ourselves to four investment companies specializing in office building investment only – the Nippon Building Fund, Japan Real Estate Investment Corporation, Global One, and Nomura Real Estate Office Fund – and calculated the discount rate r

[25]This simply reproduces the discount rate on an ex-post facto basis, and for the actual market, it is necessary to note that, as explained previously, it is determined as a result of the process of comparison with property investment returns and other markets such as stocks and bonds.

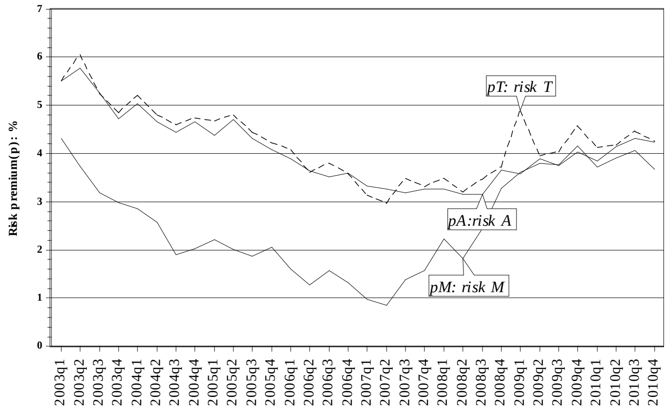

Figure 5: Trend of Risk Premium: %

Here, i signifies the investment return on safe assets,ρ the risk premium with respect to property investments, and δ the anticipated growth rate of property income (y).

Property income is here calculated based on the rent estimated by the market, and it is assumed that the anticipated growth rate(δ) is a value mutually recognized by the property appraisers who determine property price, transactors in the real property market, and market participants involved in the stock market (although this is by no means thought to be a strong assumption). This being the case, the discrepancies between the three – the discount rate set by property appraisers (r^A), the discount rate presumed by transactors (r^T), and the discount rate considered by stock market participants (r^M) – represent differences in the respective assumed risk premiums (ρ).

Based on this assumption, the calculation results for the risk premiums (ρ) for the stakeholders setting discount rate (r^A), discount rate (r^T), and discount rate (r^M) are shown in Figure5.[26] .

First, as seen when looking at changes in price indexes, there was no significant difference between risk premiums set by property appraisers (ρ^A) and risk premiums set by transactors (ρ^T). If we focus on the differences, whereas (ρ^T) increased significantly in the first quarter of 2009 following the Lehman Shock, no change of this kind was observed with (ρ^A)).

On the other hand, comparing (ρ^A) and (ρ^T) to (ρ^M), (ρ^M) declines significantly from 2003 until 2008, when the Lehman Shock occurred. With regard to the reason for the divergence between them, it means Tobin's q does not reach 1. This means, in other words, in the period when r falls below r and r enterprise values determined by the stock market were evaluated at a higher level than property appraisal prices determined by the property market and transaction prices. That is, risk premiums (ρ^M) were set at a low level.

[26]The return on 10-year Japanese government bonds was used for the return on safe assets

Meanwhile, with risk premiums (ρ^M) increases in one shot in the downward price phase,r_M observed using enterprise values increased significantly from the second quarter of 2007 onward. This means the rate of decline in property prices in property appraisals was slower than the rate of decline in prices observed using enterprise values. It can be understood that this fluctuation discrepancy is due to the volatility of significantly exceeding the volatility of and .

Then should the change in risk amount that occurred in the stock market therefore be reflected in the property market? It is known that present values determined using dividend income and prices and risk amounts determined using the stock market are not necessarily matched (LeRoy and Porter, 1981; Shiller, 1981).[27]

When, given such previous research, if one reflects ρ^M determined using the stock market in the property market, it causes changes in property price to react excessively. On the other hand, with the property appraisal price discount rate, the risk amount (ρ^A) changes insufficiently. Based on these results, it can be understood in selecting a discount rate for the property price index to estimate using the present value model, it is necessary to use these risk amounts for different purposes or revise them.

