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— Lessons from Japanese experience in Bubble period —

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# Biases in commercial appraisal-based property price indexes in Tokyo\*

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## Summary

This paper seeks to investigate the nature and magnitude of the distortion in appraisal land price information according to change in the market, with a special focus on the Government's Published Land Prices. In Japan, there is an item of land price information, the so-called Koji-Chika (PLPS: Published Land Price Information System), that is a survey of fair market value by qualified appraisers. The valuation error of this land price information was analyzed using the following method. First, hedonic price indexes were constructed based on both actual transaction prices and the Published Land Prices, they were then compared to detect possible distortions in the governmental price information. The possibility of structural change in the Japanese real estate markets was also studied and its effect on price indexes was considered. Analysis of the Tokyo metropolitan area took place between 1975 and 1999. Large and systematic discrepancies between actual transaction prices and the Published Land Prices were identified, which might suggest that there are serious problems with the governmental information system. It is believed that it is necessary to consider this issue in the context of the entire real estate appraisal system in Japan.

*Key Words* :Hedonic approach; Structural change; Valuation error problem; Smoothing problem; Client influence problem; Appraisal based price indexes; Transaction based price indexes; Public land prices

*JEL Classification* :R33

## 1 Introduction

The boom and bust of property prices during the age of the so-called bubble economy affected the economy in general as well as all aspects of life in Japan and its economic system.

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We wondered how much property prices had risen in the boom period and subsequently fallen in the post bubble period.

This might seem to be a very simple question, but at the height of the bubble and amid the subsequent abrupt collapse process, no one was able to answer it. As a result of this, many problems arose with respect to policy management during the bubble era and especially following the collapse of the bubble. The most typical problem was the one surrounding financial institutions' disposal of bad loans. Since no real estate price index/real estate price information existed that made it possible to capture real estate market conditions, it was not possible to calculate correct bad loan debt amounts, and it took a long time until policy measures were implemented, including the injection of public funds. This was a major factor leading to the prolonged economic stagnation known as the "lost decade."

This does not mean, however, that there were no real estate price indexes in Japan during the bubble era and the subsequent period of collapse. Multiple real estate price indexes were published by the private and public sectors. The Japan Real Estate Institute's Urban Land Price Index is one of Japan's leading real estate price indexes. Originating as a real estate market survey prior to World War II<sup>1</sup>, this index has been published since 1955. In the public sector, the Published Land Price has been published since 1970 by the Ministry of Land, Infrastructure, Transport and Tourism. In other words, even during the bubble era and the subsequent period of collapse, real estate price indexes existed.

In that case, the question of why these real estate price indexes were not effective in policy management during the bubble era and the subsequent collapse process is a vital one. The most significant factor is that the results shown by these real estate indexes diverged significantly from both the transaction price levels and trends being observed by participants in the actual market. What was the cause of this?

One cause suggested during the series of policy-related discussions following the bubble's collapse was that there were significant errors in the real estate appraisal value (prices) forming the raw data for creating the indexes. That is, neither the Urban Land Price Index nor the Published Land Price were indexes created with actual transacted prices; instead, they were based on the appraisal value determined by real estate appraisers (appraisal-based indexes). Generally, in the case of "price indexes," prices transacted on the market are used. However, as is evident in the case of Japan, in the creation of real estate price indexes – especially commercial real estate price indexes – that it is not unusual for real estate appraisal value to be used. It is not only the Japanese Urban Land Price Index and Published Land Price – commercial real estate price indexes published in China and Korea are also based on real estate appraisal value. Investment Property Databank (IPD), which supplies property return (income return and capital growth) indexes for 24 countries, focusing on the UK, creates its indexes based on appraisal value.<sup>2)</sup>The NCREIF capital value(real estate prices) index – a leading U.S. real estate investment index – is also, like

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<sup>1</sup>Surveying for Urban Land Price Indexes began on a trial basis in 1926 by "*Nihon Kangyo Ginkou*" (Japan National Industrial Bank).

<sup>2</sup>) For details of IPD's real estate investment index, see <http://www1.ipd.com/Pages/default.aspx>.

IPD's index, a real estate investment index based on appraisal evaluation amounts.<sup>3)</sup> In recent years, on the other hand, commercial price indexes based on transaction prices have also come to be published, such as the U.S. Moody's/REAL Commercial Property Price Index (CPPI) and the MIT/CRE Transaction Based Index (TBI).<sup>4)</sup> In addition, IPD is developing a transaction price-based index.<sup>5)</sup>

Thus, an important point that arises with regard to the creation of commercial real estate price indexes is the question of selecting the data, along with the issue of the calculation method. The question is whether to use transaction price data, to use real estate appraisal value, or to select a different method.<sup>6)</sup>

Focusing on Japan's bubble era, the aim of this paper is to statistically clarify problems that occur with Japan's commercial real estate price indexes, as well as to outline issues relating to the preparation of future commercial real estate price indexes. Specifically, we will clarify the accuracy of the commercial real estate price indexes able to be used during the bubble era and the extent to which they were distorted.

First, with regard to real estate price index creation, we will outline how real estate appraisal value came to be used in Japan. The first reason is the problem of limited data. Commercial real estate and industrial real estate transactions in particular are extremely few in number compared to other asset/service or housing transactions, and collecting sufficient data is difficult. The second reason is the problem of heterogeneity inherent in the real estate market. Heterogeneity is especially pronounced for commercial real estate. As a result of this, advanced quality adjustment must be performed when aggregating such data. In terms of the problem of insufficient data, it is not just a problem of there not being enough data to perform aggregation; since the liquidity is extremely low, it also involves the problem of there being the possibility of observing only one specific transaction.

Specifically, a large amount of prime Japanese commercial land is owned by big corporations, such as former zaibatsu conglomerates, and it is extremely rare for transactions involving this land to occur; on the other hand, transactions involving small- and medium-scale commercial real estate occur frequently. In such a case, there is a possibility that the problem of sample selection bias will occur when creating real estate price indexes.

In order to avoid these problems, real estate price indexes were constructed by performing quality adjustment using a real estate appraisal evaluation method and determining the real estate transaction price even if the transaction did not occur. In light of this, the question that arises is why indexes using real estate appraisal value deviated from the market conditions in the bubble era and the bubble collapse era. To answer this, it is necessary to outline the relationship between "real estate appraisal value," "market prices," and "transaction prices." The problems that may be foreseen shall here be broadly categorized into: a) problems of defining the price determined by real estate appraisers, and b) technical

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<sup>3)</sup> NCREIF: (<http://www.ncreif.org/>)

<sup>4)</sup> <http://web.mit.edu/cre/research/credl/rca.html>

<sup>5)</sup> For details of IPD's transaction price-based index, see Devaney and Diaz (2009).

<sup>6)</sup> With regard to problems surrounding data selection and calculation methods, refer to Diewert, et al. (2012).

problems.

First, let us look at the former. Many discussions have been held both in Japan and abroad surrounding real estate appraisal value. In Japan, the real estate appraisal value set by real estate appraisers should determine the “fair value.” And as far as the concept of “fair value” is concerned, discussion of whether it is the “ideal value (sollen)” or the “actual value (sein)” that should be evaluated has been ongoing for a long time. The current definition, revised in 2002, defines “fair value” as the “fair value representing the market value that would be produced in a market meeting conditions assumed to be reasonable in the present socio-economic circumstances for real estate that has marketability.” In other words, insofar as is possible, the price transacted on the market – i.e., the “actual value” – should be evaluated.

Meanwhile, prices are categorized under the following definitions in England: the actually transacted price (comparables), the market price, and the investment value or worth.<sup>7)</sup> In the U.S., appraisal value fall under the definition of the “most probable price.”<sup>8)</sup> In Germany, there is a pronounced tendency for real estate appraisers to determine what they consider the “ideal price” rather than reflecting market fluctuations. As a result of this, it is known that the appraisal value has a strong tendency to diverge from the market price. In light of this, as far as real estate appraisal value are concerned, we are confronted with the following problem: the nature of the prices that are sought varies by country.<sup>9)</sup>

The next issue is technical problems. A number of studies have been conducted concerning the gap between real estate appraisal evaluations and market prices. Looking at past studies, one can see that the following issues occur with respect to real estate appraisal value: the so-called “valuation error” problem, “smoothing” problem, and “client influence” problem.

Cole, Guilkey and Miles (1986) , Jeffries (1997), Shimizu and Nishimura (2006) for example, statistically checked the difference between transaction prices and appraised values. Crosby (2000) is an international comparison study of impact on valuation accuracy caused by different social structure in each country. Geltner, Graff and Young (1994), Geltner (1997, 1998) , Bowles, McAllister, and Tarbert (2001) dealt with the impact of appraisal error to property index and pointed out time-lag structure in appraisal-based index.

