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Land Prices in the Tokyo Metropolitan Area: A Hedonic Analysis of Judicial Auction Prices*

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** Research and Statistics Department

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Abstract

In this paper, hedonic price indices for land in Tokyo sold by auction are estimated for the period 1992-2002, relying upon a newly constructed auction property database. The estimation results show that since the bursting of the bubble, auction prices of land in the Tokyo metropolitan area have continued to decline, although, with the exception of 1997, the pace of their decline has been slowing. It is also found that compared to the Officially Published Land Price index and the Urban Land Price index, which are based on appraisal prices, the estimated hedonic price index has the following characteristics. (i) It has fallen more sharply, (ii) it has been more volatile, and (iii) its turning points have preceded those of the other indices.

1 Introduction

This paper investigates developments in the price of land once used as collateral and sold through judicial auction. For this purpose, we gather information on individual auctioned properties in the Tokyo metropolitan area from January 1992 through June 2002 and compile them in the form of a large database. Based on this database, price indices for land sold by auction are calculated by estimating hedonic functions.

There are two merits of focusing on judicial auction prices. First, land auction prices provide valuable information to creditors writing off non-performing loans. As will be seen in Section 2, the judicial auction market has been functioning as a place where creditors, such as financial institutions, may recover part of their loans by selling off borrowers'

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collateral. A better understanding of movements in land auction prices would help the process of evaluating loan recoverability.

Second, judicial auction prices are the only market prices disclosed in Japan for real estate. Two major land price indices frequently referred to as "land prices" in Japan, the Officially Published Land Price index (hereafter the OPLP index) and the Urban Land Price index (hereafter the ULP index) are based on appraisal prices, and it is often pointed out that these diverge from actual transaction prices.

Although the real estate auction market provides information that is highly useful in following the development of land prices especially in the post-bubble period, empirical analysis of this market has been very limited.[1] Thus, this paper is the first study focusing on the auction market in the Tokyo metropolitan area.

The rest of the paper is organized as follows. Section 2 briefly explains the judicial auction of real estate in Japan, while Section 3 introduces the database construction process and explains its coverage. In Section 4, hedonic indices for auction prices are estimated, and Section 5 summarizes the results and discusses possible extensions of the research.

2 What Is A Judicial Auction?

A judicial auction is a legal process in which property is auctioned under the jurisdiction of a district court. While real estate is normally transacted through agencies or directly between sellers and buyers, property whose owner has gone into bankruptcy is subject to foreclosure and auctioning by the creditors. In fact, many of the properties entered in an auction market are said to be either those foreclosed by national or local government because the owner is behind in tax payment, or collateral held by financial institutions against non-performing loans.

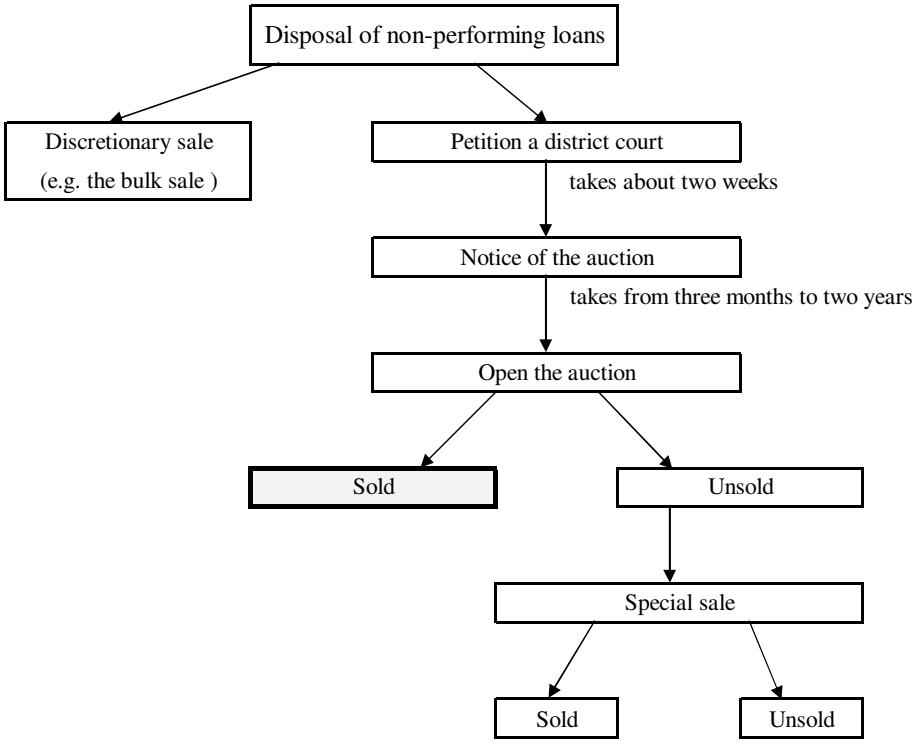
The auction market has been characterized as a wholesale market for the real estate agencies. Nowadays, more consumers participate in the auction market since they can buy properties at lower prices by circumventing the agency commission. Nevertheless, the auction market is better suited to professional realtors who deal with non-performing loans because it involves the assumption of certain risks, such as the possible existence of illegal occupants.[2] The principles governing the auction do not hold sellers responsible for defects in properties nor are prospective buyers allowed to enter and look at properties prior to bidding. The result is that there are often illegal occupants, some of whom may claim compensation for being removed by force.[3] The fact that auction properties are

[1] The exception is analysis of the Osaka auction market (Idee [2000, 2001], Taguchi and Idee [2002], Toda and Idee [2000]).

[2] The auction market has been described as "a limited market where most of the buyers, so-called "Jiken-ya (fraudsters)," are aiming for resale profit" (Miyagahara [1994]). Although there has been some market entry by the general public and real estate investment funds, participation is still limited.

[3] A prize winning novel written by Miyabe [2002] features a debt-laden family after the collapse of

Figure 1: Judicial Auction Procedure



cheaper than those in general market may be attributed to not only to the absence of intermediaries but also to the existence of such peculiar risks.[4]

From the creditors' point of view, the judicial auction is a way of disposing of non-performing loans that offers an alternative to a discretionary sale, such as a bulk sale (Figure 1). Discretionary sales involve owners selling off their properties at their own discretion in a general market, without being subject to any specific legal due process.

Both auctions and discretionary sales have their advantages and disadvantages. In an auction, a creditor needs neither to acquire debtors' approval nor to coordinate with other creditors since district courts carry out all the procedures. It takes long time, however, to conduct sales by auction, and prices are often lower than market prices in a discretionary sale because the auction involves risks such as those discussed above. On the other hand,

the bubble, and provides a detailed description of the protected law enforcement process that attends contingencies such as illegal occupancy.

[4]In addition, consumers have hesitated to participate in the auction market for institutional reasons. For instance, a bidder needs to prepare a bid deposit prior to an auction and is obligated to pay in full as soon as a bid is successful. Consumers, however, have had difficulties in securing bank loans for making payments because banks were not allowed to establish mortgages at the same time as the ownership of the property was transferred. In December 1998, the second paragraph of Article 82 of the Law of Civil Execution was amended in order to facilitate auction proceedings, and buyers became able to make loans, that is, ownership transfer and mortgaging were permitted to be executed simultaneously.

while a discretionary sale is likely to expedite credit collection, it has the disadvantages that it involves (i) the acquirement of debtors' approval, (ii) the search for buyers, and (iii) coordination with other creditors.

The procedure for disposing of collateralized property in an auction market is as follows. First, a creditor takes a property to a court in order to foreclose on the mortgage.[5] The court examines the property, sets and announces a minimum sales value, and then puts it out to tender. Once received by the court, it may take anywhere from three months to two years to open an auction, depending on the degree of court congestion and the difficulty of examining a given property. If bidding is unsuccessful, the property will be entered into a "Special Sale," in which the buyer is not decided via bidding but on a first-come-first-served basis.

A close relationship between the development of the auction market and non-performing loan (NPL) write-offs can be seen in Figure 2. It shows that the number of properties sold at auction (the bottom panel) has moved together with the amount of NPL disposals (the upper panel). For instance, the increase in direct write-offs in 1995, which reflected the disposal of loans to housing loan companies (jusen), resulted in an increase in the number of properties sold at auction in 1996. Subsequently, through 1998, in line with more rigorous bank self-assessments and the implementation of the Financial Inspection Manual by the Financial Service Agency, disposals of NPLs increased further, leading to an upward trend in the number of properties sold at auction.

The successful sale rate (= number of properties sold / number of properties put up for auction) rose in 1996 and has maintained an upward trend except for the decline during the 1998 financial crisis. This rise in the successful sale rate may correspond to an improved supply-demand balance owing to an increase in demand for auction properties. In addition, legislative facilitation of the auction procedure is also thought to have contributed to the rise in the successful sale rate.[6]

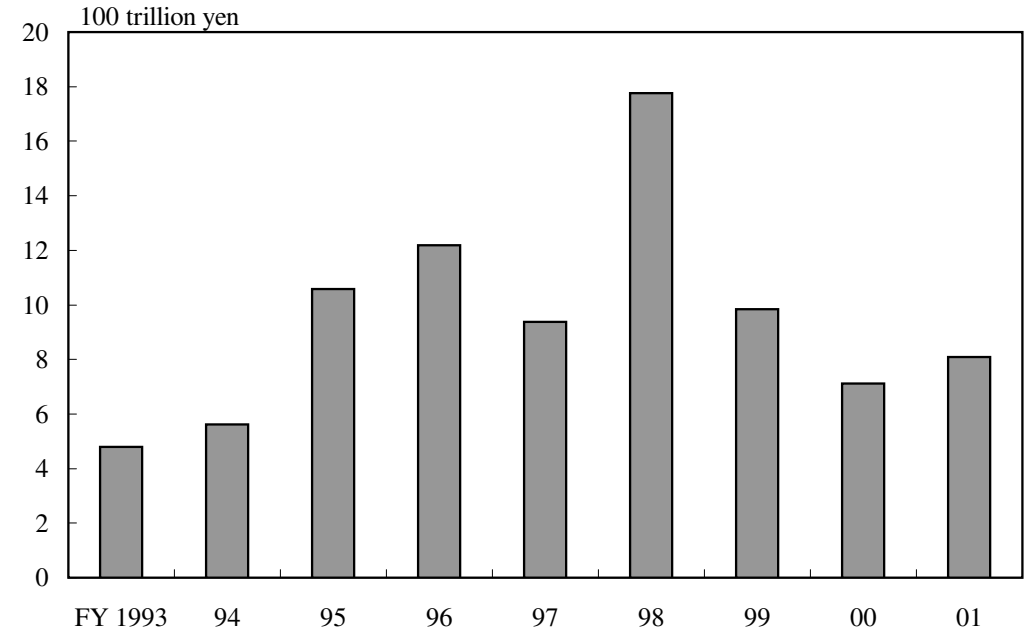
[5]This procedure is called a "collateral auction" and is distinct from a "compulsory auction," in which any foreclosed property (not restricted to collateral) may be auctioned in the absence of mortgage arrangements.

[6]In July 1998, at the Extraordinary Diet Session, the Financial Reconstruction Law was deliberated with a view to addressing the crisis in the financial system. In December, as part of this bill, the following laws were enacted: "Law on the development of relevant laws facilitating auction proceedings (*Keibai Tetsuzuki no Enkatsuka wo Hakaru Tame no Kanren Houritsu no Seibi ni Kansuru Houritsu*)" and "Temporal expedient law on survey of existing circumstance and evaluations for special cases of certain auction proceedings (*Tokutei Keibai Tetsuzuki ni okeru Genkyou Chousa oyobi Hyouka-tou no Tokurei ni Kansuru Rinji Sochi-hou*)".

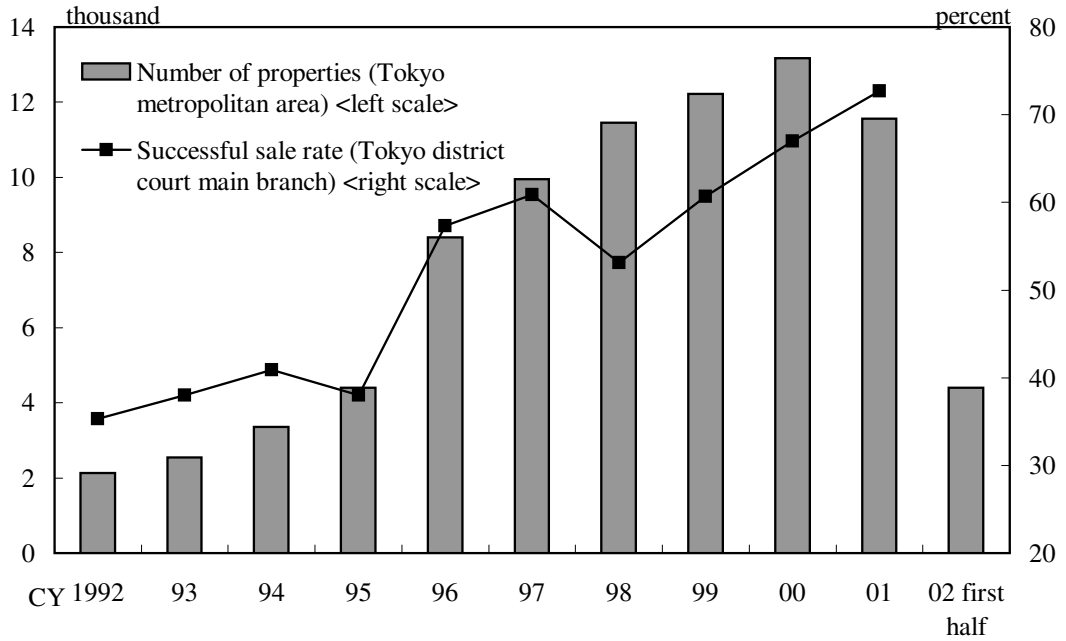
Auction properties often carry the risk that professional (or agent) occupants abuse procedures for appealing to the high court with the intention of achieving delay. They hinder the public purchase procedure by hiding information on building structures that is not on the register; when land is subject to a sale by itself, an ill-willed occupant builds a structure with the purpose of hindering the sale. The new act made it possible to dismiss an unlawful execution appeal without sending the case to the high court for review. Each district court was given a broader authority to access property information held by local authorities and utility service providers who collect fixed property taxes. For more detail about this law, see Kohori [1999].