4.3 "Investor-Evaluated" Market Value and "Potential" Market Value

Office Rent Regidity The property income used in the series of analyses up to this point was the actual paying rent. However, since paying rent is often based on leases agreed in the past, it diverges from the market rent at a specific time, and, what's more, it is known to have a high level of viscosity. Therefore, it is possible that "potential" market values using equivalent rent in the current market (Diewert and Nakamura, 2009) differ significantly from the investor-observed REIT enterprise values realized in the REIT market.

Accordingly, we estimated a market rent function based on a hedonic function using actual contracted rent data.[28] We collected 3,985 samples for market rent, and the estimation results for the hedonic function using these samples is shown in Table7. In estimating the hedonic function, in order to obtain compatibility with other models, we input a location dummy based on national census survey areas.

Figure6 compares the estimated quality-adjusted office market rent index and the income index for property appraisals estimated in Table5. When both indexes are compared, although the overall trends are the same, one can see with respect to the extent of the decrease in rents from 2001 to 2003, the subsequent growth rate of office rents until the third quarter of 2008, and the extent of the decrease in office rents after the Lehman Shock, in each period market rents fluctuated by a greater amount than rents used in property appraisals. In

[27]When the volatility of discounted cash flow obtained from income and the volatility determined by the stock market are compared, in theory, the volatility determined with discounted cash flow should be greater. However, in reality, it is known that the volatility of prices determined by the stock market is greater (Shiller, 1981).

[28]Market rents were supplied by a major brokerage company. This data is contracted rent that were actually agreed.

Table 7: Estimation Result of Hedonic Equation: Market Office Rent

	Model.y_M		
	Coef	std err	
Constant	9.854	0.091	***
S: Floor space (m^2)	0.000	0.000	***
A: Age of Building (years)	-0.007	0.000	***
H: Number of stories (stories)	0.013	0.002	***
TS: Time to the nearest station: (mimutes)	-0.018	0.002	***
TT: Travel Time to Central Business District (minutes)	-0.001	0.001	
LD_k $(k=0,\ldots,K)$	Yes: Census		
TD_q $(q=0,\ldots,Q)$	Yes		
Adjusted R-square=	0.556		
Number of Observations=	3,985		

*P<.01, **P<.0.05, ***<.0.01

Note: The dependent variable in each case is the log of the price.

other words, in the office market as well, income indexes used for property appraisals have a high level of viscosity due to the impact of rent under renewed lease and so forth. This result is consistent with research focusing on the housing market (Shimizu, Nishimura, and Watanabe, 2010a).

Estimation of Potential Market Value(Discount Cash Flow) Index Here, we shall try to estimate an index for prices observed as discounted cash flow using estimated income and discount rate. First, with respect to present value $PV_{M,M}$, we obtained (Y^M/r^M) with the market rent (Y^M) based on the discount rate r^M estimated using enterprise value. With regard to $PV_{M,A}$, taking the income only as market rent y^M, we estimated this using the discount rate r^A used based on property appraisals (y^M/r^A). Figure7 compares$PV_{M,M}$,$PV_{M,A}$, and the transaction price index V_{M3} based on property appraisal prices.

Taking the first quarter of 2003 as the starting point, each index increases until the so-called mini-bubble of 2007. The average rate of change observed with the geometric average from the first quarter of 2003 to the first quarter of 2007 was 5.9% for $PV_{M,M}$, 3.2% for $PV_{M,A}$, and 2.0% for the transaction price index V_{M3} based on property appraisal prices. This shows $PV_{M,M}$'s rate of increase is approximately three times that of V_{M3} and $PV_{M,A}$'s rate of increase is approximately 1.5 times that of V_{M3}.

Focusing here on the time of peaking out, compared to $PV_{M,M}$ (first quarter of 2007), there was a lag of one year in the movement of $PV_{M,A}$(first quarter of 2008) and a lag of 1.5 years in the movement of V_{M3}(third quarter of 2008).