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<sup>7)</sup>For details see, Royal Institution of Chartered Surveyors (RICS), RICS Valuation – Professional Standards

Incorporating the International Valuation Standards, March 2012

<sup>8)</sup>”The most probable price (in terms of money) which a property should bring in a competitive and open market under all conditions requisite to a fair sale, the buyer and seller each acting prudently and knowledgeably, and assuming the price is not affected by undue stimulus. Implicit in this definition is the consummation of a sale as of a specified date and the passing of title from seller to buyer under conditions whereby: the buyer and seller are typically motivated; both parties are well informed or well advised, and acting in what they consider their best interests; a reasonable time is allowed for exposure in the open market; payment is made in terms of cash in United States dollars or in terms of financial arrangements comparable thereto; and the price represents the normal consideration for the property sold unaffected by special or creative financing or sales concessions granted by anyone associated with the sale.”(Appraisal Institute, (2002))

<sup>9)</sup>The International Valuation Standards Council (IVSC) defines the market price as “the estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arm’s-length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently, and without compulsion” and is attempting to move forward with the international standardization of real estate appraisal evaluation systems. However, there are many countries that are not complying with this movement, including Japan and South Korea.

In addition to technical aspect in appraisal practice, the independency of appraisers is another serious issue. Gallimore and Wolverton (1997), Kinnard, Lenk and Worzala (1997) and Wolverton (2000) suggested the possible bias caused by clients and appraisal fee related to appraised value. In other words, with respect to appraisal value, there is a problem of the price being distorted due to the client influencing the real estate appraisal. This is known as the Client Influence Problem.

It is possible that Japan's commercial real estate price indexes have not functioned properly due to distortion of real estate appraisal value caused by this kind of problem. As a result, careful judgments are required when creating commercial real estate price indexes and employing real estate appraisal value. On the other hand, there are many problems even if transaction prices are employed. As explained earlier, since there is an insufficient amount of data for creating indexes and considerable heterogeneity, it is necessary to establish a method for adjusting quality.

In our opinion, our discussion should be based on transaction price information since transaction prices are resources of all property price information. We summarised types and characteristics of property price information and explained its statistical meaning. Then we developed a price index through the Hedonic Approach based on transaction price information in Tokyo area. For commercial sector, the database was constructed on transaction information in three core Wards in Tokyo, namely Chiyoda-Ward, Chuo-Ward and Minato-Ward. In those areas, we collected historical transaction information as many as possible. And finally, an empirical analysis was undertaken between the hedonic-based index and two most frequently used property price information in Japan. One is *Published Land Price* produced by the MLIT and the other is *Urban Land Price Index* by Japan real Estate Institute. Above all, we compared the transaction-based index with another hedonic-based index on *Published Land Price* information so that we can analyse bias of appraisal-based *Published Land Price*.

## **2 Type and characteristics of real estate price information: Data source for the Commercial Property Price Indexes**

We have several kind of information on property price. This was once described as a situation of “four prices for one commodity”. Thus, it is necessary to make it clear what “property price” means, what kind of information is available and what characteristics the information has.

### **2.1 Multi prices for one property**

We have property price information published by government offices. They are *Published Land Price (PLP)* and *Sales comparables* by the MLTI, *Land Price Survey (LPS)* by each pre-

fecture, *Land value for Inheritance Tax* by National Tax Office and *Land value for Property Tax* by each municipal office.

Additionally, private company or think tanks have produced their own research. They are; *Nikkei Real Estate Information* has been issued by Nikkei Business Publications, *Urban Land Price Index(ULPI)* by Japan Real Estate Institute, *IPD Property Index(IPD)* by the Investment Property Databank, *ARES J-REIT Property Index(ARES)* by The Association for Real Estate Securitization, and *MUTB-CBRE Real Estate Investment Index* by Mitsubishi-UFJ Trust Bank & CB Richard Ellis (See, Table1).

The information is divided into two categories. The first one includes the index of which object is to observe land price change in time series. The second one consists of information, which provides with estimated land price in certain areas.

As for the former, *Urban Land Price Index* had been the only single index available for long time, but new indexes such as *IPD Property Index*, *ARES J-REIT Property Index* and *MUTB-CBRE Real Estate Investment Index* have recently joined the group. The methodology of index construction of *Urban Land Price Index(ULPI)* and the latter three indexes are entirely different. The *ULPI* estimates the trends of Land prices, and the other indexes measure the investment return; income return, capital return and the total return(income return + capital return). And, the *ULPI* have appraised the certain sites(Land) half-yearly to produce their *ULPI* while the other property informations; *PLP*, *LPS* and tax purposed assessed value aim to investigate price level on either appraisal value, market estimate or transaction information.

In addition, reporting of the *MUTB-CBRE Real Estate Investment Index* ceased in 2010. Similarly, the STB Research Institute, which published the first *STIX real estate investment index* in Japan in 1997, ceased reporting of the index in 2008 because it had become difficult to obtain the raw data. Besides these, reporting of the *Sumitomo Life Insurance Research Institute Index* published by the Sumitomo Life Insurance Research Institute ceased with the institute's demise. From 2000 to 2005, when expansion of the real estate investment market was anticipated, there was a glut of commercial real estate price indexes. However, from 2005 to 2010, companies continued to go out of business or ceased performing index provision activities. Furthermore, since they were calculated using differing methods, the trends showed by the indexes varied and this caused confusion among users.

There are significant lessons to be learned from this. First, there is the issue of comparability. Results calculated separately using different methods lack comparability and lead to confusion. In view of this, when it comes to attempts to develop internationally comparable indexes, insofar as is possible, a common calculation method must be used. Second, it is extremely important to ensure the stability and continuity of index provision by building them into policy management. In view of this, the Japanese experience makes it clear that the public sector should assume a major role as a leading administrator of real estate price indexes.

Table 1: Commercial Real Estate Price Information in Japan

Survey	Organisation	Type1	Type2	Frequency	Availability*
Published Land Price Survey	The Ministry of Land, Traffic and Infrastructure	Appraisal	Price & index	Annual	1970
Land Price Survey	Prefectural and city governments	Appraisal	Price	Annual	1975
Assessed value for Inheritance Tax	National Tax Administration Agency	Assessment	Price	Annual	1963
Assessed value for Fixed Asset Tax	Municipal governments	Assessment	Price	Every three years	1950
Sales Comparables	Ministry of Land, Infrastructure, Transport and Tourism	Transaction	Price	Monthly	2006**
Nikkei Real Estate Information	Nikkei Business Publications, Inc	Transaction	Price	Monthly	2002
Urban Land Index	Japan Real Estate Association	Appraisal	Index	Bi-annually	1955
IPD Property Index	IPD: Investment Property Databank	Appraisal	Index	Monthly	2001
ARES JREIT Property Index	The Association fro Real Estate Securitization	Appraisal	Index	Quarterly	2001
MUTB-CBRE Real Estate Investment Index	Mitsubishi-UFJ Trust Bank & CB Richard Ellis	Appraisal	Index	Yearly	1968

\*Availability means that the data is available from this year.

\*\*Sales comparables are owned Appraisal Association before 2006.

## 2.2 Transaction price & comparables, appraised value& value for tax purposes

We have a few types of property price such as Transaction Price, Appraised Price and Price for Tax and investigate these in detail in this section.

### 2.2.1 Transaction prices and transaction data

Generally, price means transaction price in economic activities. However, we must bear in mind the fact that there is a gap between the Asking Price and Contract Price in the property market since each transaction price is decided finally through individual negotiation (Shimizu, Nishimura and Watanabe (2011)).

It is very difficult to collect transaction price information in Japan compared to western countries. However, there is transaction price information, which is called *Transaction Comparables* or *Torihiki Jirei* in Japanese. These sales comparables are basic information for the *Published Land Prices Survey* and collected by MLIT. The process of collecting those comparables depends on local practices and the purpose of collection. A typical case can be described as follows.

When a real estate transaction is realized, the buyer notifies the Land Registry and registers the real estate. In western countries such as the U.S. and the UK, the real estate

price is recorded in the registry at this stage, but in Japan, China, South Korea, Taiwan, etc., the price is not recorded in the registry. As a result, it is necessary to investigate real estate prices separately. The registry office sends the information as a registration completion letter to MLIT. Then, MLIT sends questionnaires to buyers to get transaction price information. However, the data in registry does not include any information about a property's characteristics. The qualified appraisers add other information such as site condition including the width of facing roads, grade of road, the nature of and distance to the nearest station, city planning regulations and conditions on transactions. Then they keep it as a transaction comparable record and share it with each other.

In some western countries such as the U.S., UK, Germany and France, the transaction price information is systematically collected and disclosed through a formal land registration system. However, in these countries, although real estate price data is recorded, data related to real estate characteristics is not prepared. As a result, if attempting to calculate a real estate price index using price data based on the registry, one faces many problems with respect to quality adjustment.

### 2.2.2 Appraised price

Since many real estate characteristics are examined when determining a real estate appraisal value and the noise that occurs with various transactions is removed, appraisal value data is easy to use in calculating real estate price indexes. In particular, since it is possible to continue observing the price at a fixed point, there is no need for quality adjustment. However, it has been suggested that divergence of real estate appraisal evaluations from market conditions could be a problem. Accordingly, we will take a look at real estate appraisal value.