Figure 2: Judicial Auction Market in the Tokyo Metropolitan Area

1. NPL Disposals (based on original principal)



2. Number of Properties Sold by Judicial Auction



Note: Amount of NPL disposals = (Withdrawal from Loan-loss provisioning + NPLs removed from balance-sheets) × (ratio of purchasing values of NPLs by Cooperative Credit Purchasing Company (CCPC) to overall values of NPLs).

Sources: The Japanese Bankers Associations "Analysis of Financial Statemensts of All Banks," KINZAI Institute for Financial Affairs, Inc. "Kinyu Homu Jijo (Semi-monthly Banking Law Journal)" No.1616, 1634.

Table 1: Number of Properties Sold at Auction

	Number of properties	(%)
Land	7,260	8.68
Buildings with land	43,380	51.87
Buildings	62	0.07
Apartment houses	29,784	35.62
Buildings with leased land	2,741	3.28
Buildings with legal superficies	183	0.22
Buildings with user leased land	146	0.18
Legal superficies	3	0.004
Others	67	0.08
Total	83,626	100

Table 1 presents the number of properties sold by auction under the jurisdiction of the Tokyo, Kanagawa, Chiba and Saitama district courts from January 1992 to June 2002. It tells us that most properties in the auction market are accompanied by buildings. *Buildings with Land*, a combination of land and a building sold as a unit, make up about half of the market. The second largest share is taken by *Apartment houses*, which account for 35%, while *Land* by itself has only 8.68%.

Hereafter, the analysis will be based on two separate samples, a *Land* sample and a *Buildings with Land* sample, since this paper tries to shed light on land prices, for which actual market prices are difficult to observe. Since database construction is highly labor-intensive work, other types of property are not considered in this paper. The previous study dealing with the auction market in Osaka prefecture, is based only on a pure *Land* sample to eliminate the effect of building prices. This paper, however, analyses a *Buildings with Land* sample as well as a *Land* sample in order to check the robustness of the results gained from the estimation of the pure *Land* sample.

3 Data

3.1 Database Construction

Characteristic information on properties is indispensable for this research. Although such information is provided for auction properties by each district court, it has not been compiled in the form of an electronic database except for the Osaka district court.[7] Thus,

[7]Data on auction properties under the jurisdiction of Osaka district court has been stored as a database since 1997 by a private company. The Osaka and Tokyo district courts started to release (i) Property Statements, (ii) Reports of Current Conditions, and (iii) Evaluation Statements on the web

[Box] NPL Collection Rates

In the context of the relationship between the auction market and disposals of NPLs, a critical issue is to what extent creditors are able to collect debts via auction. By exploiting auction data from the Tokyo district court (main branch), collection rates are calculated from July 2001 to June 2002.

First, classified by mortgage priority, the average collection rate for Priority 1 mortgages is 55.6% while that of Priority 2 mortgages is 18.6%, resulting in a 34.2% average. For this calculation, it is assumed that mortgages of Priority 2 or lower prioritized mortgages are repaid only when the bid values are greater than the loan values of the Priority 1 mortgage. As a result of the decline in land prices, there have been significant numbers of mortgages of Priority 2 or lower that have not been repaid.

Second, collection rates are calculated by creditor (the table below). *Housing Loan Corporations*, which hold mainly personal loans largely classified as Priority 1 mortgages, achieved the highest collection rate. The second highest was *Other Government Financial Institutions (Other GFIs)*; the lowest was *Cooperative Credit Purchasing Companies (CCPC).*

	Priority 1 mortgage	Priority 2 mortgage	Priority 1 + 2		Collection rate
	Cases	Cases	Cases	(%)	(%)
Total	2,348	1,456	3,804	100.0	34.2
Public Servicer Companies	163	67	230	6.0	32.1
CCPC	70	36	106	2.8	18.8
Governmental Financial Institutions	282	150	432	11.4	61.9
Housing Loan Corporations	235	121	356	9.4	64.2
Other GFIs	47	29	76	2.0	51.2
Private Financial Institutions	872	558	1,430	37.6	42.2
City & Regional Banks	463	318	781	20.5	40.4
Cooperative Banks	342	204	546	14.4	43.4
Credit Associations	65	34	99	2.6	47.4
Others	961	645	1,606	42.2	38.1
Commerce and Industry Loans, etc.	128	54	182	4.8	29.6
Others	833	591	1,424	37.4	39.2

Notes: *Housing Loan Corporations* consist of the Housing Loan Corporation and the Housing Loan Guarantee Corporation. *Other GFIs* consist of the Japan Finance Corporation for Small Business, the People's Finance Corporation, and the Central Cooperative Bank for Commerce and Industry. *Public Servicer Companies* consist of Tokyo Kyodo Bank, the Resolution and Collection Bank, the Housing Loan Administration Corporation, and the Resolution and Collection Corporation (RCC). *Commerce and industry loans, etc.* consist of commerce and industry loans, consumer loans, and listed credit loan companies.

Collection rates may differ depending on mortgage priorities and the main borrowers' characteristics, whether corporate or personal (personal loans are more likely to be collected than corporate loans). In addition, the following factors are also considered to contribute to the collection rate.

-to be continued-

- *Public Servicer Companies* and *CCPC* show lower collection rates than private financial institutions because these servicer companies accepted delinquent loans that it is hard for private financial institutions[a] to collect.
- *Other GFIs* achieved a higher collection rate than private financial institutions. Given that both of them had roughly similar shares of loans backed by Priority 1 mortgages—62% for other GFIs and 61% for private financial institutions—, this result may reflect differences in their loan to value ratios and/or the timing of loan provision[b].
- Loan sharks such as *Commerce and industry loans, etc.* show low collection rates. This may reflect the business model of commerce and industry loan companies, in which loans are provided on the basis of the existence of a cosignatory than the value of the collateral.

[a]Even when the collection rate is low, servicer companies do not necessarily suffer a loss as long as they purchase the properties at prices well below the auction prices.

[b]Due to a decline in land prices, properties collateralized during the bubble period have lost more of their original value than those collateralized after the bursting of the bubble. As a result, loan collection rates for post-bubble loans appear to be higher than those for loans arranged during the bubble, even when the loans were originally set at the same loan to value ratio. In fact, it is likely that other GFIs, having adopted an active lending stance after the government implemented its economic package in response to the 1997-98 financial crisis, have more post-bubble loans than private financial institutions.

in this paper, a database for the Tokyo metropolitan area is constructed following the procedure shown in Figure 3.

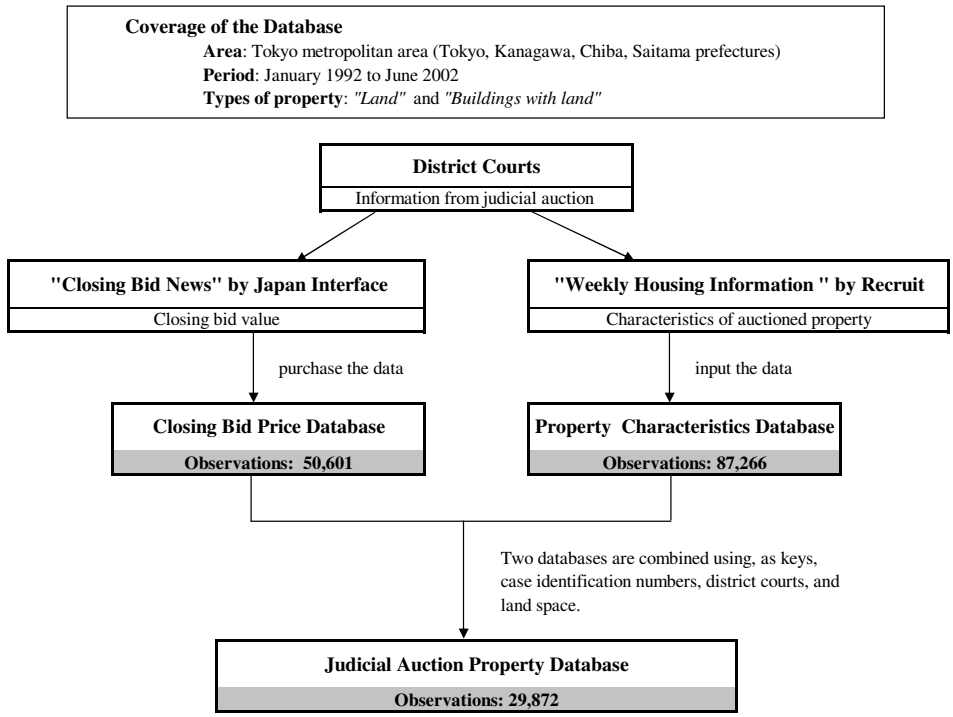
The original sources of information are two magazines "Weekly Housing Information (Shukan Jutaku Jouhou)"[8] published by Recruit Co., Ltd. and "Closing Bid News (Keiraku Nyuusu)" published by Japan Interface Co., Ltd.. The first magazine, "Weekly Housing Information" provides properties' structural and locational attributes, namely the nearest train station, land space, floor space, and so on. This information is based on notifications at district courts. 87,266 observations from January 1992 to June 2002 are included in the database from this data source. The second magazine, "Closing Bid News" provides closing bid values for properties. This information is merged with the first database using, as keys, the case identification numbers, district courts and land space.

This database, therefore, excludes properties for which (i) bidding could not be closed for some reason; (ii) the auction was cancelled after the information was released in "Weekly Housing Information"; (iii) the keys did not match; (iv) one or more of the characteristics were missing. As a result, the available dataset contains 3,387 observations for *Land* and 26,385 for *Buildings with Land.*

from respectively July and August 2000, and other major district courts are also planning to follow in it(http://bit.sikkou.jp).

[8]From 23rd January 2002, the name was changed to "Housing Information STYLE (Jutaku Jouhou Sutairu)".

Figure 3: Database Construction



The contents of the database are listed in Table 2. As structural characteristics, "Land space," "Floor space," "Floor to land space ratio" and "Building volume to lot ratio," etc. are included. Properties' locational characteristics are captured by "Time to the Yamanote line" from the nearest station,[9] "Time to the nearest station" (where time is not reported in the original source, it is calculated from the distance divided by a walking speed of 80m/min), and a dummy for having to make "Use of a bus" to reach the nearest station.

The database also contains dummy variables for land use: "Land category," "Zoning category," and "Current use". While "Land category" describes the main usage addressed in the register book, "Zoning category" represents its classification according to the Building Standard Law. It often happens that land categorized as Housing Land by "Land category" and as a Residential District such as a "Category 1 exclusive district for low-rise residential buildings" by "Zoning category," is actually used as Vacant Land or Parking. "Current use," therefore, is used in order to identify its actual current use.

Auction properties often involve problems caused by complicated legal relationships. To take account of the effects that may be attributed to these problems, the database includes dummy variables to indicate whether there are any claims attached to a property, such as "Short-term leasehold," "Long-term leasehold,"[10] "Third party occupancy," impo-

[9] If the nearest station is on or surrounded by the Yamanote line, the time is set to zero.

[10] When the lease contract has been concluded prior to mortgaging, the vendee has to continue leasing the property in accordance with the Civil Code and Land and House Lease Law (this is called long-term

sition of an "Accommodation road,"[11] and "Legal superficies."[12] In addition, geographic information such as "Sloping land" and "Breach of adjoining road duty"[13] is included.

3.2 Data Properties

Data properties, which will be exploited hereafter, are summarized in Figures 4 and 5. For the *Land* sample (Figure 4), when broken-down by "Region,"[14] we see Tokyo retaining a roughly 50% share until around 1998, after which Kanagawa, Chiba, and Saitama begin to increase their shares. Looking across "Zoning categories," although Residential Districts dominate throughout the sample period, there was a temporary increase in the share of Commercial Districts in the mid-1990s and of Non-urbanized Districts after 2000.

Next, we break down each regional sample across zoning and land categories. In Tokyo, the share of Commercial Districts is greater than that of other districts, where, in contrast, the share of Non-urbanized District is relatively large (Figure 4-3). As for "Land category," a large volume of properties in Forest and Plow Land seem to have been transacted in the Kanagawa, Chiba, and Saitama areas (Figure 4-4). In sum, the increase in the share of Commercial Districts in the mid-1990s corresponds to an increase in the share in the Tokyo area, whereas increases in the shares of Residential and Non-urbanized Districts correspond to increases taking place in non-Tokyo area. Properties in Non-urbanized Districts, which approximately correspond to the Forest and Plow Land category frequently seen in the non-Tokyo area, seem to include past resort developments such as golf courses.

Similarly, Figure 5 depicts the sample properties of *Buildings with Land*. The features are roughly the same as those of *Land*. In the breakdown by "Structural type," commercial buildings such as Shops and Offices have a large share in Tokyo, in line with the "Zoning category" of the land they are built on. In other areas, by contrast, Houses have a more than 60% share.