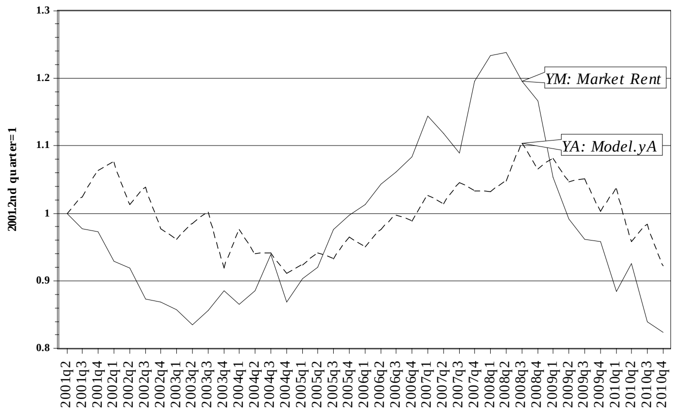

Figure 6: Trend of Market Rent and Appraisal Rent Indexes

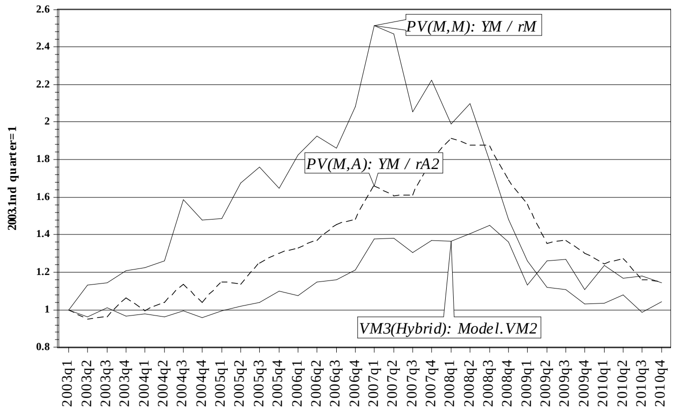

Figure 7: Trend of Present Value Indexes

5 Conclusion: Issues in conducting of Commercial Property Price Indexes

With regard to the estimation of commercial property price indexes, appraisal-based property price indexes have been published for many years focusing on Japan, the U.S., and the U.K. With these indexes being used, questions have been raised about whether fluctuations in appraisal-based property price indexes diverge from actual market conditions, and considerable research has been conducted in order to clarify the distortion in appraisal-based property price as well as revising them. Furthermore, in recent years, commercial property transaction price indexes have been developed and started to be published in the U.S.

However, in many countries, such as Japan, since not enough transaction price data is provided/collected, many difficulties accompany the estimation of indexes based on transaction prices. In addition, compared to housing and so forth, commercial property has a high level of heterogeneity, so quality adjustment must be rigorously performed.

In addressing problems such as this lack of data and rigorous quality adjustment, one may refer to past experience and efforts that have been made in the practical property appraisal. Residential property appraisal prices are determined based on the sales comparison approach, using comparables for similar transactions in the vicinity of the property being appraised. For housing price indexes, this leads to the price index being estimated by performing quality adjustment through direct use of transaction prices.

For commercial property, on the other hand, since there is lack of transaction comparables as well as a high level of heterogeneity, it has been recognized it is difficult to perform appraisal based on the sales comparison approach. As a result, commercial property appraisals are generally determined with present value, based on a method known as the capitalization method. This means that the difficulty level of estimating commercial property price indexes using transaction prices is extremely high compared to housing.

In this study, based on past experience in the practical property appraisal, in addition to a price index using property appraisal prices and price index using transaction prices, we explored the possibility of estimating a price index based on a present value model. Specifically, focusing on the Tokyo area, we estimated a present value-based property price index, along with an appraisal-based price index and transaction price index, using published J-REIT data with the same characteristics as data possessed by NCREIF in the U.S., IPD in the U.K., etc. The following provides an overview of the analysis and results obtained.

First, we estimated commercial property price indexes based on the hedonic price method, using property appraisal prices and transaction prices available for the J-REIT market.

In estimating the appraisal-based property price index, we performed quality adjustment based on the total building floor space (S), building age (A), number of stories (H), distance to the nearest station (TS), average day-time travel time to the central business district (Tokyo Station) (TT), as well as a location dummy (LD). With regard to the location dummy, estimating two cases – one in which the location dummy was input using census survey areas, and one in which it was input using municipalities – showed that it was not possible to sufficiently eliminate regional differences with the location dummy using municipalities; it is therefore necessary to input a dummy variable based on census survey areas. In other words, one can understand from this that the commercial property market is a market with a high level of heterogeneity that is differentiated across highly detailed spatial units. This is the first conclusion that we were able to draw from this study.