In July 1980, prior to the occurrence of the real estate bubble, the Japan Association of Real Estate Appraisal defined "fair value" as "referring to the fair value representing the market value that would be produced in a rational free market for real estate that has marketability," and stated that this is the "value realized when market conditions are communicated sufficiently and multiple buyers and sellers with no ulterior motivation exist in a market where supply and demand are able to operate freely with no market control."<sup>10</sup>) However, this definition required revision during the bubble era.

In 1990, at the peak of the bubble, it was still defined as "fair value representing the market value that would be produced in a rational free market for real estate that has marketability," while evaluation was performed in a manner that would suppress soaring real estate prices. In this context, significant divergence arose between real estate appraisal value and transaction prices. This supported the notion that the "ideal value" should be determined using a price that diverges from the market conditions. However, when real

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<sup>10</sup>In 1964 (Showa 39), when the modern appraisal evaluation system was inaugurated, "fair value" was defined as the "fair value that it is presumed would be realized in cases where the real estate has existed for a reasonable period of time in the general free market and the market conditions are communicated sufficiently to sellers and buyers, who also have no ulterior motive," which strongly contradicts the price formed by the market.

estate prices are determined based on this notion, the problem of market control occurs. Accordingly, in 2002, after the collapse of the bubble, the definition was changed to the “fair price representing the market value that would be produced in a market meeting conditions assumed to be reasonable in the present socio-economic circumstances for real estate that has marketability.” In other words, insofar as is possible, appraisers should target the price that will be transacted on the market when performing evaluations.

This kind of discussion offers extremely important pointers when attempting to create real estate price indexes using real estate appraisal value. Even if one looks only at Japan, the definition of the price that should be represented by appraisal value changes over time. In addition, in the case of attempting international comparisons, definitions vary among the respective countries and prices are determined based on different methods. In such a case, it is not possible to create internationally comparable indexes.

Meanwhile, the series of discussions surrounding real estate appraisal value has provided many important pointers when it comes to considering the transaction prices of commercial real estate. It has been suggested that, in commercial real estate market transactions, the transacted price level may change significantly based on the characteristics of different sellers and buyers, rather than transaction prices being determined by a competitive market. In other words, this suggests the possibility that these transaction prices are not prices determined by a large number of market participants.

### **2.2.3 Land prices for tax purposes**

There are a few property-related taxes and assessments. Each municipal head has carried out the valuation for local property tax. The prefectural governor has undertaken the valuation for property acquisition tax. While the director of the tax office does valuation for inheritance tax and gift tax, the local tax officer estimates the value for registration tax. Because the purpose and underlying market of each assessment differs, it is pointed out that the value was unbalanced against each other.

This created problems in assessment of local property tax and inheritance tax of which valuation was undertaken by individual municipal governments and their respective officers. The assessment was not well balanced between local governments as well as property types in a government. Also there were significant gaps in assessed values between two taxes, which developed into a serious social problem especially during the Bubble period in Japan.

Then they indicated that coordination of this assessment was necessary in the Land Basic Law 1989 and Comprehensive Land Policy Promotion Outline 1991. Since 1992 the value for inheritance tax is set at 80% of the level of the Published Land Price while the value for property tax aims to be 70% of the Published Land price level. The situation is more complicated in property tax where the assessment value is not always the taxable value. In order to avoid sudden increases in tax charges, the assessment value has been smoothed through a rate of burden adjustment. The taxable value, affected by previous values, has still been lopsided. In 1999, the ratio between taxable value and assessment value was,

on average, 51.17% for commercial land. (This ratio is called the contribution ratio in local public finance.) However, the ratio is more than 20% and less than 40% for 27.1% of commercial land. In the extreme case for 1.5% of commercial land, it is only under 20% during the Bubble period. <sup>11)</sup>

As shown above, it is the Published Land Price that gives a base for public property valuation. It is also the base of valuation for private transaction. Consequently, the accuracy of the published land value affects all appraised land value in Japan.

## 2.3 Published Land Price and Urban Land Price Index - characteristics

In this section, we summarize the characteristics of the *Published Land Price* statistics by MLIT and the *Urban Land Price Index* by Japan Real Estate Institute.

### 2.3.1 Published Land Price

The *Published Land Price* was established in 1970 and its purpose is to give a benchmark to land transactions in general and to help estimate the fair amount of compensation for those who give their land for public welfare so that a fair land price is achieved. Put into a more detailed manner, the Price would be used as a benchmark for land transactions in private deals; a property appraisal; a valuation for public land acquisition; an estimate for compensation for compulsory land acquisition; a price check for land transactions in the Land Use Planning Law; and an acquisition price in the Land Use Planning Law. In practice, it represents an official land price.

The fair market value of each surveyed site per square meter is published as of January 1st each year (Rule 1 of Article 2-2). The Land Appraisal Committee instructs two qualified appraisers to undertake each site and then decide on the public price (Article 2-1).

The subject area for this survey is described in Article 2-1 of the Published Land Law (No. 49 Showa 44 as Urban Planning Area designated by Article 4-2, Town Planning Law (Law No. 100, Showa 43 excluding Area Under Regulation designated by Article 12-1, National Land Planning Law (Law No. 92, Showa 49).

The appraisers use three approaches: Comparison Approach, Income Capitalization Approach and Cost Approach and conciliate the estimated price by each approach (Article 4). In practice, however, the value based on the Comparison Approach is heavily weighted when valuing a matured urban site, although they have been said to put more weight on the Income Approach in recent years.

From a statistical point of view, the error incurred in this survey has decreased in theory as the number of samples has increased. However, the number of appraisers responsible for the survey has not increased with the number of samples and hence the error incurred for each survey site can be bigger (there are 26,000 samples in 2011). The land price has not

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<sup>11)</sup>According to the Ministry of Public Management, Home Affairs, Posts and Telecommunications.

been adjusted once published and the error has accumulated over time. A survey site is replaced when the cumulative gap is too big to ignore. Consequently, only a small number of survey sites have long-term historical records to observe.

### 2.3.2 Urban Land Price Index

The Japan Real Estate Institute has published the *Urban Land Price Index*. Its aim is to survey average fluctuations of land prices in urban areas all over Japan on a macro scope. It is a rare land price index by which we can understand long-term trends of prices.<sup>12)</sup> The methodology is described below.

The qualified surveyors in the Institute undertake valuation of selected points in 230 cities twice a year. Then the indexes are calculated based on the appraised value of each point. They classify the urban areas of each city into commercial area, residential area and industrial area. Each area is divided into three ranks as Upper, Middle and Lower. They assume a representative plot in each rank. Additionally, they survey the highest land price of each city. Each city has ten surveyed points generally.

The characteristics of this index are: it is based on appraised value, is a long-term land price index only available since pre-war period and aims to survey land price trend. However, it is impossible to validate how the samples are representative and accurate since the information of the samples is not fully disclosed. Additionally, the valuation error in a single sample can have significant impact since they have only 10 samples in each city.

Furthermore, when the same site is evaluated on an ongoing basis, if there were significant errors in the price level at the time of the previous survey, it is often necessary to correct them. This provides an important pointer with respect to appraisal-based indexes such as the IPD Property Index and ARES Property Index. These indexes are calculated based on ongoing appraisal evaluation amounts for the same properties. Also, when calculating the price fluctuation rate at a point in time “ $t$ ”, even if significant errors are found in the appraisal evaluation amounts at the point in time, correction is not conducted at a point in time of “ $t - 1$ ”. In this case, errors accumulate over time and correcting them becomes extremely difficult. The Published Land Price has also frequently faced the same problem during periods of price fluctuation, such as the bubble era. In the case of the Published Land Price, past appraisal evaluation errors were resolved by changing survey points. We believe this experience is an important issue when considering appraisal-based indexes.

## 2.4 Error in appraisal

It has been pointed out that there is a gap between the *Published Land Price Index* and *Urban Land Price Index*, and ‘intrinsic’ market price since they are both based on appraised land values(Shimizu and Nishimura(2006),(2007)).

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<sup>12)</sup>Nippon Kangyo Bank started this index in September 1936 (Showa 11) and Japan Real Estate Institute has taken it over since March 1959 (Showa 34).

We have known that there are three types of potential valuation errors. It is important to understand these to analyse appraised values(Shimizu and Nishimura,(2006)).

#### **2.4.1 Valuation error 1 - Market change: Lack of information and valuation error**

First of all, in our valuation practice, the comparison approach weights more than other approaches. The valuation accuracy depends on the number of comparables available, their precision and accuracy. Generally, fewer transactions happen when the market changes with much uncertainty. The accuracy of valuation is more fragile when fewer comparables are available in the property market, which is originally not so liquid. It is more likely to make errors in choosing information when the market turns into a different stage. It is highly likely for the appraiser to mistakenly choose wrong comparables for an appraisal when the prices drastically rise or fall.