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leasehold). However, even if it has been concluded subsequent to mortgaging, this claim has to be honored by the vendee if the contract period is limited to the given periods established in Civil Code paragraph 602: 10 years for forest land, 5 years for other land type, and 3 years for building (this is called short-term leasehold).

[11] A road situated in a part of one's property is called an accommodation road. An accommodation road is a road defined as a "road" by paragraph 42 of the Building Standard Law or which is subject to an easement.

[12] In the case that land with a state of easement, mentioned in an "abstract of easement contract implemented by sales" is auctioned separately from a building, the land purchaser is required to assume the easement.

[13] In principle, under the conditions set forth in the Building Standard Law, unless more than two meters of a site adjoins a public road with more than four meters width, no construction is admitted.

[14] Here, "Region" includes the Tokyo, Yokohama, Chiba, and Saitama district courts and each of these corresponds to the Tokyo, Kanagawa, Chiba, and Saitama prefectures, respectively.

Table 2: Database Description

	Variables	unit
1	**Closing bid value**	yen
2	**Bidding year**	year
3	**Asking year**	year
4	**Case identification number**	
5	**Region dummy**	
	Tokyo district court	(1,0)
	Main branch	
	Hachiouji branch	
	Yokohama district court	(1,0)
	Main branch	
	Kawasaki branch	
	Yokosuka branch	
	Sagamihara branch	
	Odawara branch	
	Chiba district court	(1,0)
	Main branch	
	Matsudo branch	
	Kisarazu branch	
	Sakura branch	
	Saitama district court	(1,0)
	Main branch	
	Kawagoe branch	
	Koshigaya branch	
	Kumagaya branch	
6	**Time to Yamanote line**	Minutes
7	**Time to the nearest station**	Minutes
8	**Use of a bus dummy**	(1,0)
9	**Land space**	㎡
10	**Floor space**	㎡
11	**Floor to land space ratio**	%
12	**Building volume to lot ratio**	%
13	**Land category dummy**	
	Housing land	(1,0)
	Forest and plow land	(1,0)
	Miscellaneous land	(1,0)
14	**Zoning category dummy**	
	Residential	(1,0)
	Residential district	
	Category 1 exclusive district for low-rise residential buildings	
	Category 1 exclusive district for medium-rise residential buildings	
	Category 2 exclusive district for low-rise residential buildings	
	Category 2 exclusive district for medium-rise residential buildings	
	Category 1 residential district	
	Category 2 residential district	
	Quasi-residential district	
	Commercial	(1,0)
	Neighborhood commercial district	
	Commercial districst	
	Industrial	(1,0)
	Quasi-industrial district	
	Industrial & exclusively industrial district	
	Non-urbanized	(1,0)
	Urbanization control area	
	City planning area (not delineated)	
	Outside of city planning area	

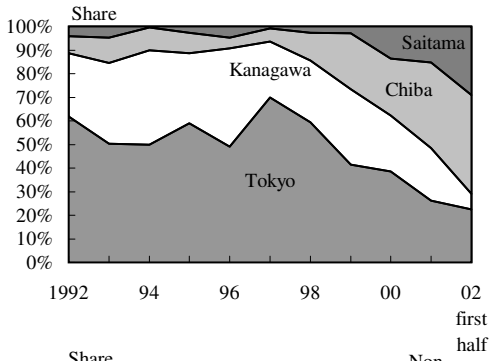
	Variables	unit
15	**Claims on the property dummy**	
	Short-term leasehold	(1,0)
	Long-term leasehold	(1,0)
	Third party occupancy	(1,0)
	Accommodation road	(1,0)
	Legal superficies	(1,0)
16	**Breach of adjoining road duty dummy**	(1,0)
17	**Sloping land dummy**	(1,0)
18	**Current use dummy**	
	Vacant land	(1,0)
	With building structure	(1,0)
	Parking	(1,0)
	Forest and plow land	(1,0)
	Miscellaneous land	(1,0)
19	**Building age**	year old
20	**Wooden construction dummy**	(1,0)
21	**Structural type dummy**	
	House	(1,0)
	Office	(1,0)
	Work area and yard	(1,0)
	Shop	(1,0)
	Factory and warehouse	(1,0)
	Hotel	(1,0)
	Apartment house	(1,0)
	Others	(1,0)

Notes: The variables corresponding to 17 and 18, except for "with Building structure", are available only for the "Land" sample. Those corresponding to 19 and 20 are only available for the "Buildings with land" sample.

Figure 4: *Land* Sample Properties

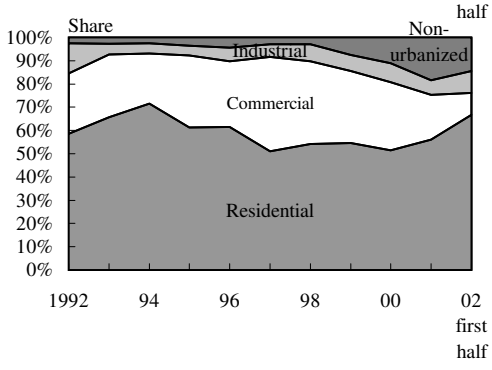
1. Breakdown by Region

	Tokyo	Kanagawa	Chiba	Saitama	Total
1992	76	33	9	5	123
93	75	51	16	7	149
94	100	80	19	1	200
95	152	77	22	7	258
96	157	133	15	15	320
97	240	81	19	3	343
98	251	110	50	11	422
99	208	161	119	15	503
00	185	113	116	65	479
01	145	123	200	84	552
02 first half	31	9	58	40	138
Total	1,620	971	643	253	3,487

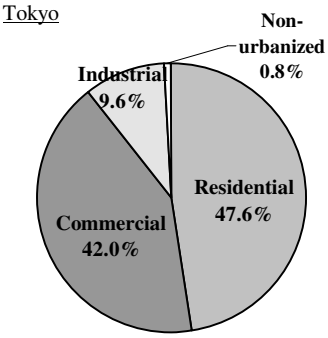


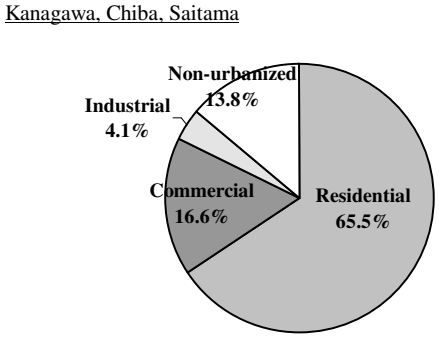
2. Breakdown by Zoning Category

	Residential	Commercial	Industrial	Non-urbanized	Total
1992	72	32	16	3	123
93	98	40	7	4	149
94	143	43	9	5	200
95	157	81	11	9	258
96	196	91	19	14	320
97	171	143	19	10	343
98	230	149	31	12	422
99	275	154	36	38	503
00	248	139	39	53	479
01	310	106	34	102	552
02 first half	92	13	13	20	138
Total	1,992	991	234	270	3,487

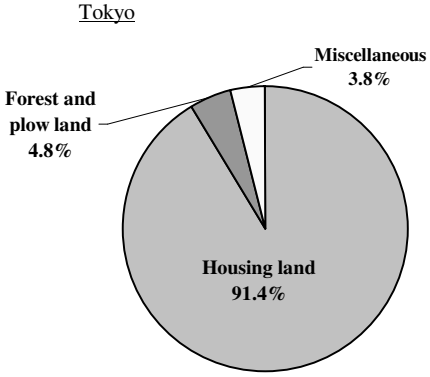


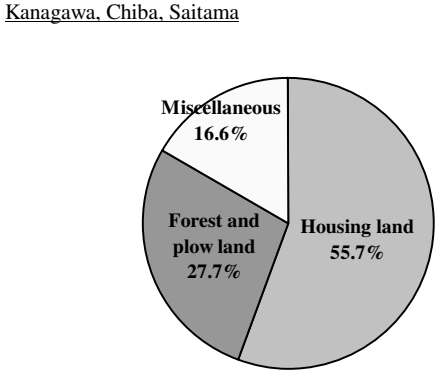
3. Breakdown by Region and Zoning Categories





4. Breakdown by Region and Land Category



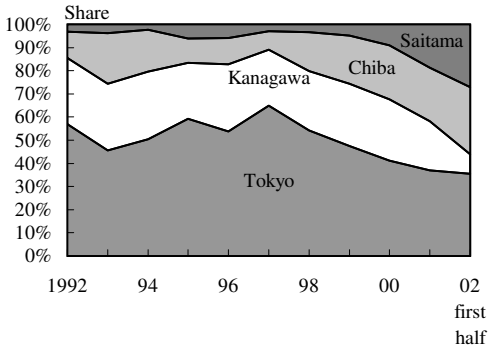


Note: Pie charts are based on the whole sample period.

Figure 5: *Buildings with Land* Sample Properties

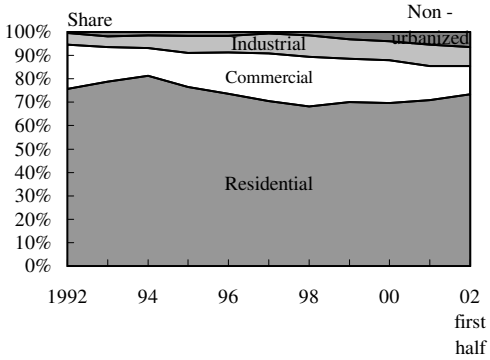
1. Breakdown by Region

	Tokyo	Kanagawa	Chiba	Saitama	Total
1992	232	117	46	13	408
93	328	208	158	27	721
94	619	360	222	29	1,230
95	1,129	460	203	115	1,907
96	1,134	611	235	126	2,106
97	2,461	915	303	110	3,789
98	1,867	877	582	115	3,441
99	1,597	909	697	165	3,368
00	1,497	965	848	330	3,640
01	1,614	917	1,011	812	4,354
02 first half	504	120	411	386	1,421
Total	12,982	6,459	4,716	2,228	26,385



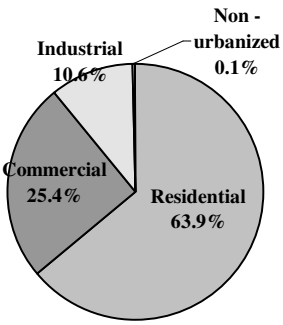
2. Breakdown by Zoning Category

	Residential	Commercial	Industrial	Non-urbanized	Total
1992	309	77	20	2	408
93	568	106	33	14	721
94	999	147	65	19	1,230
95	1,459	278	140	30	1,907
96	1,552	368	149	37	2,106
97	2,673	768	321	27	3,789
98	2,347	729	313	52	3,441
99	2,362	621	278	107	3,368
00	2,536	663	298	143	3,640
01	3,086	631	404	233	4,354
02 first half	1,042	173	114	92	1,421
Total	18,933	4,561	2,135	756	26,385

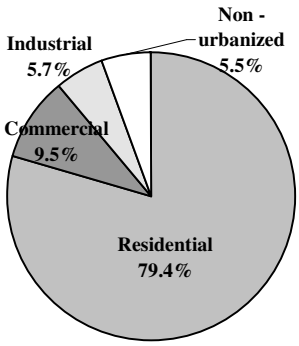


3. Breakdown by Region and Zoning Category

Tokyo

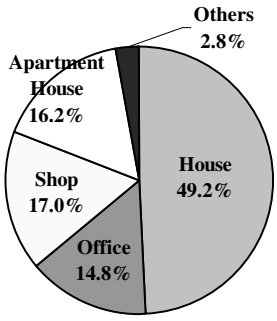


Kanagawa, Chiba, Saitama

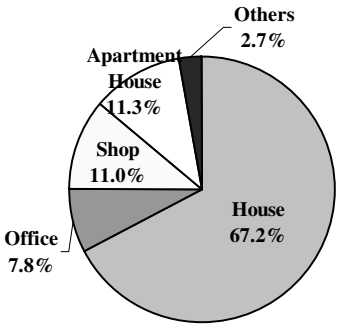


4. Breakdown by Region and Land Category

Tokyo



Kanagawa, Chiba, Saitama



Note: Pie charts are based on the whole sample period.

4 Construction of Hedonic Price Indices

4.1 Hedonic Approach

In this paper, we employ a hedonic approach to investigate developments in the price of auctioned land. This approach is widely used in the calculation of various price indices. Ohta [1978], Shiratsuka [1994] and Bank of Japan [2001] provide detailed explanations.

The hedonic approach is one method of estimating a "quality adjusted price index," which describes prices under the condition that the quality of goods is kept constant from a base period. In practice, to make adjustments for differences in the quality of goods, the individual quality characteristics of each good are allotted a monetary value. This approach is based on the theoretical foundation of consumer behavior provided by the Lancaster model, which assumes a market where each characteristic, a proxy for quality, is implicitly transacted. A hedonic function is a market price curve where supply and demand for each characteristic reach equilibrium (Lancaster [1991] and Rosen [1974]).

Given that there are no identical goods in a real estate market, the hedonic approach, which equalizes the differences embodied in each good, is useful in estimating a price index. There exist considerable numbers of empirical studies that apply the hedonic approach to real estate properties: for land prices, Nakajima [1990], Idee [1997, 2001], Nishimura and Shimizu [2002], Suzaki and Ohta[1994]; for apartment house prices, Ito and Hirono [1992], Suzuki [1995], Tanabe [1994], Kasuga [1997], Nakamura [1998]; and for office rent, Nagai, Kondo and Ohta [2000].

The auctioned value of property i, P_i, is regressed on a set of characteristic variables as in equation (1), where the equation is expressed in double log form.[15]

$$\ln P_i = \alpha + \sum_{j=1}^{n} \beta_j \ln X_{ij} + \sum_{k=1}^{m} \delta_k D_{ik} + \phi_i TD_i + \varepsilon_i, \tag{1}$$

where the X_{ij} (j = 1,..., n) describe property characteristics such as "Land space" or "Time for the Yamanote line," etc.; the D_{ik} (k = 1,..., m) are dummy variables capturing characteristics as "Land category" or "Zoning category," etc.; and TD_i and ε_i are time dummies and estimated residuals, respectively.