Next, we estimated an index with the hedonic price method based on transaction price data. Verifying the estimate values and their reliability by the number of samples and time dummy for each time period using the calculated results showed there were periods when there were almost no transactions, such as the second quarter of 2002 (three transactions) and the third quarter of 2003 (only one transaction). In other words, it was understood that with transaction prices only, it is difficult to estimate a transaction price index with geographic range such as the Tokyo area or frequency such as every quarter. This shows that even if one attempts to estimate a price index using transaction prices, it is difficult to obtain enough data even in a large urban area like Tokyo, and it is difficult to create an index with a high frequency such as every quarter. This is the second conclusion that we were able to draw from this study.

In order to resolve these problems, we tried estimating a transaction price index using a cross-term with a transaction price dummy, based on the appraisal-based property price index. The estimates enabled us to recognize that the transaction price index modified from property appraisal prices exceeded the property appraisal price index in the first and second quarter of 2007 (the period dubbed as the mini-bubble), as well as dropping significantly more than the appraisal-based property price index in the first quarter of 2009 following the Lehman Shock. However, since the index was based on property appraisal prices in most periods, we were unable to resolve the fundamental problems with appraisal-based property price indexes, such as the smoothing problem and lag problem which have been pointed out in much previous research. Nevertheless, we clarified the fact that with a lack of transaction price data, there is a possibility of creating a transaction price-based index by modifying an appraisal-based property index. This is the third conclusion that we were able to draw from this study.

Next, in keeping with property appraisal practice, we explored the possibility of estimating a commercial property price index based on present value. In estimating present value, the determination of discount rate is extremely important. Income, which is the numerator, is already finalized by the market, so it is difficult to imagine that significant differences would occur between property appraisers and transactors when forecasting it. However, it is to be expected there would be significant differences between the respective stakeholders with respect to the risk premiums for property forming the discount rate. Accordingly, we obtained the discount rate for property appraisal prices and transaction prices and the discount rate using enterprise values able to be obtained using the J-REIT investment unit market, and estimated the respective risk premiums.

The results showed there was significant divergence between the risk premiums set with property appraisals (ρ^A) and with transactions (ρ^T)and the risk premium for property investments formed by the stock market (ρ^M)– in particular, ρ^M was significantly lower from 2003 until 2008, when the Lehman Shock occurred. With regard to the reason for the divergence between them, it is significant that Tobin's q does not reach 1, which means enterprise values determined by the stock market were evaluated at a higher level than property appraisal prices and transaction prices determined by the property market. In other words, risk premiums (ρ^M) determined through the stock market were set at a low level. That is, it was understood the difference between these discount rates and the prices determined through them is caused by differences in the risk premiums. This is the fourth conclusion that we were able to draw from this study.

Moreover, if one looks at the extent of risk premium fluctuation, the volatility of risk premiums formed in the stock market (ρ^M) is greater than those of (ρ^A) or (ρ^T) hypothesized with appraisals or transactions. In other words, as indicated by Shillers' Test (Shiller, 1981) and clarified by many subsequent studies focusing on the stock market, risk premiums (ρ^M) formed in the stock market fluctuate more than risk premiums (ρ^A) or (ρ^T) determined with present values. On the other hand, as indicated by the term smoothing problem, since the fluctuation of risk premiums set with appraisals (ρ^A) is extremely gradual, it is said they do not accurately represent market conditions either. In such a case, in determining present value, it is important to consider changes in the market while also referring to risk premiums formed in the stock market (ρ^M). This is the fifth conclusion that we were able to draw from this study.

As well, the income (y^A) determined in the property investment market is paying rent. With regard to paying rent, when it is paid based on rent agreed in leases concluded in the past, there are times when it diverges significantly from the market conditions. In particular, in periods when market rents increase or decrease significantly, the divergence is considerable. Accordingly, we estimated a market rent index using actual contracted rents. Using the market rent index estimated in this manner and the discount rates obtained previously, we estimated multiple present value indexes. Specifically, we estimated two new price indexes that obtained the present value $PV_{M,M}$ (obtained with the discount rate r^M estimated using market rent y^M and enterprise value) and the present value $PV_{M,A}$ (using the discount rate r^A used based on property appraisals and market rent y^M taking the latter as income only). Comparing the two estimated indexes and transaction price index V_{M3} based on property appraisal prices showed that compared to $PV_{M,M}$, which peaked out in the first quarter of 2007, $PV_{M,A}$ moved with a lag of one year (peaking out in the first quarter of 2008) and V_{M3} moved with a lag of 1.5 years (peaking out in the third quarter of 2008). This is the sixth conclusion that we were able to draw from this study.