Each transaction has various confidential conditions. This makes it difficult to judge if the “abnormal” actual prices are results of a particular condition of the deal or if they are signals of market change. Then not a few transactions are regarded as abnormal samples and ignored. In other words, there is a high possibility for appraisers to omit “abnormal prices” when they evaluate a “fair value.” Consequently the appraisers cannot sensitively respond to price change when the market moves faster than the appraisers can recognize. According to Gallimore and Wolverton (1997), appraisers tend not to pick up comparables which do not follow the past trend but to choose comparables with the smallest change.

#### **2.4.2 Valuation error 2: The highest price?**

The next issue occurs when they undertake valuation of a property in an area where few transactions have taken place for years. For example, the appraisal of a property demands good imagination when located in a premium area where head offices of major listed companies concentrate. The same is the case for the valuation of the best properties in the area since they are rarely traded. In these cases, the valuation largely relies on the valuer’s skill of analysis and imagination rather than using relevant evidence available. This may lead to a big difference when a transaction in the area actually occurs.

For example, the land price of a site in the Ginza area becomes a matter of discussion as the most expensive site location in Tokyo or Japan. It is imaginable that the valuation of the site would have a larger error than that of a site of average price.

#### **2.4.3 Valuation error 3: Valuation on a future date**

The effective date of the *Published Land Price* valuation is January 1st each year. Their estimates rely on the comparables which are derived from transactions that occurred several months prior to the date of valuation. The appraisers need to do a time-adjustment for

comparables to fill the gap between the transaction date of the comparables and the valuation date. The bigger the market change, the more likely it is for the appraisers to make an error in their judgment of the time-adjustment rate as well as the estimated price. For the valuation of the *Published Land Price* on January 1st each year, the appraisers should adjust a comparable for five months if the transaction happened in July of the previous year. Similarly, they have to adjust the comparable for another five months based on the *Land Price Survey* by each prefecture on July 1st each year should the transaction happen in February.

On some occasions, the error caused by the time-adjustment doubles in a year. The valuation for the *Published Land Price* may comprise errors. One type of error is to misread the market, which leads to the wrong selection of comparables. The other is caused by wrong time adjustment of the comparables. We have pointed out possible valuation errors derived from our appraisal system. Further to the above, it is possible that the appraisers are reluctant to lower the *Published Land Price* in financially vulnerable local governments since their income depends on property tax linked to the Published Land Price. The appraisal committee is under pressure when they lower the price. There is another possibility that the Published Land Price has been kept high so that public bodies can purchase land for public purposes easily without having any disputes from landowners. This is an issue on independency of appraisers from their instructors as Gallimore and Wolverton (1997), Kinnard, Lenk, and Worzala (1997) and Wolverton (2000) suggested.

We have given the Published Land Price as an example of this kind of error, but the same kind of problem is faced with the securitization real estate appraisal evaluations employed by IPD and ARES. This is because when it is not possible to know the transaction price at a specific point of time when evaluating that point, it is inferred from past transaction prices.

#### **2.4.4 Valuation error 4: Client influence problem**

There is also the possibility of price correction being performed due to pressure from clients. The issue of interference from clients in real estate appraisal value (the Client Influence Problem) has arisen within the securitization market in particular. This is because, at the time of sale/purchase, the buyer and seller's interests are in conflict. This problem occurs most notably in the following two cases. The first case is appraisal evaluations when a loan is issued from a financial institution. In this case, the person in charge at the financial institution that wishes to issue the loan and the applicant who wishes to receive the loan have a shared motivation to direct the market price upward. The second case is when ongoing appraisal is performed for an investment fund. In cases where the investment performance and the operating company's revenue are linked, there is an incentive to direct the price upward. This tendency has been especially pronounced during phases when prices are declining. Also, unlike selling/buying, when the market has entered a downward phase, fund managers have encouraged real estate appraisers to maintain prices at a high level,

since there are no parties with conflicting interests (Shimizu, 2010).<sup>13)</sup> What's more, this kind of problem has been reported not only in Japan but also in the UK (Crosby, Lizieri and McAllister, 2009).

### 3 Precision of appraisal-based property price indexes - Empirical analysis

Now, through empirical analysis, we will clarify the extent of the divergence that exists between transaction prices and appraisal value for the Tokyo commercial real estate market, including the bubble era.

In an accurate analysis of the land price trend, we need to observe a transaction-price based index which reflects differences in quality of different properties. In this section, firstly we constructed such time-series index. Secondly we established an index based on *Published Land Price* by the same methodology. Then we compared those indexes to clarify characteristics of the underlying land price information. Additional comparison with *Urban Land Price Index* was also carried out.

#### 3.1 Database construction

The number of vacant land transactions is not so large. The majority of real estate is traded in the form of land and building. MLIT had collected transaction price information including both land and building values in response. Then they remove the value of building from the total transaction price to reach the land price.<sup>14)</sup>

We have constructed our database to bear statistical analysis as described below.

The information on the Published Land Price has been more digitized and is easier to obtain in recent years. We can obtain a lot of information for each site: address, registered lot number and residential location; price in that year as well as in the previous year and inflation rate; site shape including area size and width to depth ratio; road conditions such as width of road, direction and pavement condition; utility facilities such as water supply, drainage and gas supply; traffic conditions such as the nearest station and the proximity to the station; planning specifications such as designated land use, floor to site ratio, building coverage ratio, height regulation and land use of the surrounding area. We added the accessibility to CBDs in order to cope with a wide range of investigated areas.

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<sup>13)</sup>In order to address this kind of problem, a securitization real estate appraisal evaluation monitoring system was set up within the Ministry of Land, Infrastructure, Transport and Tourism, and real estate appraisers are guided and supervised via on-the-spot inspections. One of the authors, Chihiro Shimizu, chaired a committee Working Group and dealt with this issue from 2008 to 2011. The cases indicated here are typical cases, but many different cases in which clients interfere have been observed. In addition, the aforementioned system drew upon discussions of the Carlsberg Committee in the UK. Professor Neil Crosby provided valuable advice concerning its administration.

<sup>14)</sup>Diewert, Haan and Hendriks (2010) Hedonic, The vacant land method, The construction cost method. Glaeser and Gyourko (2003), Gyourko and Saiz (2004) and Davis and Palumbo (2008) Davis and Heathcote (2007). The construction cost method.

Secondly, we collected actual sales transaction data. This data is, as we explained, open only to qualified appraisers. Most of this data has been recorded on paper and it is difficult for us to obtain long-term historical records. In this study we have collected 8,315 commercial land transaction records for Chiyoda Ward, Chuo Ward and Minato Ward.

In the process of dealing with paper-based records,<sup>15)</sup> we have ignored double-counted data and data with special contract conditions. Then the data was digitized. Many of them still lack important variable data such as site area, road width, the nearest station and proximity to the station and floor to site ratio.<sup>16)</sup> We have filled in the site area in samples after 1987 using the Land Registration Notice from Land Transaction Data.<sup>17)</sup>

Additionally, measurement errors can be seen for the width of road, the nearest station and proximity to the station as well as floor to site ratio. We have plotted the samples on a GIS map using Zenrin's Residential Map and Road database, then re-measured those figures. Thus, 1,738 samples of commercial land transactions and 2,897 samples of residential land transactions are excluded to make the totals 6,577 and 7,991 respectively.<sup>18)</sup> We disregarded sample selection bias due to lack of information on bias.

### 3.2 Construction of hedonic land price index – Basic Models

We constructed the hedonic land price index based on the database described above and analyzed its time trend. There is no central property market as such and every property is different from each other.

In the *Published Land Price survey*, they have appraised the same sites repeatedly with some exceptions, but most of all sites have not been transacted. In transaction data, the same sites have not been sold and purchased repeatedly. Each sample has different qualities in terms of size, width of road, floor to site ratio, nearest station and proximity to the station and CBD.

These differences cause problems when we established the index. Take for example the case where we try to compare price trends with an index made using average transaction prices each month. If transactions concentrate in city centers where sites are on main streets and close to the station or CBD area, the average price in that month can be higher even if the general property market shows a downward movement. Therefore we need to control quality differences of properties when we compare the property markets in a time-series.

To control the differences in qualities, there are two approaches. One is the Repeat Sales Approach and the other is the Hedonic Approach. In our study, we did not use the repeat sales approach because there was not a sufficient amount of samples. Additionally, the

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<sup>15)</sup>We found out that quite a few data has identical location and data of transactions with different transaction land prices. This is due to the difference in estimates of building value as explained later.

<sup>16)</sup>This fact is crucial for the creditability of the transaction data collected by the appraisers. It is urgently required that the authorities tackle this issue.

<sup>17)</sup>Land Registration Notice has been digitized in each prefecture since 1987. We used the data from the Tokyo Metropolitan Government office.

<sup>18)</sup>The reasons for this exclusion are first we could not plot its location on the map since the information was not accurate enough and secondly we could not identify the transactions from the Land Registry Notice records. Due to such, we could not measure the distance to the station and CBD.

repeated transactions were very likely to be short-term speculative. We therefore used the hedonic approach.