Since there are no theoretical restrictions on the functional form of the hedonic equation, the form is determined by empirical tests. In this paper, we carry out a Box-Cox test. This is based on the method of maximum likelihood and compares the transformed Box-Cox function to the restricted function. The Box-Cox transformation incorporates both logarithmic (when $\lambda = 0$) and linear (when $\lambda = 1$) forms as special cases.

[15] As the data sample covers successfully auctioned properties, the independent variable (closing bid value) is restricted to being larger than the minimum sales value. Since this violates one of the assumptions of the classical linear regression model, the ordinary least squares estimator is biased. This bias might be avoided by applying a truncated distribution model. Using such a model to check the robustness of the OLS estimator is worthy of further investigation in the future.

$$P_i^{(\lambda)} = \begin{cases} \frac{P_i^{\lambda}-1}{\lambda}, & \text{when } \lambda \neq 0; \\ \ln P_i, & \text{when } \lambda = 0. \end{cases}$$

There are a variety of Box-Cox models. In this paper, two cases are considered: the double Box-Cox model, in which all the variables except for the dummy variables are transformed into Box-Cox form (equation (2)), and the semi Box-Cox model, in which only the dependent variable is transformed (equation (3)).

$$P_i^{(\lambda_0)} = \alpha + \sum_{j=1}^{n} \beta_j X_{ij}^{(\lambda_1)} + \sum_{k=1}^{m} \delta_k D_{ik} + \phi_i TD_i + \varepsilon_i, \tag{2}$$

$$P_i^{(\lambda_0)} = \alpha + \sum_{j=1}^{n} \beta_j X_{ij} + \sum_{k=1}^{m} \delta_k D_{ik} + \phi_i TD_i + \varepsilon_i. \tag{3}$$

Equation (2) reduces to the semi Box-Cox model when $\lambda_1 = 1$; to the double log model when $\lambda_0 = \lambda_1 = 0$; to the semi log model when $\lambda_0 = 0, \lambda_1 = 1$; and to the linear model when $\lambda_0 = \lambda_1 = 1$. Similarly, equation (3) reduces to the semi log model when $\lambda_0 = 0$ and to the linear model when $\lambda_0 = 1$. We carry out maximum likelihood ratio tests for these functional forms and determine which form should be adopted.

In addition, following Shiratsuka and Kuroda [1996] and Bank of Japan [2001], we use Ramsey's RESET test to test whether there are any omitted variables. In practice, this paper checks the significance of a squared fitted dependent variable, $(\ln \hat{P}_i)^2$ in equation (1).

4.2 Hedonic Price Indices for Land

4.2.1 Estimation Results: Basic Specification

This section presents the estimation results of the hedonic function for the *Land* sample. The model is labeled as the Basic specification to distinguish it from the one estimated in the next section.

Many of the previous studies applying the hedonic approach to real estate prices incorporated the following variables to capture property characteristics: (i) accessibility to the central business district (CBD); (ii) distance from the property to the nearest railway or underground station, with or without the use of a bus; and (iii) land space or floor space. This paper incorporates such explanatory variables via (i) "Time to the Yamanote line," (ii) "Time to the nearest station" and the "Use of a bus" dummy, and (iii) "Land space" and "Building volume to lot ratio."

In addition, the paper also incorporates characteristic variables peculiar to the judicial auction. These include region ("Region" dummy) and land classification ("Land

Table 3: Box-Cox Test: Basic Specification for *Land*

	λ_0	Log-likelihood	LLR (double)	LLR (semi)
double Box-Cox	0.007	-64593.1		
semi Box-Cox	-0.013	-65546.2	1906.2^{***} $[\lambda_1 = 1]$	
double log		-64641.4	96.6^{***} $[\lambda_0 = \lambda_1 = 0]$	
semi log		-65547.7	1909.2^{***} $[\lambda_0 = 0, \lambda_1 = 1]$	20310^{***} $[\lambda_0 = 0]$
linear		-76289.2	23392.2^{***} $[\lambda_0 = \lambda_1 = 1]$	139710^{***} $[\lambda_0 = 1]$

Notes: 1. Results of Box-Cox test for equations (2) and (3). λ_0 is the parameter for the dependent variable and λ_1 for the independent variable.

2. LLR (double) and LLR (semi) are Log-Likelihood Ratios against the double Box-Cox model and semi Box-Cox model, respectively.

3. *** denotes that null hypotheses shown in squared brackets are rejected at the 1% statistical significance level.

category," "Zoning category," "Current use" dummies), claims on the property ("Long-term leasehold" and "Legal superficies"[16] dummies, etc.), and geographical information ("Sloping land" and "Breach of adjoining road duty" dummies).

The results of the Box-Cox test are given in Table 3. They show that the log-likelihood ratio tests against the double Box-Cox form reject all the restrictions on the Box-Cox parameters and thus accept the double Box-Cox form.

However, the analysis that follows will be based on the estimation results obtained from the double log form, which is easier to interpret, even though the double Box-Cox form is selected in the above test. This is because, since the Box-Cox parameter λ_0 is extremely close to zero, the hedonic price index estimated from the double Box-Cox form was confirmed to be almost the same as that obtained from the double log form.

Estimation results for the double log form are shown in Table 4. We carry out a test for residual heteroscedasticity and the null hypothesis that the residuals are homoscedastic is rejected at the 1% significant level. We, therefore, make use of Heteroscedasticity Consistent Standard Error (HCSE). The RESET test, of which the null hypothesis is that there is no specification error, is rejected warning of the existence of omitted variables.

With the caveat of the failure of the RESET test, almost all coefficients are significant and signs are as expected. For example, the longer the time to the Yamanote line or

[16] Although "Short-term leasehold" and "Third party occupancy" may also be incorporated among the explanatory variables, they are excluded since observations on these claims are very few.

Table 4: Hedonic Function: Basic Specification for *Land*

Dependent variable: log (Closing bid value)

Independent variables	Coefficient	HCSE
Constant	14.08	(0.34) ***
log (Time to the Yamanote line)	-0.31	(0.02) ***
log (Time to the nearest station)	-0.27	(0.03) ***
Use of a bus dummy	-0.32	(0.05) ***
log (Land space)	0.81	(0.02) ***
log (Building volume to lot ratio)	0.13	(0.04) ***
Sloping land dummy	-1.29	(0.17) ***
Breach of adjoining road duty dummy	-0.51	(0.09) ***
Region dummy		
Tokyo district court	0.17	(0.07) **
Yokohama district court	-0.09	(0.07)
Chiba district court	-0.29	(0.06) ***
Land category dummy		
Forest and plow land	-0.42	(0.06) ***
Miscellaneous land	-0.24	(0.05) ***
Zoning dummy		
Residential	1.04	(0.07) ***
Commercial	1.29	(0.08) ***
Industrial	0.84	(0.09) ***
Current use dummy		
With building structure	-0.29	(0.04) ***
Parking	0.34	(0.04) ***
Forest and plow land	-1.29	(0.13) ***
Miscellaneous land	-0.47	(0.07) ***
Claims on the property dummy		
Long-term leasehold	-0.93	(0.07) ***
Legal superficies	-0.59	(0.12) ***
Time dummy		
D1993	-0.22	(0.13) *
D1994	-0.33	(0.10) ***
D1995	-0.63	(0.10) ***
D1996	-0.79	(0.10) ***
D1997	-0.89	(0.10) ***
D1998	-1.14	(0.09) ***
D1999	-1.37	(0.09) ***
D2000	-1.44	(0.09) ***
D2001	-1.51	(0.09) ***
D2002	-1.55	(0.12) ***
R^2	0.65	
σ	0.88	
RESET	10.01	[0.002]**
Variables	32	
Observations	3,487	

Notes: 1. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

2. Figures in brackets are standard errors. Since the variance of the residual shows heteroscedasticity, the equation is estimated using White's standard error (HCSE: Heteroscedasticity Consistent Standard Errors).

3. The figure in the squared bracket is p-value for RESET test.

4. Time to the Yamanote line, which contains zero observations, is converted into natural logarithms after adding one to each observation.

nearest station (especially where the use of a bus is required), the lower the property is valued. From the coefficients on the "Region" dummy, we see that property within the Tokyo district court is more highly valued than within other district courts.[17] Coefficients on the "Land category" dummy demonstrate that the value of Forest and Plow Land is significantly lower than that of Housing Land. The "Zoning category" dummy indicates that Commercial Districts are the most highly valued, followed by Residential, Industrial, and Non-urbanized Districts. The "Current use" dummy reveals that a building structure which exists within a property but is not subject to an auction acts to push down the property value. As for claims on the property, "Long-term leasehold" and "Legal superficies" have negative effects on the property value because they limit land use. In addition, when land is sloping or breaches adjoining road duty, its valuation is lower.

4.2.2 Estimation Results: Extended Specification

In this section, we modify the model to deal with the misspecification problem that appeared in the Basic specification, in which the rejection of the RESET test implied the existence of omitted variables. This misspecification problem may arise because coefficients on characteristics varied across different land usages. The model is therefore extended to allow for variation in the parameters by introducing cross terms between each characteristic and the "Current use" dummy.[18] It is labeled as the Extended specification to distinguish it from the Basic specification.

The estimating equation is as follows.

$$\begin{aligned} \ln P_i &= \alpha + \sum_{j=1}^{n} \beta_j \ln X_{ij} + \sum_{k=1}^{m} \delta_k D_{ik} \\ &\quad + \sum_{j=1}^{n} \sum_{h=1}^{l} \gamma_{jh} \ln X_{ij} \tilde{D}_{ih} + \sum_{k=1}^{m-l} \sum_{h=1}^{l} \theta_{kh} \bar{D}_{ik} \tilde{D}_{ih} + \phi_i T D_i + \varepsilon_i, \end{aligned} \tag{4}$$

where, along with the variables in the Basic specification, we also include cross terms consisting of the "Current use" dummy $\tilde{D}_{ih}$, which is a part of dummy variables D_{ik}, and each of the characteristic variables X_{ij} as well as the other dummy variables $\bar{D}_{ik}$.

Table 5 reports the Box-Cox test results. While the semi log form is accepted for the test against the semi Box-Cox form, the semi Box-Cox form is rejected against the double Box-Cox form. As a result, the double Box-Cox form is accepted. As the Box-Cox parameter, however, is nearly equal to zero, similar to the Basic specification, the results for the double log form will be reported hereafter.

[17] "Region," "Land category," "Zoning category," and "Current use" dummies are standardized to Saitama district court, Housing Land, Non-urbanized District, and Vacant Land, respectively. Parameters on these dummies, therefore, take magnitudes relative to the standardized variables.

[18] In addition to the "Current use" dummy, models including cross terms with "Region," "Zoning category," and "Land category" dummies are also estimated (Hedonic indices are presented in the upper panel of the Supplementary Chart. Estimation results are omitted). Results are similar to the Extended specification: the development of the hedonic index is quite similar to that of the Basic specification while the RESET test statistics are improved.

Table 5: Box-Cox Test: Extended Specification for *Land*

	λ_0	Log-likelihood	LLR (double)	LLR (semi)
double Box-Cox	0.001	-64420.5		
semi Box-Cox	0.003	-64798.0	755^{***} $[\lambda_1 = 1]$	
double log		-64450.3	59.6^{***} $[\lambda_0 = \lambda_1 = 0]$	
semi log		-65798.2	755.4^{***} $[\lambda_0 = 0, \lambda_1 = 1]$	0.4 $[\lambda_0 = 0]$
linear		-76193.1	23545.2^{***} $[\lambda_0 = \lambda_1 = 1]$	22790.2^{***} $[\lambda_0 = 1]$

Note: See notes for Table 3.

The estimation results are shown in Table 6. The RESET test statistics in the bottom left panel of the table improve compared with the Basic specification. This time the test is not rejected at the 5% significance level.

The left column of Table 6 presents parameters for Vacant Land. The middle and right columns show parameters on the cross terms, between each variables and the following four dummy variables: (i) With building structure,[19] (ii) Parking, (iii) Forest and Plow Land, and (iv) Miscellaneous Land. The magnitudes of the coefficients are relative to those for Vacant Land. For instance, the positive coefficient on "Time to the Yamanote line" for (ii) Parking, 0.23, does not mean that the further the distance from the Yamanote line, the more valuable Parking becomes. The impact of the distance from the Yamanote line on the value of Parking should be calculated as -0.20, which is obtained by adding this figure together with the coefficient on Vacant Land -0.43, since the former represents the magnitude of the coefficient on Parking relative to that on Vacant Land.

Significances and signs on the coefficients for Vacant Land (left column) are largely the same as those in the Basic specification and thus in line with prior expectations. Also, the middle and the right columns are broadly in line with intuition.

[19]With building structure dummy indicates that one or more building structures that are not subject to an auction are built on a property.