What do the six conclusions obtained from this series of analyses imply in terms of creating commercial property price indexes?

First, in estimating commercial property price indexes, it is necessary to rigorously perform quality adjustment. Since commercial property has a high level of heterogeneity compared to housing, it is necessary to perform more advanced quality adjustment. This means that, in the case of applying the hedonic method, significant costs will arise in data provision relating to property characteristics.

Second, data selection must be performed carefully. In estimating commercial property price indexes, along with transaction price indexes based on transaction prices, appraisal-based property price indexes using property appraisal prices have been estimated. For transaction prices, even in large urban areas such as the Tokyo area, it is possible that there will be very few – and in some cases zero – transactions. On the other hand, for property appraisal prices, as has been pointed out in many previous studies, there are inherent problems such as the smoothing problem, valuation error problem, and lag problem. In order to resolve these problems, what modifications can be made using transaction prices should also be considered.

Third, setting of risk premiums for property appraisals must be performed in light of market data. Property appraisals of income properties such as office buildings are performed based on the capitalization method. In terms of the reasons that smoothing and lags occur with property prices determined using the capitalization method, it has become clear there are problems in the setting of risk premiums. In determining these, it is perhaps necessary to incorporate data from markets such as the stock market.

Fourth, price indexes must be explicitly defined: do they measure investor-observed market values, or do they measure potential market values?[29] Property appraisal prices determined in the property investment market are determined as market values based on paying rent. The income used in property appraisals is calculated based on paying rent. This is because, in terms of the characteristics of investment property, appraisal should be performed based on paying rent.

The opinion has also been expressed that if trying to obtain market values transacted in the market, the price should be determined based on the income that would be generated at the present. In such a case, it should be estimated as the market rent that would presumably be determined by the market at that particular time. In other words, this means that equivalent rent would be obtained as the market rent.

This is a problem related to an index's purpose and definition. The purpose of the IPD property price index and NCREIF property price index is to measure property investment returns. The estimation method and so on for commercial property price indexes will change based on the purpose: Is it aimed at measuring investment market returns? Does it seek to capture macro changes in the more general commercial property market? Or does it seek to calculate property market risk amounts?

Finally, it is also necessary to consider the relationship with other statistical surveys such as Producer Price Indexes (PPIs). In many countries, office rents are surveyed as part of PPIs. There is a possibility that discounted cash flow is also obtained by using such rents. However, in such a case, the problem of how to set the discount rate remains. The fact that

[29] In practical property appraisal, there have been various discussions surrounding the definition of price. In the U.K., it is based on the definitions of market value and worth or investment value. In the U.S., there are definitions for open market value, investment value, and most probable selling value, while in Japan, market value and investment value are distinguished based on the definitions of "normal price" and "specific price." However, it should be noted the price distinctions discussed here differ from price-related definitions implemented in practical property appraisal.

the estimation of risk premiums is especially important has also been made clear from this paper's analysis.

The estimation of commercial property price indexes is restricted in different ways based on the data that is available in different countries. In countries where data for the property investment market is available, it is possible to use both property appraisal price data and transaction price data. For such countries, it is perhaps necessary to outline how property appraisal prices should be modified after understanding their mechanism. As well, in countries where the investment market is undeveloped, indexes are estimated after collecting/preparing transaction prices. In such countries, since it is difficult to obtain property characteristics data, there are many problems accompanying the application of the hedonic method.

As well, in countries where office rents are provided in PPIs, obtaining the price as the present value based on the income data may also be considered.

With the strong data limitations in different countries, when it comes to the preparation of commercial property price indexes, one must perhaps select the estimation method based on the available data and consider how to prepare it.

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