We have developed a multiple linear regression model to explain land price/LP by proximity to the nearest station and CBD, surrounding environment, site size, floor to site ratio and so on. Then we established a land price index based on the price model.

The model is described as follows.

$$\log LP_{it} = a_0 + \sum_i a_{1i} \log X_i + \sum_k a_{2k} D_k + \sum_{i,k} a_{3ik} (\log X_i) (RD_k) + \sum_t a_{4t} D_t + \varepsilon \quad (1)$$

Table 2 and Table 3 show the results of the Transaction Price Model and the Published Price Model respectively. Figure 1 indicates quarterly price change estimates with a time dummy factor.

In the Transaction Price Model, the adjusted  $R^2$  is 0.889. The adjusted  $R^2$  in the Published Price Model is 0.919. Both models fit substantially well, especially the Published Price Model.

The Published Price Model explains better than the Transaction Price Model. We suppose that one of the reasons is that transaction price data reflects actual conditions in the market and individual negotiations. This suggests that the Published Price data has been substantially adjusted in cross section thorough the appraisers' filter.

### 3.3 Comparisons: Transaction Price-based Index and other indexes

In this part, we compared the Transaction Price-based Index (TPI) with the Published Price-based Index (PPI). In order to view general trends, we assumed one function through the subject period and ignored the possible structural change of the function, which we will deal with in a later section. Then the TPI is compared with the *Urban Land Price Index*.

#### 3.3.1 TPI and PPI

First, for commercial land prices, Figure 1 shows that PPI followed TPI with a certain lag since 1983 when land prices increased. Second, PPI rose while TPI dropped in 1982. This leads to filling the lag between two indexes. The same is true to 1986. The jump of price this year is likely to reflect the fact that the published price did underestimate the price change in the previous year. This suggests that we must be very careful when estimating market trends using published price statistics.

Third, Figure 1 shows PPI rose steadily between 1987 and 1992 while TPI looks as though the price fell in 1988 and picked up in 1999. This explanation fits better for those who got involved in the market at that time. In fact it is possible to prove by TPI that the asset price bubble started from the Tokyo area followed by the Osaka area and the Chubu (Central) area to other local cities then flooded back to Tokyo again.

Table 2: Transaction price-based Index

Dependent Variable:Log of Transaction Land Price per square Meter .Method of Estimation:OLS  
Commercial Area(Chiyoda,Chuo,Minato Wards)

Variables(all in log except for dummies )	Coefficient	t-value
<b>Property Characteristics</b>		
Constant	9.734	43.965
LA:Lot Area(m <sup>2</sup> )	0.092	11.047
RW:Front Road Widths(10cm)	0.303	38.960
ST:Distance to nearest station(m)	-0.063	-5.958
AC:Accessibility to Central Business District*	-1.040	-20.627
YK:Floor Area Ratio/FAR	0.822	29.143
<b>Railway/Subway Line Dummy</b>		
Ginza Line	-0.642	-2.173
Marunouchi Line	-3.110	-1.312
Hibiya Line	0.722	3.226
Tozai Line	-1.496	-2.478
Yurakucho Line	-0.392	-1.508
Asakusa Line	0.124	1.305
Mita Line	-0.804	-3.064
Shinjuku Line	0.201	1.715
Chuo Line	-1.789	-1.795
Soubu Line	0.149	5.240
<b>Cross-term Effect by Railway Line Dummy</b>		
LA × Yamanote	-0.056	-4.281
LA × Ginza	-0.035	-2.480
LA × Hibiya	-0.027	-2.189
LA × Chiyoda	-0.138	-3.800
LA × Asakusa	-0.061	-2.926
LA × Mita	0.055	2.367
LA × Shinjuku	0.025	1.553
RW × Murunouchi	0.815	1.682
RW × Yurakucho	-0.072	-2.920
RW × Mita	0.096	2.663
RW × Shinjuku	-0.071	-2.963
ST × Yamanote	-0.222	-12.183
ST × Ginza	-0.035	-1.539
ST × Hibiya	-0.108	-6.350
ST × Tozai	-0.052	-1.630
ST × Yurakucho	-0.146	-6.673
ST × Mita	0.060	1.675
ST × Chuo	0.064	1.554
YK × Yamanote	0.092	2.345
YK × Ginza	0.208	5.427
YK × Hibiya	-0.054	-1.825
YK × Tozai	0.316	3.167
YK × Chiyoda	0.536	3.878
YK × Yurakucho	0.233	5.918
YK × Chuo	0.260	1.577
AC × Yamanote	0.367	3.930
AC × Hibiya	0.194	5.538
AC × Chiyoda	-0.839	-2.570
<b>Time Dummy</b>		Yes

Adjusted R square=0.889

Number of Observations=6,577

\*Distance measured by time(minutes) required from nearest railway/subway station to major terminals (Tokyo,Shibuya,Shinjuku,Ikebukuro,Ueno,Kasumigaseki,Ootemachi)

Base Line=Yamanote

Table 3: Published Price-based Index

Dependent Variable:Log of Published Land Price per square meter.Method of Estimation:OLS  
Commercial Area(Chiyoda,Chuo,Minato Wards)

Variables(all in log except for dummies )	Coefficient	t-value
<b>Property Characteristics</b>		
Constant	11.883	29.046
LA:Lot Area(m <sup>2</sup> )	0.175	14.894
RW:Front Road Widths(10cm)	0.312	18.719
ST:Distance to nearest station(m)	-0.255	-18.733
AC:Accessibility to Central Buisness District*	-0.244	-2.397
YK:Floor Area Ratio/FAR	0.330	7.795
<b>Cross-term Effect</b>		
LA × Ginza	-0.087	-3.774
LA × Hibiya	-0.098	-4.113
LA × Chiyoda	0.070	6.136
LA × Asakusa	-0.082	-8.215
LA × Mita	0.056	4.141
LA × Shinjuku	-0.522	-5.090
LA × Soubu	-0.124	-1.599
RW × Tozai	0.068	3.106
RW × Shinjuku	0.354	5.794
ST × Yamanote	0.055	8.338
ST × Ginza	-0.053	-6.218
ST × Hibiya	-0.032	-3.603
ST × Asakusa	0.055	5.246
ST × Mita	-0.036	-2.623
ST × Soubu	-0.047	-2.461
YK × Shinjuku	0.280	4.011
AC × Ginza	-1.041	-4.486
AC × Hibiya	-0.129	-2.189
<b>Time Dummy</b>		Yes

Adjusted R square=0.919

Number of Observations=1,712

\*Distance measured by time(minutes) required from nearest railway/subway station to major terminals (Tokyo,Shibuya,Shinjuku,Ikebukuro,Ueno,Kasumigaseki,Ootemachi)

Base Line=Yamanote

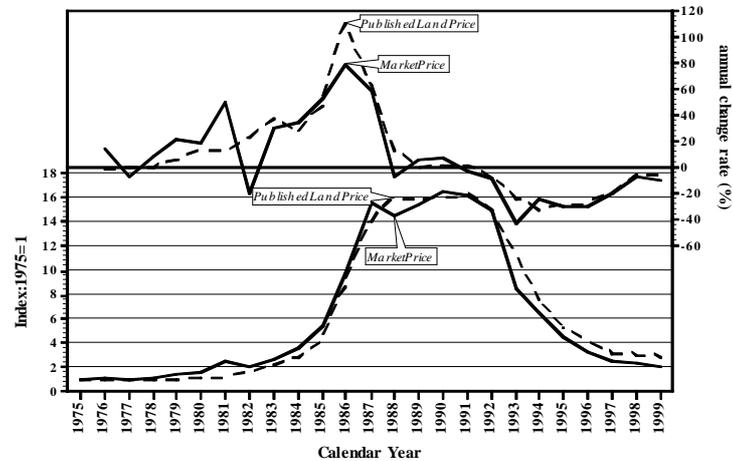


Figure 1: Transaction price-based index and Published Price-based Index

During the bubble burst economy, there was a big difference in the degree of price drop in 1993 between the commercial land price indexes. The PPI looks as if it tried to fill the gap since 1983. Currently, they argue that the level of the published price is beyond that of the market price. The indexes support this argument. The reason is that the published price did not reflect the fall of the market price fully in 1993 and still it has been behind.

The published price rose at a similar degree to the increase of the ratio of published price to transaction price. Consequently, PPI in this period shows that they made amends of their underestimation in the previous years and the inflation rate did not reflect the actual market movement. During the bubble economy, as was in the commercial land index, PPI chased TPI with some time lag.

### 3.3.2 TPI and Urban Land Price Index

We move to our analysis of the commercial land index in the biggest six cities with the *Urban Land Price Index* (indexes are adjusted as 1990=100).

First, Figure 2 describes two commercial land price indexes that illustrate totally different patterns. The samples of transaction price index come from the three core wards of Tokyo as opposed to the six biggest cities for ULPI. This clearly appears in the bubble years when the sharp price rise happened in the core wards of Tokyo followed by the surrounding wards, urban cities and further local areas.