Table 6: Hedonic Function: Extended Specification for *Land*

Dependent variable: log (Closing bid value)

	Base line: Vacant land		(1) With building structures		(2) Parking		(3) Forest and plow land		(4) Miscellaneous land	
Independent variables	Coefficient	HCSE	Coefficient	HCSE	Coefficient	HCSE	Coefficient	HCSE	Coefficient	HCSE
Constant	15.69	(0.55) ***	-3.49	(0.86) ***	-3.60	(0.82) ***	3.02	(1.72) *	0.77	(0.98)
log (Time to the Yamanote line)	-0.43	(0.04) ***	0.20	(0.06) ***	0.23	(0.05) ***	-1.21	(0.28) ***	-0.28	(0.12) **
log (Time to the nearest station)	-0.35	(0.04) ***	0.18	(0.07) ***	0.18	(0.07) ***	0.11	(0.16)	0.20	(0.10) **
Use of a bus dummy	-0.43	(0.07) ***	0.27	(0.11) **	0.07	(0.13)	-0.06	(0.28) *	-0.08	(0.18)
log (Land space)	0.74	(0.04) ***	0.18	(0.05) ***	0.25	(0.05) ***	0.07	(0.10)	0.04	(0.07)
log (Building volume to lot ratio)	0.03	(0.07)	0.18	(0.11) *	0.33	(0.10) ***	0.51	(0.19)	0.11	(0.12)
Sloping land dummy	-1.38	(0.26) ***	-0.56	(0.64)	0.72	(0.29) **	1.15	(0.39) ***	0.11	(0.39)
Breach of adjoining road duty dummy	-0.59	(0.13) ***	0.07	(0.20)	0.31	(0.23)	0.33	(0.34)	0.07	(0.28)
Region dummy										
Tokyo district court	0.18	(0.09) *	0.24	(0.16)	0.43	(0.16) ***	0.26	(0.52)	-0.97	(0.24) ***
Yokohama district court	-0.07	(0.10)	0.29	(0.16) *	0.44	(0.16) ***	-1.10	(0.45) **	-0.67	(0.20) ***
Chiba district court	-0.25	(0.09) ***	0.11	(0.17)	0.27	(0.15) *	-0.57	(0.44)	-0.40	(0.21) *
Land category dummy										
Forest and plow land	-0.50	(0.08) ***	0.27	(0.15) *	0.22	(0.14)	0.96	(0.36) ***	0.15	(0.18)
Miscellaneous land	-0.30	(0.07) ***	0.29	(0.15) *	0.00	(0.12)	0.59	(0.44)	0.13	(0.19)
Zoning dummy										
Residential	0.99	(0.11) ***	-0.06	(0.20)	-0.67	(0.19) ***	-0.11	(0.29)	0.14	(0.19)
Commercial	1.14	(0.11) ***	0.07	(0.20)	-0.68	(0.20) ***	0.54	(0.57)	0.63	(0.28) **
Industrial	0.90	(0.18) ***	-0.33	(0.24)	-0.73	(0.24) ***	0.10	(0.57)	0.33	(0.35)
Claims on the property dummy										
Long-term leasehold	-0.85	(0.07) ***								
Legal superficies	-0.60	(0.12) ***								
Time dummy										
D1993	-0.24	(0.12) *								
D1994	-0.35	(0.10) ***								
D1995	-0.63	(0.09) ***								
D1996	-0.81	(0.09) ***								
D1997	-0.89	(0.09) ***								
D1998	-1.15	(0.09) ***								
D1999	-1.35	(0.09) ***								
D2000	-1.43	(0.09) ***								
D2001	-1.51	(0.09) ***								
D2002	-1.57	(0.12) ***								
R^2	0.69									
σ	0.84									
RESET	3.15	[0.08]								
Variables	92									
Observations	3,487									

Note: See notes for Table 4.

4.2.3 Hedonic Price Indices for *Land*

Based on these estimation results, we calculate hedonic price indices (Figure 6). The three panels on the left present indices standardized to 1992 = 1.[20] Those on the right present annual changes in the indices.

The top panels depict auction price indices estimated from the Basic and Extended specifications. It is observed that (i) the indices have continued to decline, and in 2002 had reached 20% of their levels in 1992; (ii) they fell by –25% to –15% annually during the first half of the 1990s, although the speed of decline then slowed down particularly after 2000; and (iii) the speed of decline has undergone considerable fluctuation slowing from 1995 to 1997, but then falling faster due to the 1998 financial crisis. These features are seen equally in both the Basic and the Extended specifications. It should be noted that changes in the indices follow a similar pattern of development to the successful sale rate in Figure 2. This may imply that underlying auction price developments reflect the supply-demand balance in the auction market.

The middle panels compare the hedonic price index with the OPLP index in the Tokyo metropolitan area. The level of the hedonic index has been much lower than that of the OPLP index, having undergone a faster pace of decline since 1992. Changes in the hedonic index have been far more volatile than those in the OPLP index. They have also preceded changes in the OPLP index; the turning points in 1994 and in 1997 for the hedonic index lead the 1995 and 1998 turning points of the OPLP index. These results are qualitatively the same when we compare the hedonic and ULP indices.

The fact that the hedonic index is constantly lower than both OPLP and ULP indices implies that if we try to figure out the amount recoverable from collateralized loans arranged during the bubble period (or equivalently, the extent of losses on NPL disposals) by using the OPLP or ULP index, we are likely to overestimate it (i.e., underestimate losses).[21]

The auction market is generally characterized as a "marginal market," and one that is quite responsive to the market supply-demand balance. As described in Section 2, participation in the auction market is largely limited to professionals, and auction prices are likely to be determined by the supply-demand balance of properties up for auction, which in turn depends on the amount of NPL write-offs. In fact, the spread between the OPLP index and the hedonic index, as well as the difference in their volatilities, are far more obvious than those reported in Nishimura and Shimizu [2002], who compare appraisal and transaction prices for ordinary real estate.

[20] Since the equations are estimated in logarithms, the price indices are calculated by taking exponents of the coefficients on the time dummies.

[21] Valuation of NPL collateral is not necessarily affected by the upward bias of the OPLP index since banks—although evaluation techniques vary across them —evaluate collateral conservatively by applying loan to value ratios calculated from previous cases or by having it appraised by experts.

It is often pointed out, however, that as banks tend to sell relatively valuable collateralized properties first, the remaining collateral tends to suffer from insufficient loan to value ratios. Appraisal prices are also thought, ultimately, to be considerably affected by the OPLP index.

In sum, the hedonic index has moved ahead of the OPLP index and its volatility has been larger. It has also declined more significantly due to the large supply of properties that has accompanied NPL disposals since the bursting of the bubble.

The above indices are based on the full sample estimation, which assumes stable parameters (no structural change) throughout the sample period. As a check of robustness, the model is re-estimated using samples for two adjacent years, say, 1992-1993 samples, 1993-1994 samples,..., and then compared with the full sample model (the bottom panel). Development is similar, except for the year 2002, for which there is only a small number of observations available. Presumably, this makes estimation of the two-adjacent-year model more responsive to outliers.

4.2.4 Hedonic Price Indices for *Land* — for Each Zoning Category and Region

By splitting the sample, we estimate indices for each "Zoning category" and "Region" (Figure 7). Estimation results are recorded in Supplementary Tables 1 and 2.

In the top panels, indices for Commercial and Residential Districts reveal a clear lead-lag relationship: a decline in the former has been followed by a decline in the latter. Meanwhile, movements in indices for Industrial and Non-urbanized Districts reveal volatility. In fact, however, observations in these categories are too few to draw sensible conclusions.

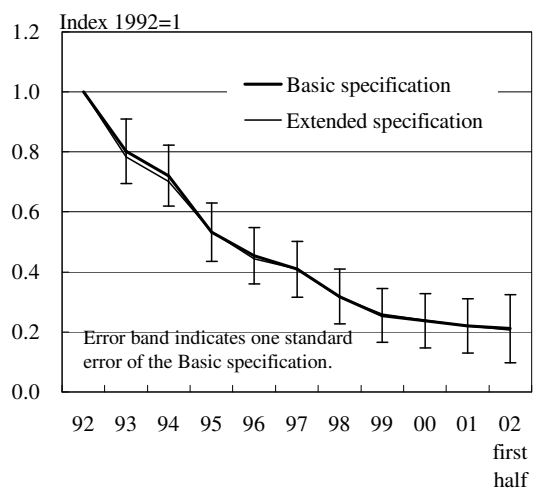
From the middle panels, falls in the Tokyo area index may be observed to have preceded those in other areas (Kanagawa, Chiba, and Saitama prefectures). It should also be noted that observations for the first half of 2002 are very few (Commercial Districts and the Tokyo area have 13 and 31 observations, respectively—see Figure 4.) The 40% to 50% drops in the indices for Commercial Districts (the top right panel) and the Tokyo area (the middle right panel) in this year are likely to be due to the presence of outliers.

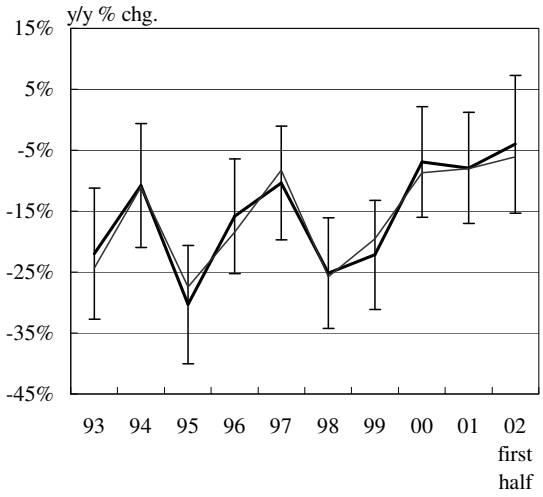
Next, indices for each "Zoning category" and "Region" are averaged using the value weight (= total values transacted in a year) for each year. The bottom panels in Figure 7 show the weighted indices. The annual changes in the indices throughout the sample period fall within the range of one standard error of the Extended specification. The trend of these indices is thus seen to be similar to that of the Extended specification.[22] In the first half of 2002, it is likely that outliers in the sample cause a large decline in the weighted average for each "Zoning category" and "Region," as mentioned above. The Extended specification uses as many as 138 observations for the first half of 2002 and seems to be more robust against the influence of outliers.

[22]Similar results can be obtained when the volume weight (= number of transactions in a year) is used instead of the value weight.

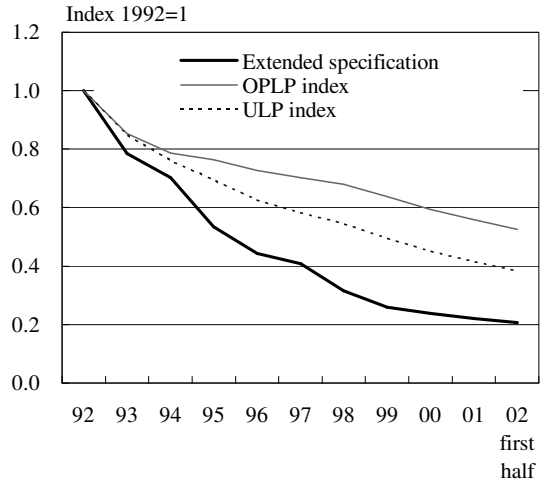
Figure 6: Hedonic Price Indices for *Land*

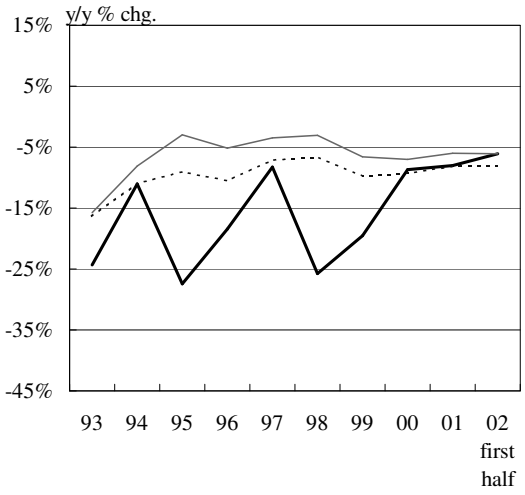
1. Basic and Extended Specifications



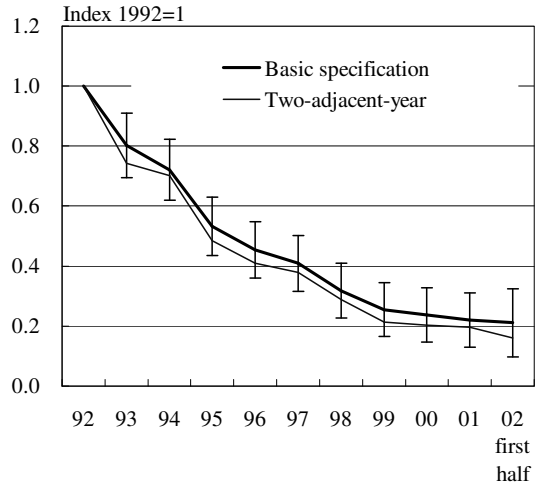


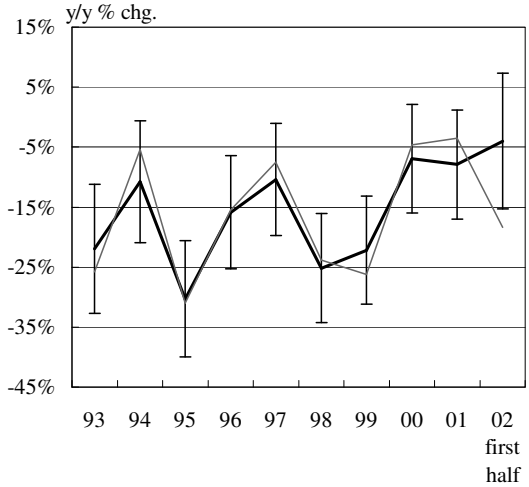
2. Comparison with the OPLP and ULP Indices





3. Comparison with Two-adjacent-year Estimation

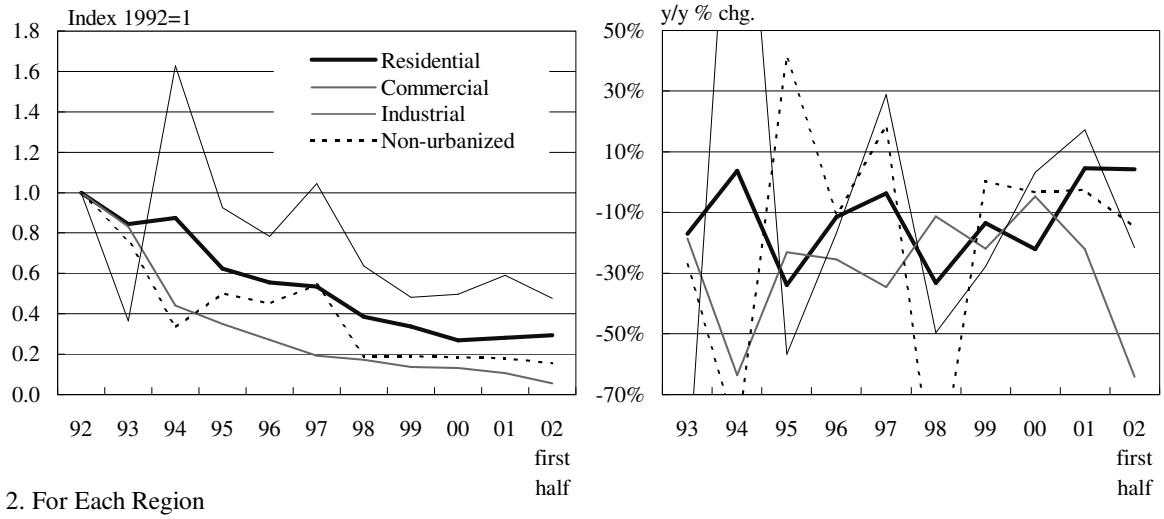




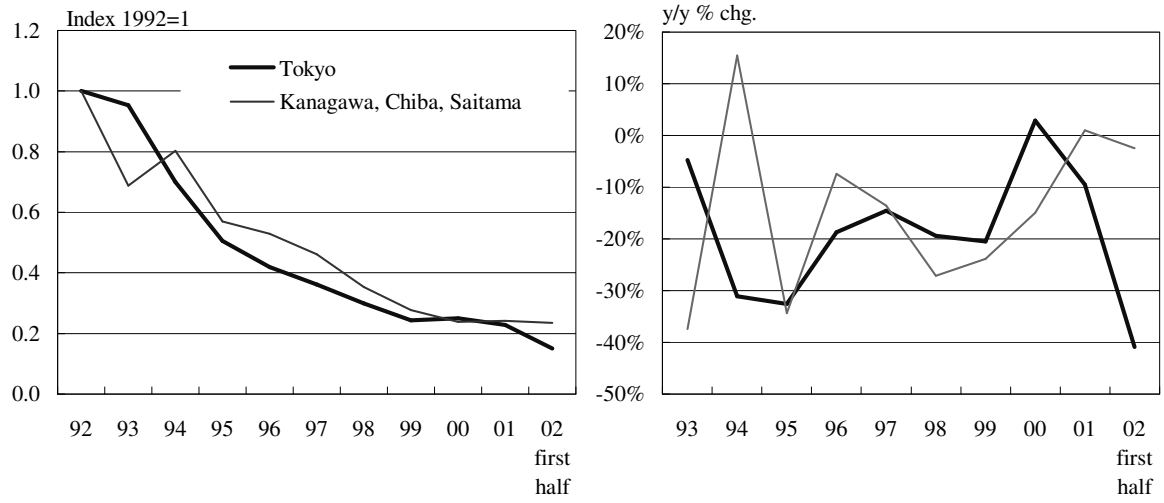
Note: The two-adjacent-year estimation is based on the Basic specification.

Figure 7: Hedonic Price Indices for *Land* — for Each Zoning Category and Region

1. For Each Zoning Category



2. For Each Region



3. Comparison with Weighted Average Indices

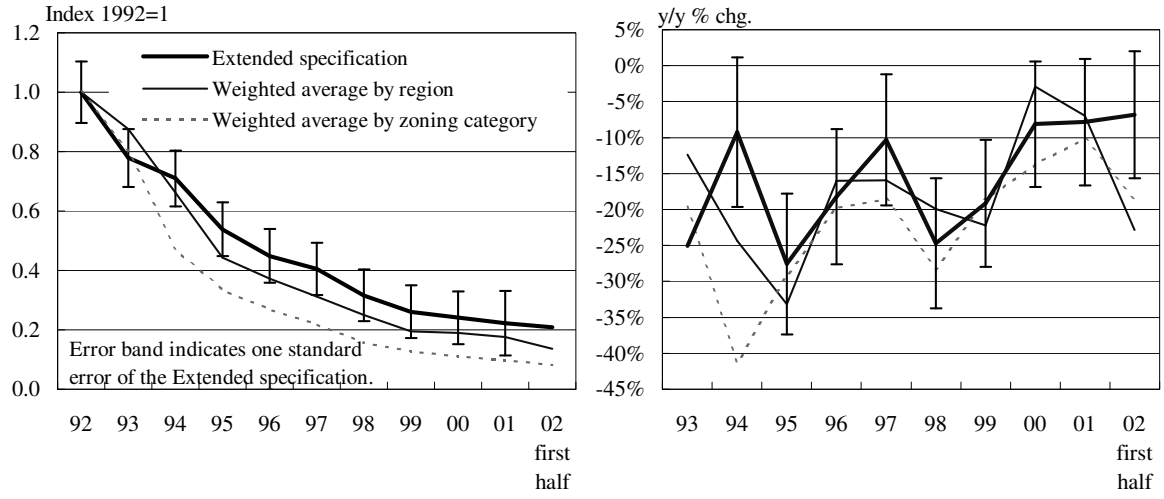


Table 7: Box-Cox Test

(1) Basic Specification for *Buildings with Land*

	λ_0	Log-likelihood	LLR (double)	LLR (semi)
double Box-Cox	-0.012	-479640		
semi Box-Cox	-0.084	-479614	19948^{***} $[\lambda_1 = 1]$	
double log		-479656	32^{***} $[\lambda_0 = \lambda_1 = 0]$	
semi log		-479826	20372^{***} $[\lambda_0 = 0, \lambda_1 = 1]$	20340^{***} $[\lambda_0 = 0]$
linear		-549511	139742^{***} $[\lambda_0 = \lambda_1 = 1]$	139710^{***} $[\lambda_0 = 1]$

(2) Extended Specification for *Buildings with Land*

	λ_0	Log-likelihood	LLR (double)	LLR (semi)
double Box-Cox	-0.012	-479606		
semi Box-Cox	-0.084	-489545	19878^{***} $[\lambda_1 = 1]$	
double log		-479623	34^{***} $[\lambda_0 = \lambda_1 = 0]$	
semi log		-489754	20296^{***} $[\lambda_0 = 0, \lambda_1 = 1]$	20262^{***} $[\lambda_0 = 0]$
linear		-549492	139772^{***} $[\lambda_0 = \lambda_1 = 1]$	139738^{***} $[\lambda_0 = 1]$

Note: See notes for Table 3.

Table 8: Hedonic Function: Basic Specification for *Buildings with Land*

Dependent variable: log (Closing bid value)

Independent variables	Coefficient	HCSE	
Constant	14.35	(0.09)	***
log (Time to the Yamanote line)	-0.24	(0.01)	***
log (Time to the nearest station)	-0.15	(0.01)	***
Use of a bus dummy	-0.30	(0.01)	***
log (Land space)	0.52	(0.01)	***
log (Floor space)	0.41	(0.01)	***
log (Building age)	-0.13	(0.01)	***
With building structure dummy	-0.17	(0.03)	***
Accommodation road dummy	-0.10	(0.02)	***
Breach of adjoining road duty dummy	-0.32	(0.03)	***
Region dummy			
Tokyo district court	0.45	(0.01)	***
Yokohama district court	0.35	(0.01)	***
Chiba district court	-0.07	(0.01)	***
Land category dummy			
Forest and plow land	-0.15	(0.02)	***
Miscellaneous land	-0.01	(0.03)	
Zoning dummy			
Residential	0.37	(0.02)	***
Commercial	0.47	(0.02)	***
Industrial	0.22	(0.02)	***
Structural type dummy			
House	0.05	(0.06)	
Office	0.02	(0.06)	
Work area and yard	-0.14	(0.07)	**
Shop	0.00	(0.06)	
Factory and warehouse	-0.18	(0.07)	***
Hotel	-0.31	(0.09)	***
Apartment house	-0.10	(0.06)	
Claims on the property dummy			
Short or Long leasehold duumy	-0.02	(0.01)	*
Time dummy			
D1993	-0.13	(0.04)	***
D1994	-0.27	(0.04)	***
D1995	-0.42	(0.04)	***
D1996	-0.51	(0.04)	***
D1997	-0.60	(0.04)	***
D1998	-0.72	(0.04)	***
D1999	-0.83	(0.04)	***
D2000	-0.86	(0.04)	***
D2001	-0.92	(0.04)	***
D2002	-0.97	(0.04)	***
R^2	0.71		
σ	0.52		
RESET	0.80	[0.37]	
Variables	36		
Observations	26,385		

Note: See notes for Table 4.

Table 9: Hedonic Function: Extended Specification for *Buildings with Land*

Dependent variable: log (Closing bid value)

Independent variables	Coefficient	HCSE
Constant	14.36	(0.09) ***
log (Time to the Yamanote line)	-0.24	(0.01) ***
log (Time to the nearest station)	-0.15	(0.01) ***
Use of a bus dummy	-0.30	(0.01) ***
log (Land space)	0.52	(0.01) ***
log (Floor space)	0.41	(0.01) ***
log (Building age)	-0.13	(0.01) ***
With building structure dummy	-0.17	(0.03) ***
Accommodation road dummy	-0.10	(0.02) ***
Breach of adjoining road duty dummy	-0.32	(0.03) ***
Region dummy		
Tokyo district court	0.45	(0.01) ***
Yokohama district court	0.35	(0.01) ***
Chiba district court	-0.06	(0.01) ***
Land category dummy		
Forest and plow land	-0.15	(0.02) ***
Miscellaneous land	-0.01	(0.03)
Zoning dummy		
Residential	0.37	(0.02) ***
Commercial	0.46	(0.02) ***
Industrial	0.22	(0.02) ***
Structural type dummy		
House	0.06	(0.06)
Office	0.02	(0.06)
Work area and yard	-0.14	(0.07) **
Shop	-0.03	(0.06)
Factory and warehouse	-0.17	(0.07) **
Hotel	-0.30	(0.10) ***
Apartment house	-0.11	(0.06) *
Claims on the property dummy		
Short or Long leasehold duumy		
House	-0.14	(0.02) ***
Office	0.01	(0.03)
Work area and yard	-0.05	(0.06)
Shop	0.06	(0.02) ***
Factory and warehouse	-0.07	(0.07)
Hotel	-0.05	(0.16)
Apartment house	0.01	(0.02)
Time dummy		
D1993	-0.13	(0.04) ***
D1994	-0.28	(0.04) ***
D1995	-0.42	(0.04) ***
D1996	-0.52	(0.04) ***
D1997	-0.60	(0.04) ***
D1998	-0.72	(0.04) ***
D1999	-0.83	(0.04) ***
D2000	-0.87	(0.04) ***
D2001	-0.92	(0.04) ***
D2002	-0.97	(0.04) ***
R^2	0.71	
σ	0.52	
RESET	0.71	[0.40]
Variables	42	
Observations	26,385	

Note: See notes for Table 4.

4.3 Hedonic Price Indices for *Buildings with Land*

Next, we estimate alternative hedonic indices using data on *Buildings with Land*. As mentioned above, although estimation using this data incorporates the effect of building prices, it still provides a worthwhile check on the robustness of the estimation results for the *Land* data, since there is a much larger number of observations (26,385 observations).

4.3.1 Estimation Results

The Basic specification is basically the same as that of the *Land* sample. However, some modifications are made as follows. (i) The "Current use" dummy is now limited to just the "With building structure" dummy (*Buildings with Land* cannot be Vacant Land or Forest and Plow Land by definition). (ii) Structural attributes of buildings, such as "Floor space," "Building Age," or "Structural type" dummies are added. (iii) In the "Claims on the property" category, a "Short or long term leasehold" dummy is added: this takes a value of one when either a short or long term leasehold is established. (iv) The "Accommodation road" dummy, which is not significant in the *Land* model, is included. In addition to the Basic specification, we estimate the Extended specification, allowing for variation in the coefficients on "Short or long term leasehold" for each structural type.[23] Here, "Third party occupancy" is excluded from the explanatory variables since it is not statistically significant in the model (a result that differs that in Idee [2000] and Toda and Idee [2000].)[24]

The Box-Cox tests select the double Box-Cox forms for both the Basic and the Extended specifications (Table 7). Since Box-Cox parameters are almost zero, the estimation results for the double Box-Cox form are nearly the same as those for the double log form.

The following analysis, therefore, is based on the results estimated from the double log form (Table 8). First, the RESET test shows no specification error in either Basic or Extended specifications. Significances and signs on most coefficients are the same as those in the *Land* model, except that the Yokohama district court dummy becomes significant.

As for coefficients on the additional variables for *Buildings with Land*; "Floor space"

[23] In addition, other specifications with parameter dummies for "Region," "Zoning category" and "Land category" are also estimated (see footnote 18). Indices are shown in the bottom panel of the Supplementary Figure. Although estimation results are omitted, all the models pass the RESET test, except for the sample broken-down by region. The hedonic price indices move similarly to those in the Basic specification.