ULPI has been heavily smoothed when the inflation rate is dispersed between surveyed areas since they have given no weighing for the samples. Consequently, care must be taken

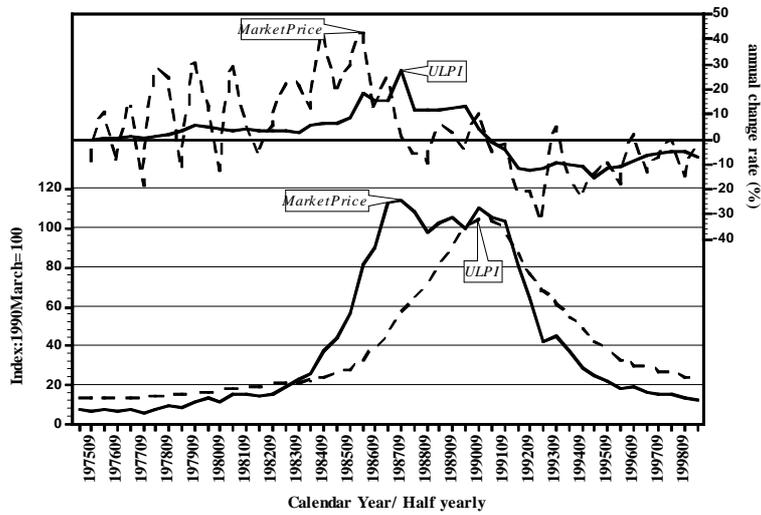


Figure 2: Transaction price based index and Urban Land Price Index

for this smoothing effect while UPLI has the advantage of being published every half a year. In addition, the degree of error for the four grading - the high, upper, middle, low - in each city has not been the same and the difference has changed from time to time.

We compare the average and standard deviation of TPI, PPI and ULPI (Table 4).

**TPI versus PPI (annual)** In the commercial land price index, the average and standard deviation of TPI is 7.77% and 30.19 respectively as opposed to 7.30% and 26.27 for PPI. The coefficient of variance (SD/AV) of TPI (3.89) is slightly larger than that of TPI (3.60).

**TPI versus UPLI (every half a year)** In the commercial land price index, the average and standard deviation of TPI is 3.15% and 13.32 respectively as opposed to 2.22% and 6.50 for UPI. The coefficient of variance (SD/AV) of TPI (4.23) is slightly larger than that of TPI (2.93).

In conclusion, if we consider the growing variance of market growth in each region, it is fair to say that the Published Price-based Index is more suitable when analyzing local markets although it is available only once a year.

Table 4: Statistical Comparisons of TPI, PPI and ULPI

		Transaction price-based Index	Published Land Price-based Index	Transaction price-based Index	ULPI
Term		1976-1999(annually)		9/1975 - 9/1999(bi-annually)	
N=		24		48	
Commercial Land	(Average)	7.77	7.30	3.15	2.22
	(Standard Deviation)	30.19	26.27	13.32	6.50

## 4 Establishing the hedonic index under structural changes

### 4.1 Detection of bubble era through structural change test

We then improved the model to observe the temporal change of valuation error in the Published Land Price. In the last analysis, the estimated scale dummy  $TD_M$  was the most important factor in order to make a comparison between indexes in different periods. However, we seek to improve the accuracy of the model when detecting the valuation error.

In the last section, we assumed that there is a stable relation between price and variables for the long term in the Basic Models. But this assumption is problematic when we pursue the improvement of accuracy of the models. The subject period of this study is the twenty-years from 1975, which is a long time. In addition, this term includes the bust and burst of the Bubble economy and hence it is unlikely that the relation had been stable.

In dealing with the structural change of a hedonic function, Smith and Tesarek (1991) pointed out the difficulty of establishing a price index using a single model and that we should separate data. Shimizu, et al. (2010) used transaction data as in our study and divided the observations into monthly and estimated hedonic models for each subset of data. Then we put data on a selected location into the model to produce an index. But this separation of data makes it difficult to compare different times since the coefficient of determination and distribution of disturbance change in accordance with the periods. In this study, therefore, we identified points of structural change for each coefficient by structural change test. Then we put a cross factor into each term to estimate a single hedonic function model for producing an index.

In general, a structural change test is an equality test of partial regression coefficient  $\beta_1, \beta_2$  where a point of structural change is known and where the data is split into two parts accordingly. The methodology of testing is different from assumptions on the variance of error, namely either in the case of  $\sigma_1^2 = \sigma_2^2$  or  $\sigma_1^2 \neq \sigma_2^2$ . We tested linear model hypothesis where the variance of error is equal ( $\sigma_1^2 = \sigma_2^2$ ). When it is different ( $\sigma_1^2 \neq \sigma_2^2$ ), an asymptotic likelihood ratio test is carried out and unknown parameters are sought by convergent calculation through the fact that  $-2\log(\text{likelihood})$  chi-square dispersion. (Amemiya

Table 5: Transaction Price Function under Structural Changes

	Pre-Bubble vs. Bubble	Bubble vs. Post-Bubble	Pre-Bubble vs. Post-Bubble
Lot size	0.0232	0.0001	0.0001
Road Width	0.0057	0.0001	0.0001
Distance to the Nearest Station	0.0090	0.0023	0.2324
Proximity to CBD	0.2072	0.0458	0.3282
Floor to Lot Ratio	0.0914	0.0320	0.0099
ALL*	0.0001	0.0001	0.0001

\*Bulk testing on five variables above was carried out.

(1985), Shimizu, Karato and Nishimura,(2007)).

However, it is reasonable to assume that the subject period of this study should be divided into three era, namely, pre-bubble, bubble and post-bubble era since the subject period includes the time of the bubble economy. On this assumption, we know there are two structural changes but do not know about changing points. Therefore we estimated changing points,  $ta$  and  $tb$ , on the basis of AIC (Akaike's Information Criterion) and pre-bubble period dummy variable ( $BB_{ta,tb}D$ ) post-bubble dummy period dummy variable ( $PB_{tb}D$ ), then we examined the results by  $F$  test.<sup>19)</sup>

Equation 1 is modified as below.

$$\log LP_{it} = a_0 + \sum_i a_{1i} \log X_i + \sum_k a_{2k} D_k + \sum_{i,k} a_{3ik} (\log X_i) (RD_k) + \sum_t a_{4t} D_t + \sum_i a_{6i} (\log X_i) (BB_{ta,tb}D) + \sum_i a_{7i} (\log X_i) (PB_{tb}D) + \varepsilon \quad (2)$$

$BB_{ta,tb}D$  : bubble -dummy

$PB_{tb}D$  : post -bubble - dummy

Assuming that the beginning of the bubble period was between 1980 and 1990 while the period ended after 1990 ( $1980ta < 1990, 1990tb$ ), we calculated 5,550 equations each for commercial land. In comparison with those models by AIC, we choose the following points as most appropriate points to estimate our functions.

We should note that these points are based on AIC and need another test. The data is separated into three groups according to the break points in 1983 1st quarter and 1995 4th quarter. Table 5 is a result of the F test to examine structural change.

The probability of structural change varies from each variable. However, five variables (All five variables) for commercial land and four variables (All four variables) for residential land prove that structural change happened in the pre-bubble period, bubble period and post bubble period.

<sup>19)</sup> Garcia and Perron (1996) showed how to identify the changing points for two structural changes. Jushan and Perron (1998) discussed the way of structural change test for unknown changing points of unknown frequencies. In our study, we used a simplified way in terms of tractability.

The commercial land price model shows that the bubble period was 12 years, which lasted from the first quarter of 1983 until the last quarter of 1995. This time it includes the time when the price rose and fell sharply and slowed down as Figure 1 suggested. Thus the period extracts the bubble period as a violent movement of the market. In this sense, it would be accurate to define it as a bubble and burst period rather than simply a bubble period. Furthermore, the structure of the pre-bubble period differs from that of the post-bubble period. This indicates that it would be wrong to think that the market returned to the previous situation after the burst of the bubble as it is often described just by impression.

## 4.2 Estimate of hedonic function model under structural changes

We estimated the price models under structural changes. Based on Equation 2, for commercial land model, we put the bubble period dummy variable between the first quarter of 1983 and the fourth quarter of 1995, and the post-bubble (and burst) dummy variable after this period, with other variables such as plot size, road width, the proximity to the nearest station and city center and floor to site ratio.

The estimated models of land prices under structural changes are shown in Table 6.

The commercial land price model suggests that the coefficient adjusted by the degree of freedom is 0.895. In comparison with the model without cross factor such as the bubble dummy variable, it has improved not only AIC but coefficient of correlation,<sup>20)</sup> which has more explanatory power. The factors of plot size, road width and floor to site ratio is positive while the proximity to the station and city center is negative. This matches our instinctive idea.