[24] Although the following three cases are actually estimated, in none are the parameters statistically significant. (i) Instead of a Short/long term leasehold dummy, a Third party occupancy dummy is included. (ii) Both a Short/long term leasehold dummy and a Third party occupancy dummy are included. (iii) Different combinations of the Short/long term leasehold and Third party occupancy dummies are included: (a) with both Third party occupancy and Short/long term leasehold, (b) with Third party occupancy but without Short/long term leasehold, (c) without Third party occupancy but with Short/long term leasehold, (d) with neither Third party occupancy nor Short/long term leasehold.

The parameters on the Third party occupancy dummy might become significant, if more detailed information on occupancy were available.

is positive and significant; "Building Age" is negative and significant; and the "Accommodation Road" dummy is negative and significant. Coefficients on Work area/Yard, Factory/Warehouse and Hotel are also negative and significant.

The coefficient on "Short/long-term leasehold" is negative and significant, just as we saw a negative sign on "Long-term leasehold" in the *Land* estimation. This implies that leasehold, which limits land use, has a negative impact on property value. However, if the coefficients on these dummy variables are allowed to vary for each structural type, as in the Extended specification (Table 9), the coefficient on House is negative and significant while that on Shop is positive and significant. These results suggest that while Houses are usually purchased for the purpose of living in, the existence of a lessor causes the property's value to depreciate. At the same time, commercial buildings such as Shops with tenancies are likely to be considered favorably because owners can gain rents.[25]

4.3.2 Hedonic Price Indices for *Buildings with Land*

Figure 8 presents hedonic indices based on the estimation results above. As in the *Land* indices, there are no significant differences between the Basic and the Extended specifications (the top panels) and also between full sample and two-adjacent-year models (the middle panels). Indeed, since the Basic and the Extended specifications follow almost precisely the same path, the two curves overlap completely. In the bottom panels, the *Buildings with Land* index is compared with the *Land* index. The results are qualitatively similar to the *Land* sample: (i) the index has continued to fall since the bubble collapsed, but (ii) the pace of decline has been slowing down, although (iii) there was a temporarily large decline after the financial crisis.

There are some differences between *Buildings with Land* and *Land*. To begin with, the former is less volatile than the latter. This may be due to a greater degree of homogeneity and the larger number of observations in the former sample, which make it unlikely to be affected by outlier observations. In fact, coefficients of variation (standard deviation divided by sample average) for the unit price of land in the two samples are 2.81 for *Land* and 1.58 for *Buildings with Land*, revealing the latter to be the more homogeneous sample.[26]

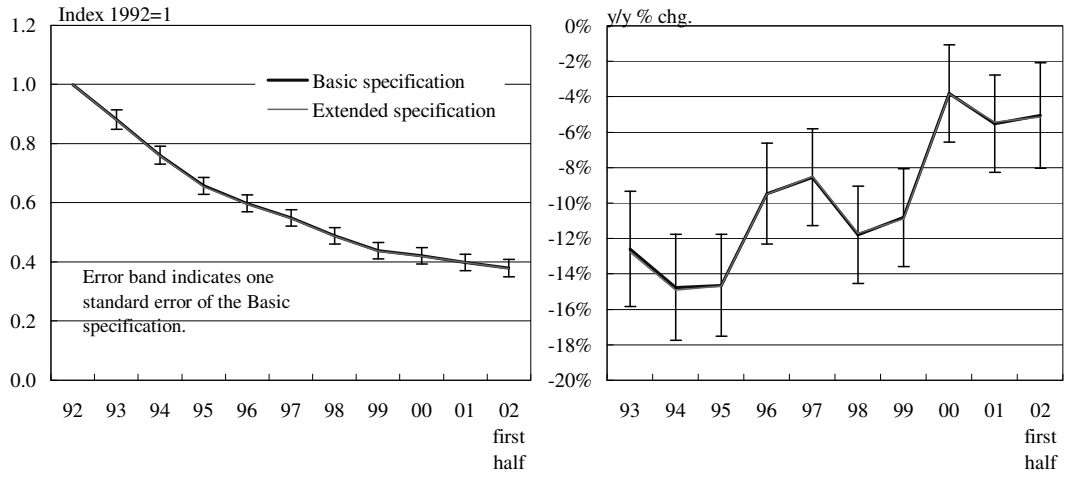
It is also observed that the index for *Buildings with Land* has fallen more moderately than that for *Land* throughout the period. This might be due to the following reasons. First, since prices of land, mainly Vacant Land from the *Land* sample, increased far more steeply than those of *Buildings with Land* during the bubble period, they may have

[25]The results of Taguchi and Idee [2002] can be interpreted as consistent with this finding. They estimated a function with the bidding rate as a dependent variable, and legal superficies and long-term leasehold as independent variables, and found that the coefficient on the dummy variable was negative and significant in Residential Districts but positive and not significant in Commercial Districts.

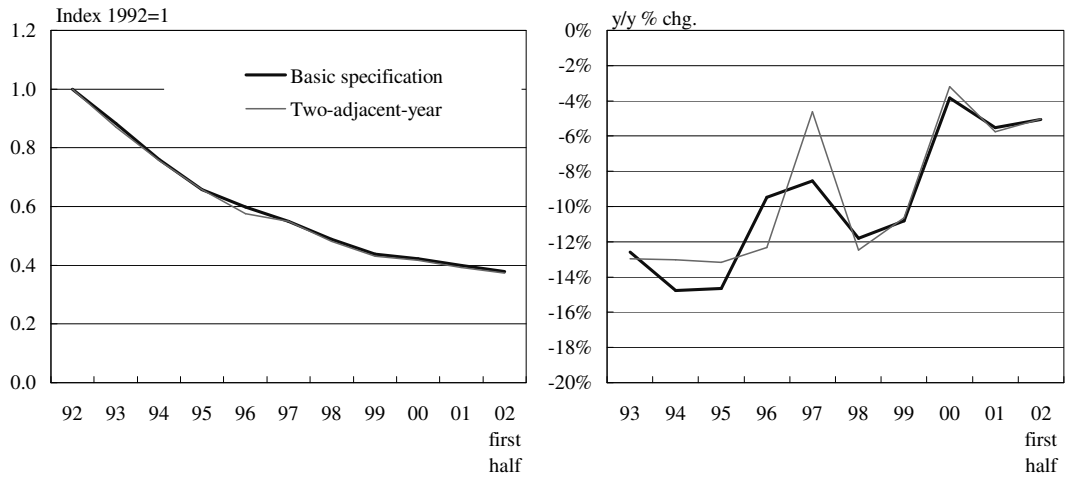
[26]For *Buildings with Land* as well as *Land*, value divided by land space is used as the unit price for convenience.

Figure 8: Hedonic Price Indices for *Buildings with Land*

1. Basic and Extended Specifications



2. Comparison with Two-adjacent-year Estimation



3. The OPLP Index and the Hedonic Indices for *Buildings with Land* and *Land*

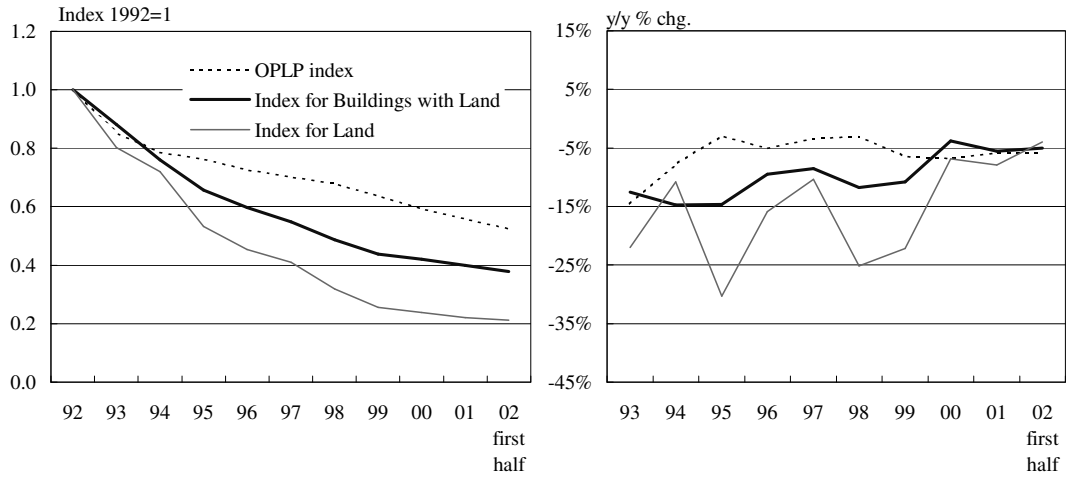
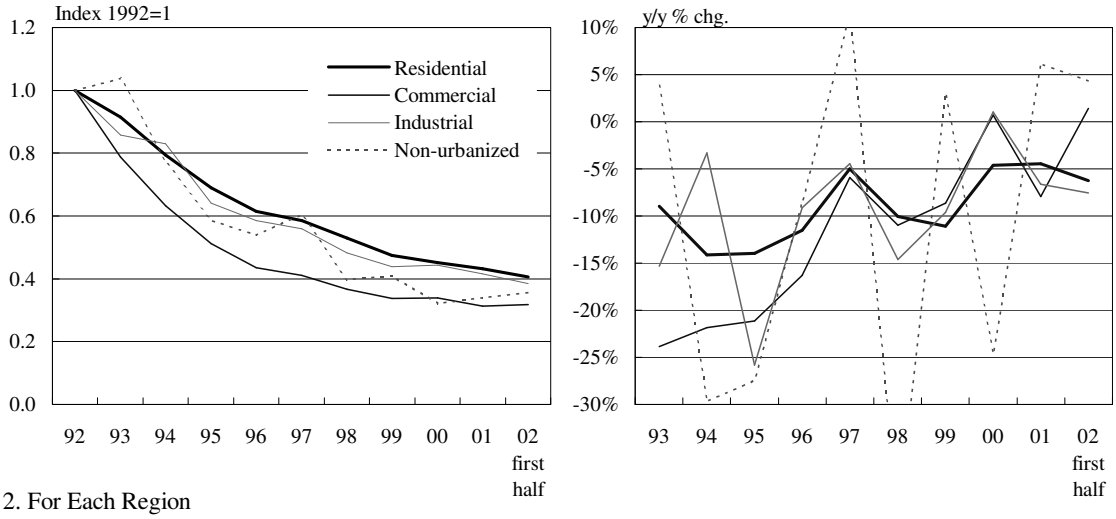
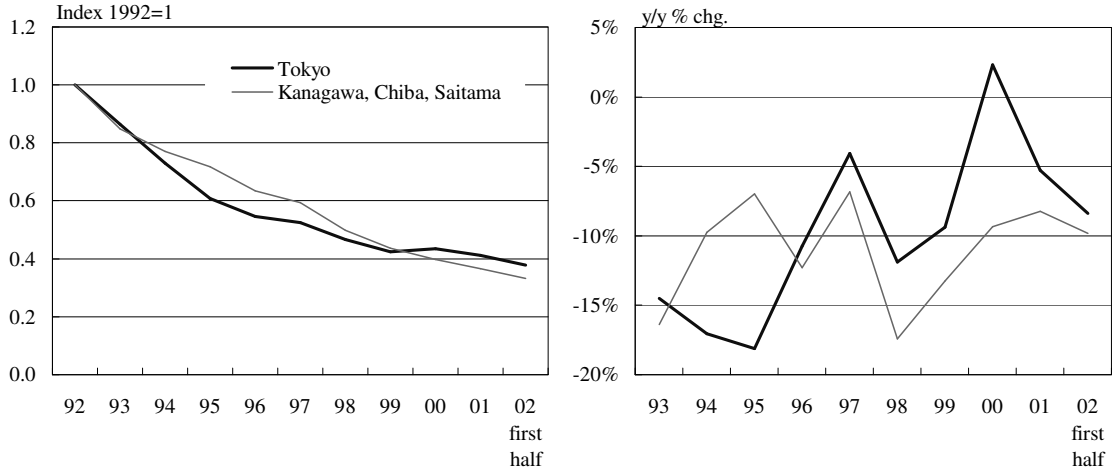


Figure 9: Hedonic Price Indices for *Buildings with Land* — for Each Zoning Category and Region

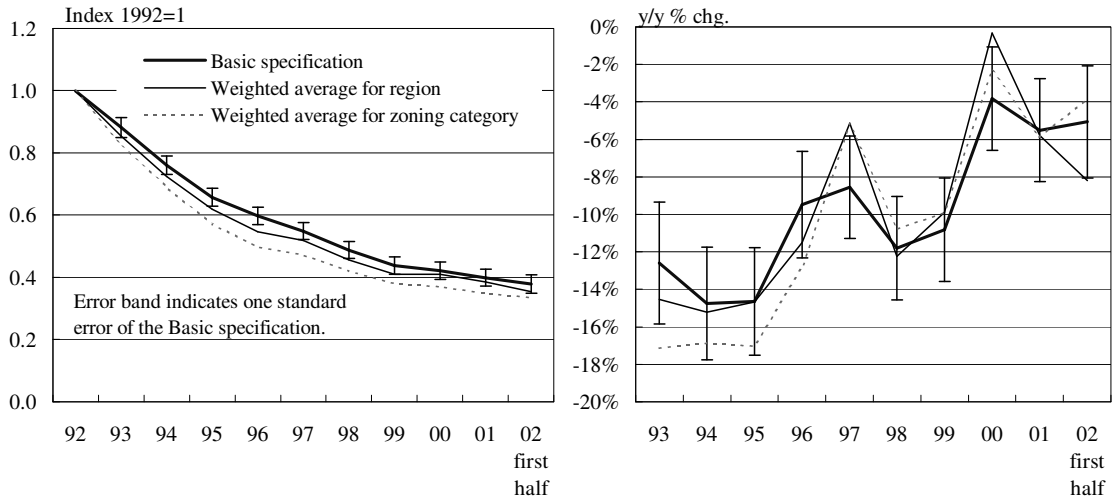
1. For Each Zoning Category



2. For Each Region



3. Comparison with Weighted Average Indices



adjusted more sharply after the bursting of the bubble. Next, the fact that there are buildings on a property tends to suggest something about the usefulness of that property — some Vacant Land is supposed to have remained vacant because it cannot be used for anything. Finally, the structural attributes of buildings may not be fully accounted for in hedonic estimations.