We investigated cross factors of the bubble-dummy and post-bubble dummy, estimated as coefficients to analyze temporal change. In terms of plot size, the cross factor with the bubble dummy is 0.083 while that of the post-bubble dummy is 0.060. This means that plot size affected the land price more in the bubble period than in the pre-bubble period but its effect weakened after the bubble period. The effect of width of the front road became strong after the bubble period as the cross factor with the bubble dummy and the post-bubble dummy is 0.111 and 0.158 respectively. Therefore, in the commercial market in the core three wards of Tokyo, the preference to the site of potentially higher use becomes a strong possibility. The degree of scale premium in site slightly decreases since more large size plots have been on the market after the bubble period.

With regard to the impact of the proximity to the station, the cross factor with the bubble dummy is 0.060, which means that the proximity had less affect than in the pre-bubble period. The cross factor with the post-bubble dummy is 0.031. Demand for sites located far from stations were strong during the bubble period and became weak after the bubble. Regarding the proximity to CBD, the cross factor with the bubble dummy is - 0.318 and - 0.139 with the post-bubble dummy. The proximity to CBD is substitute for quality of

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<sup>20)</sup>It is pointed out, generally, that too many variables are used when the variables are selected by the coefficient adjusted for the degrees of freedom. In this study, the selection of the variables is made by AIC criteria first and then by Mallow's CP to ensure improvement of the model.

networking. The preference for CBD became stronger in the bubble period than before and weaker in the post-bubble period than in the bubble period. This result can be understood as they did speculative investment by purchasing inconvenient sites for capital gain rather than convenient sites. The land price therefore was not decided by other factors than its land use, which shall be investigated in the future.

### 4.3 Published Land Price versus Sales Transactions - A statistical test-

#### 4.3.1 Valuation to Price ratio – Accuracy of Published Land Price

We examined the accuracy of the *Published Land Price* by comparison with the transaction price-based land price model responding to structural changes. In the tree core wards of Tokyo, the number of points for the *Published Land Price Survey* on commercial land is 1,722 in total between 1974 and 1999 ( $i = 1-1772$ ). Having applied our transaction price model to each point for the *Published Land Price Survey*, we have calculated the ratio of the Published Land Price to the price induced by the model as follows.

At point  $i$  = Published price at  $i$  / Hedonic price using transaction prices at  $i$

The ratio of published price to transaction prices is, on average, 86.96% for commercial land.

We then examined the ratio on a time-series basis (Figure 3). In commercial land, the ratio had been approximately 80% (80.84%) in 1975 and dropped down to 46.40% in 1981. In 1981 and 1982, the ratio shuttled to 69.55% and remained about 70% to 80% between 1987 and 1992 in the bubble period. However, in 1993, the ratio went up to 104.24%, which means that the published price did not reflect the burst of the property price. The ratio has been over 100% since 1993 and it was more than 120% in 1999.

#### 4.3.2 The transition of the ratios on certain points

We undertook more micro observation on the Value to Price relationship. It is impossible to observe the same point for published price since no single points are available for continuous observation through the past years. In this study, we choose two commercial prices from the 1975 *Published Price Survey* and calculated V/P ratios. Then we established the function of the *Published Land Price* under structural changes (Table 7) by which we can obtain an estimation of the *Published Land Price* after 1975. We can now compare the estimated *Published Land Price* with the transaction price on the same points.

The published price models fit very well. The efficiency of the coefficient of commercial land price model is 0.951. The differences of the actual published price to estimated price are very small in 1975. The largest difference occurs at point 2 of commercial land where

Table 6: Transaction Price Function under Structural Changes

Dependent Variable:Log of Transaction Land Price per square Meter .Method of Estimation:OLS  
Commercial Area(Chiyoda,Chuo,Minato Wards)

Variables(all in log except for dummies )	Coefficient	t-value
<b>Property Characteristics</b>		
Constant	8.613	18.631
LA:Land Area(m <sup>2</sup> )	0.017	1.600
RW:Road Width(10cm)	0.208	12.611
ST:Distance to the Nearest Station(m)	-0.081	-4.379
AC:Accessibility to City Core*	-0.983	-17.597
YK:Floor Area Ratio/FAR	1.047	17.643
<b>Railway/Subway Line Dummy</b>		
Ginza Line	-0.515	-1.841
Hibiya Line	0.635	3.000
Tozai Line	-1.033	-1.742
Asakusa Line	0.927	2.617
<b>Cross-term Effect by Railway Line Dummy</b>		
LA × Yamanote Line	-0.028	-2.483
LA × Marunouchi Line	0.170	4.178
LA × Chiyoda Line	-0.152	-4.405
LA × Asakusa Line	-0.062	-3.084
LA × Mita Line	0.067	2.943
LA × Shinjuku Line	0.051	3.746
RW × Tozai Line	-0.060	-2.021
RW × Chiyoda Line	0.146	2.366
RW × Yurakucho Line	-0.066	-2.741
RW × Mita Line	0.074	2.091
RW × Shinjuku Line	-0.051	-3.711
RW × Sobu Line	0.031	4.715
ST × Yamanote Line	-0.245	-13.607
ST × Ginza Line	-0.080	-3.533
ST × Hibiya Line	-0.128	-7.696
ST × Tozai Line	-0.078	-2.529
ST × Yurakucho Line	-0.159	-8.852
ST × Asakusa Line	-0.069	-2.466
ST × Chuo Line	0.014	2.404
YK × Yamanote Line	0.064	1.673
YK × Ginza Line	0.197	5.220
YK × Hibiya Line	-0.045	-1.531
YK × Tozai Line	0.301	3.065
YK × Chiyo Line	0.075	1.459
YK × Yurakucho Line	0.171	7.881
YK × Asakusa Line	-0.080	-1.711
AC × Yamanote Line	0.426	4.708
AC × Hibiya Line	0.200	5.846
AC × Mita Line	-0.221	-2.901
<b>Cross-term Effect by Bubble Dummy**</b>		
LA × BubbleDummy	0.083	6.884
RW × BubbleDummy	0.111	6.016
ST × BubbleDummy	0.060	3.123
AC × BubbleDummy	-0.318	-4.174
YK × BubbleDummy	-0.072	-1.174
<b>Cross-term Effect by Post-Bubble Dummy***</b>		
LA × Post-BubbleDummy	0.060	4.434
RW × Post-BubbleDummy	0.158	7.009
ST × Post-BubbleDummy	0.031	1.391
AC × Post-BubbleDummy	-0.139	-1.552
YK × Post-BubbleDummy	-0.487	-7.429
<b>Time Dummy</b>		Yes

Adjusted R square=0.895

Number of Observations=6,577

Table 7: Published Land Price Function under Structural Changes

Dependent Variable:Log of Published Land Price per square meter.Method of Estimation:OLS  
Commercial Area(Chiyoda,Chuo,Minato Wards)

Variables(all in log except for dummies )	Coefficient	t-value
<b>Property Characteristics</b>		
Constant	4.370	6.693
LA:Land Area(m <sup>2</sup> )	0.060	3.335
RW:Road Width(10cm)	0.083	2.901
ST:Distance to the Nearest Station(m)	-0.063	-10.752
AC:Accessibility to City Core*	-0.257	-2.390
YK:Floor Area Ratio/FAR	1.471	15.344
<b>Railway/Subway Line Dummy</b>		
Yamanote Line	-7.442	-8.798
Ginza Line	-1.565	-1.985
Shinjuku Line	32.209	9.358
<b>Cross-term Effect by Railway Line Dummy</b>		
LA × Yamanote Line	-0.078	-3.720
LA × Ginza Line	-0.079	-3.794
LA × Marunouchi Line	-0.033	-5.053
LA × Chiyoda Line	0.035	3.994
LA × Asakusa Line	-0.067	-10.102
RW × Yamanote Line	0.112	3.204
ST × Marunouchi Line	0.030	3.628
ST × Chiyoda Line	0.027	2.364
ST × Asakusa Line	0.045	6.174
ST × Mita Line	0.010	2.170
ST × Sobu Line	0.025	2.503
YK × Yamanote Line	0.673	6.002
YK × Ginza Line	0.829	7.635
YK × Shinjuku Line	-1.918	-6.576
AC × Yamanote Line	0.047	1.599
AC × Ginza Line	0.388	5.559
AC × Shinjuku Line	-1.099	-5.875
<b>Cross-term Effect by Bubble Dummy**</b>		
LA × BubbleDummy	0.043	2.247
RW × BubbleDummy	0.017	0.532
ST × BubbleDummy	0.024	3.753
AC × BubbleDummy	-0.280	-2.578
YK × BubbleDummy	-0.152	-1.413
<b>Cross-term Effect by Post-Bubble Dummy***</b>		
LA × Post-BubbleDummy	0.134	5.762
RW × Post-BubbleDummy	0.106	2.790
ST × Post-BubbleDummy	0.026	3.531
AC × Post-BubbleDummy	-0.266	-2.101
YK × Post-BubbleDummy	0.025	0.206
<b>Time Dummy</b>		Yes

Adjusted R square=0.951

Number of Observations=1,772

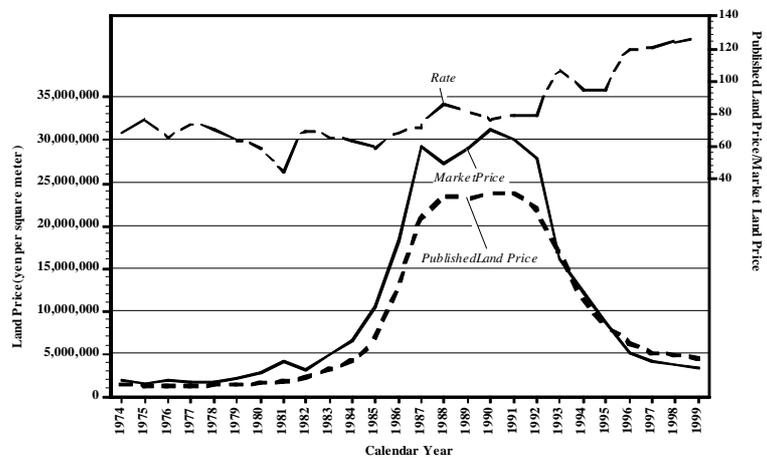
\*Average travel time during daytime including transfer between the nearest station to main terminal station

Main stations(Tokyo・Shinjuku・Shibuya・Ikebukuro・Ueno・Kasumigaseki・Otemachi)

\*\*BubbleDummy:1983~1995

\*\*\*Post-BubbleDummy:1996~

Base Line=Marunouchi, Tozai, Chiyoda, Yurakucho, Asakusa, Mita, Chuo, Sobu



ID	Neighbourhood	Area	Land Value(Yen/m <sup>2</sup> ) at 1975	Lot size	Road Width	Nearest Station	Distance to NS	FLR	Value/Estimate Ratio at 1975	Value/Estimate Ratio at 1987	Value/Estimate Ratio at 1999
Point 1	Small-sized retails and financial offices mixup	Chiyoda Ward	1,250,000	163m <sup>2</sup>	27m	Kanda	150m	800%	75.98%	58.63%	126.01%
Point 2	Retails and offices mixup	Minato Ward	1,270,000	133m <sup>2</sup>	10m	Omotesando	60m	700%	71.02%	63.14%	115.56%

Figure 3: Value to Price ratio on particular points: Commercial sites

the model is underestimated by 3.85%. Thus the estimated published price is very close to the actual published price.

Finally, we take 1975 as a base year and our estimated published price index shifted by the difference of actual published price and estimated published price in 1975 to establish an index. The index is based on actual published prices in 1975 and on estimated published prices in other years.

In commercial land, we choose one point in a small retail shops area of Chiyoda Ward and the other from a mixed area of retail and office from Minato Ward.

We choose three periods, which are 1975, 1985 and 1999. The year 1985 is two years after 1983 when the bubble (-and burst) period was believed to begin.<sup>21)</sup> And the year 1999 is the latest sample year observable. The ratio of the published price to 1975 at point ONE and point TWO is about 75% and 71% respectively. The ratio reversed in 1985 where it is 58% at point ONE and 63.14% at point TWO. In 1999, it reverses again and the ratio at point ONE is 126% and 115% at point TWO. This reflects the fact that land price fall in Omotesando area in Minato Ward (for point ONE) slows down since IT business companies concentrate in the area while they have more price drops in Kanda area of Chiyoda Ward (for point TWO) due to weakness in the financial sector that are the main occupiers of the Kanda area.

The ratios of the published price to 1975 at point ONE and point TWO is about 92% and 101% respectively, which tells that the published price is almost the same as the transaction price. In 1985, the ratio at point ONE is 73% and 71% at point TWO. Then, in 1999, the ratio at point ONE is 115% and 119% at point TWO. As in the commercial land market, the published price is beyond the transaction price. This reflects the fact that the land price fall in Omotesando area of Minato Ward (for point ONE) slows down since IT business companies concentrate in the area while they have more price drops in Kanda area of Chiyoda Ward (for point TWO) due to weakness in the financial sector that are the main occupiers of the Kanda area.

## **5 Conclusion - Requirement of commercial property price indexes based on Japanese experience -**

In this study, we have summarized the information on property prices in Japan and constructed our database on transaction comparables. Then having compared them with published price statistics and the Urban Land Price Index with our hedonic price model based on transaction price or published land price, we revealed their characteristics as shown below.

We have seen a number of land price information provided, especially from private institutions. However, most of the information is based on appraisal value and appraisal value has some problems. First, appraisal-based information has systematic problem. The accuracy

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<sup>21)</sup> We used the year 1985 since the estimate was not stable. This happens because there are big gaps between two cross factors, which are presumably the period dummy factors.

of appraisals largely relies on the number of transactions and its accuracy and precision, especially when the comparison approach is heavily weighted. When the market changes structurally, the error caused by the lack of transactions can be significant. Second, they can have an error on time adjustment where they have a lag between the valuation date and survey period. Third, as for the Published Land Price Survey, the appraisers can face a situation where they may lose their independency under political pressures. The published price-based index has followed our transaction price-based index with a time lag during the bubble economy.

Further analysis has been undertaken on the Published Land Price Index. We investigated the ratio of published land index to transaction price index to testify the magnitude of the “valuation error.” The ratio for commercial land in the three core wards of Tokyo was 80.84% in 1975 and dropped to 46.40% by 1981. Then the ratio rose in 1982 and 1983 to reach the level of 69.55%. However, it increased again after the burst of the bubble and came to 104.24% in 1993. In 1999, the published price was greater than the transaction price index by approximately 20%.

This kind of problem was a major factor in the delay in disposing of bad loans at financial institutions following the bubble’s collapse and one of the factors leading to the subsequent stagnation of the Japanese economy. We believe it is extremely significant to absorb what Japan has learned and move forward with preparing a commercial real estate price index that corresponds to the market conditions. The above line of analysis has raised some important issues with regard to preparing such a commercial real estate price index.

First, there is the problem of data selection. When it comes to calculating commercial real estate price indexes, there are two types: transaction-based indexes and appraisal-based indexes. As the empirical analysis in this study has made clear, systematic biases exist for both types. These biases are especially significant during periods of rising and falling prices, when it is most necessary to monitor price fluctuations. Whether this is due to distortion being caused in transaction prices or a problem that accompanies errors in real estate appraisal value must be determined with care.

Second, there are problems related to the heterogeneity of commercial real estate. Compared to housing and other assets, the price-determining structure for commercial real estate is complicated. As a result of this, many real estate-related characteristics must be taken into account when attempting quality adjustment. As well, when attempting to employ real estate price data based on the real estate registries provided by the public sector in many countries in Europe, the U.S. and Japan, etc., collecting data on characteristics may incur substantial costs. As this study has shown, data related to real estate characteristics is not recorded in registry data, and in order to collect data on characteristics, techniques such as geographical data systems are often required.

Third, when employing real estate appraisal value, changes in the definition of these prices should be kept in mind. In Japan, during the bubble era and the collapse period, the reason why market prices and appraisal value diverged significantly was not only a structural problem produced by appraisal errors. The fact that the definition of real estate

appraisal value changed frequently was also a major factor. This was because agreement could not be reached regarding whether to reflect the “price transacted on the market” or to determine the “ideal price” in the fundamental sense. This kind of problem becomes even more complicated when more than one country is involved, since the definition of the price determined based on real estate appraisal varies depending on the country. In order to move forward with calculating an internationally comparable appraisal-based index, this problem will surely have to be resolved. Besides these, problems surrounding the method also arise. In this study, we calculated a quality-adjusted price index using the hedonic approach. Compared to the relatively homogeneous housing market, commercial real estate is strongly heterogeneous. In such a case, since it is necessary to perform quality adjustment based on many characteristics, there is a strong possibility that data-collection costs will be high.

Fourth, it is necessary to clarify what kind of market is represented by the index to be created. Currently, indexes supplied by the private sector are aimed at measuring real estate investment market performance. As a result, the focus is solely on the investment property market. However, there is an occupiers property market that is far larger. Generally, this kind of market is not often the target of transactions, or, if it is the target of transactions, these transactions occur extremely rarely. When attempting to measure trends in the commercial real estate market, including the occupiers property market, investment property market data is insufficient, and transaction price data is also limited. In this case, it may be better to measure the current value using earnings data, instead of a real estate price index creation method using transaction prices, appraisal value, etc.

Finally, based on the Japanese experience in the 2000s, issues relating to who is the primary index supplier have also been pointed out. Reporting of multiple real estate investment indexes supplied by the private sector ceased during the 2000s, due to companies going under, finding it difficult to collect data, or abandoning the index business, which caused confusion in the market. The following problem has also been pointed out: since the various indexes were created with different methods and different sources, it was difficult to compare the various trends that they showed. We believe that in conjunction with technical problems, this problem is an extremely important point.

The question of how to address these problems should be carefully considered with respect to the preparation of future commercial real estate price indexes.

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