Next, we estimate indices for each "Zoning category" and "Region" (Figure 9). Estimation results are recorded on Supplementary Tables 3 and 4. Although with the caveat of the violation of the RESET tests, the basic features are the same as in the *Land* estimation: (i) indices for Commercial Districts (the top panel) and for the Tokyo area (the middle panel) have declined in advance of other districts/areas, and (ii) indices estimated in the Basic and the Extended specifications show similar development (the bottom panels).

Turning to the coefficient on "Short/long-term leasehold," this is negative and significant for Residential Districts, positive and significant for Commercial Districts, and not significant for Industrial and Non-urbanized Districts (Supplementary Table 3). Since there is a correlation between zoning classification and the structural type constructed within each zone, this result is consistent with the estimation results from the Extended specification: the coefficient on House is negative and that on Shop is positive.

5 Conclusion

This paper has investigated land price developments in the Tokyo metropolitan area since the collapse of the bubble by estimating hedonic price indices based on judicial auction price data. For this purpose, we construct an auction price database for the period 1992-2002. Findings from the estimated indices for *Land* and *Buildings with Land* are as follows.

- The hedonic price index for auctioned land in the Tokyo metropolitan area has fallen throughout the period since the bursting of the bubble, although, with the exception of 1997, the pace of decline has been slowing. This price movement, which is consistent with developments in the successful sale rate for auctioned property, is considered to reflect supply-demand conditions in the auction market.

- It is also found that compared with the Officially Published Land Price index and the Urban Land Price index, the hedonic index has fallen more sharply, has been more volatile, and has moved ahead of the other indices. This may be because auction prices are more responsive to market conditions than appraisal prices such as Officially Published Land Prices.

Hedonic analysis of auction properties is worth further extension. In this paper the hedonic approach is applied to an investigation of quality-adjusted price developments by focusing on the coefficients on time dummies. The approach, however, can also be used

to obtain property valuations by using fitted values. The hedonic model, by providing objectively fair values for collateral, enables creditors to figure out their loan collection rates. It also provides information useful to courts when setting minimum sales values.[27] In order to use the model for these practical purposes, however, it is necessary to improve the fit. In addition, it is important to include apartment houses in the database as well as to update it.

The hedonic approach can be applied not only to auction property but also to general real estate. It has been empirically proved that in the real estate market, characterized as a market with imperfect information, search costs are extremely large (Nishimura, Asami, and Shimizu [2002]). Estimating quality-adjusted prices via hedonic indices, accompanied by sufficient disclosure of real estate information, would be highly useful in reducing these search costs, thus increasing activity in the real estate market and enhancing its efficiency. In order to apply hedonic analysis to transaction prices, however, it is essential to disclose actual transaction prices and to construct a comprehensive database.

[27]Opaque pricing of minimum sales values is said to have been one of the reasons for the limited demand for auction properties (For example, see "Kinyu Homu Jijo (Semi-monthly Banking Law Journal)" No.1654, September 25th, 2002). In this respect, real estate appraisers have been discussing standardization of the evaluation method, which has varied across regions.

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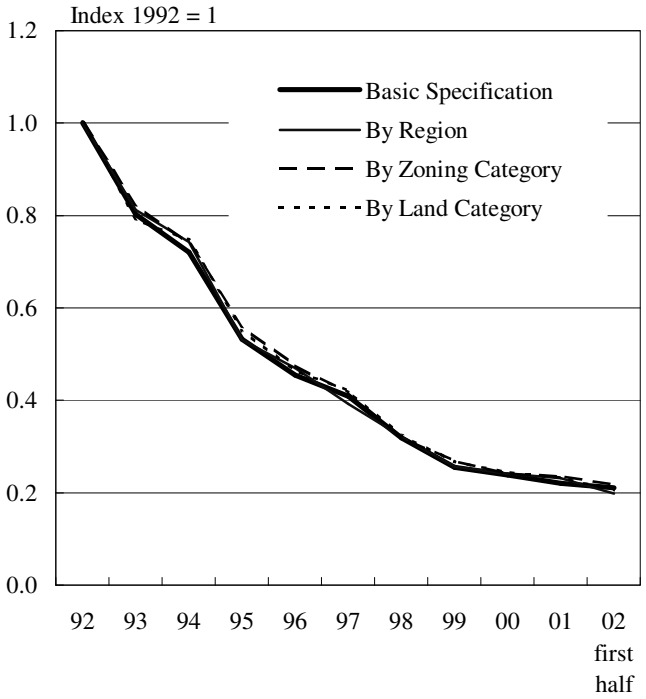
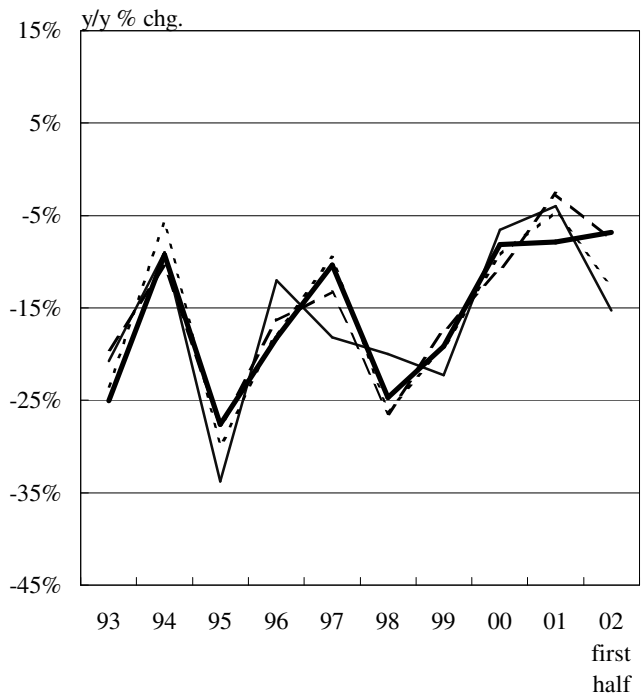
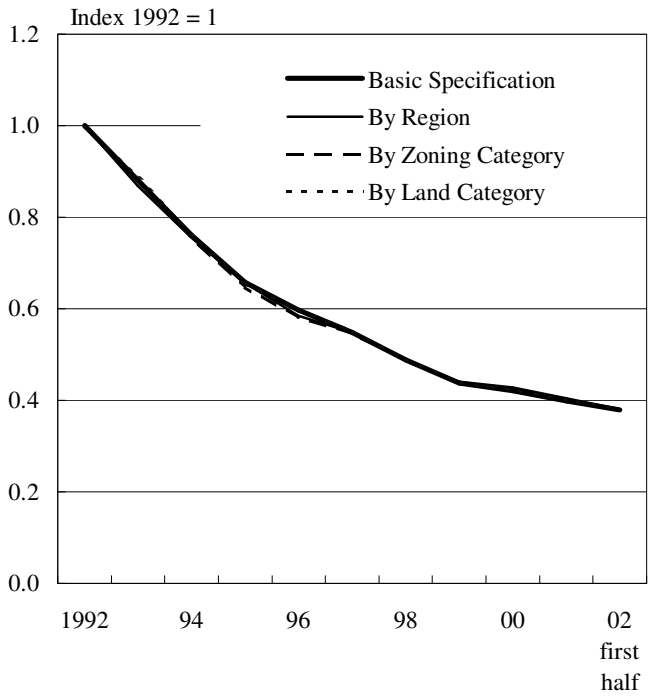
Supplementary Chart
Robustness Check Using Other Extended Specifications

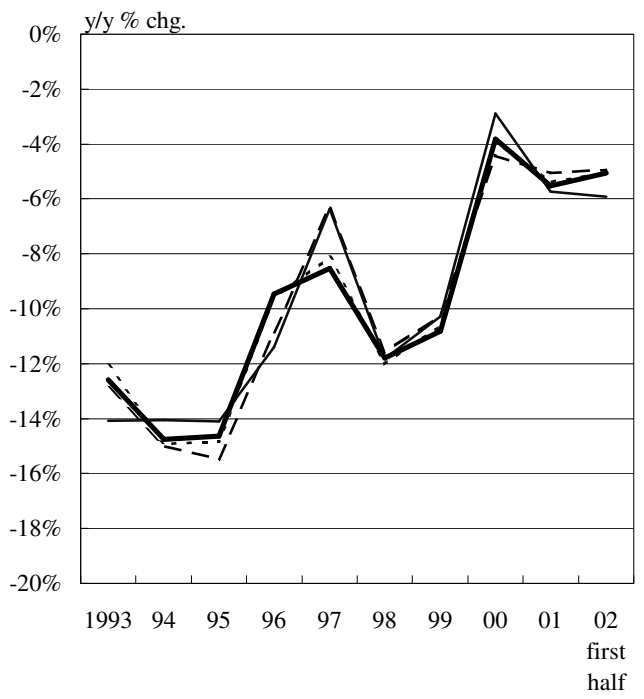
1. *Land*





2. *Buildings with Land*





Supplementary Table 1
Estimation Results for Hedonic Function for *Land*
For Each Zoning Category

	(1) Residential		(2) Commercial		(3) Industrial		(4) Non-urbanized	
Dependent variable: log (Closing bid value)								
Independent variables	Coefficient	HCSE	Coefficient	HCSE	Coefficient	HCSE	Coefficient	HCSE
Constant	16.13	(0.36) ***	9.62	(0.60) ***	11.91	(2.31) ***	17.78	(1.25) ***
log (Time to the Yamanote line)	-0.39	(0.03) ***	-0.20	(0.03) ***	-0.15	(0.08) *	-0.89	(0.20) ***
log (Time to the nearest station)	-0.20	(0.04) ***	-0.21	(0.05) ***	-0.09	(0.10)	-0.11	(0.06) ***
Use of a bus dummy	-0.30	(0.06) ***	-0.33	(0.14) **	-0.16	(0.15)	-0.01	(0.17) *
log (Land space)	0.76	(0.03) ***	1.05	(0.03) ***	0.83	(0.11) ***	0.61	(0.05) ***
log (Building volume to lot ratio)	-0.04	(0.05)	0.84	(0.08) ***	0.32	(0.38)	0.00	(0.11)
Sloping land dummy	-1.16	(0.18) ***	0.52	(0.13) ***				
Breach of adjoining road duty dummy	-0.46	(0.10) ***	-0.66	(0.27) **	-0.79	(0.33) **	-0.45	(0.19) **
District court dummy								
Tokyo district court	0.15	(0.08) *	0.64	(0.17) ***	0.46	(0.23) **	-0.06	(0.29)
Yokohama district court	-0.13	(0.08) *	0.40	(0.17) **	0.55	(0.22) **	-0.55	(0.22) **
Chiba district court	-0.28	(0.08) ***	0.21	(0.18)	-0.04	(0.30)	-0.23	(0.13) *
Land category dummy								
Forest and plow land	-0.35	(0.06) ***	-0.26	(0.42)	0.07	(0.24)	-0.51	(0.14) ***
Miscellaneous land	-0.19	(0.06) ***	0.04	(0.13)	-0.23	(0.22)	-0.37	(0.14) **
Current use dummy								
With building structure	-0.30	(0.05) ***	-0.24	(0.07) ***	-0.54	(0.16) ***	0.18	(0.15)
Parking	0.34	(0.05) ***	0.25	(0.06) ***	0.41	(0.18) **	0.66	(0.27) **
Forest and plow land	-1.28	(0.16) ***	-1.36	(1.06)	-0.70	(0.25) ***	-0.52	(0.22) **
Miscellaneous land	-0.49	(0.08) ***	0.10	(0.15)	-0.46	(0.31)	0.11	(0.15)
Claims on the property dummy								
Long-term leasehold	-0.82	(0.11) ***	-0.90	(0.09) ***	-0.45	(0.21) **	-0.83	(0.22) ***
Legal superficies	-0.56	(0.13) ***	-0.30	(0.28)	-0.63	(0.31) **	-1.00	(0.35) ***
Time dummy								
D1993	-0.17	(0.14)	-0.18	(0.24)	-1.01	(0.80)	-0.27	(0.65)
D1994	-0.13	(0.12)	-0.82	(0.18) ***	0.49	(0.30)	-1.10	(0.68) *
D1995	-0.47	(0.11) ***	-1.05	(0.16) ***	-0.08	(0.26)	-0.69	(0.65)
D1996	-0.59	(0.12) ***	-1.31	(0.14) ***	-0.25	(0.28)	-0.80	(0.63)
D1997	-0.62	(0.12) ***	-1.65	(0.14) ***	0.04	(0.28)	-0.61	(0.67)
D1998	-0.96	(0.11) ***	-1.76	(0.14) ***	-0.45	(0.20) **	-1.66	(0.61) ***
D1999	-1.09	(0.11) ***	-1.98	(0.14) ***	-0.73	(0.26) ***	-1.66	(0.60) ***
D2000	-1.31	(0.12) ***	-2.03	(0.15) ***	-0.70	(0.22) ***	-1.69	(0.59) ***
D2001	-1.27	(0.11) ***	-2.25	(0.16) ***	-0.53	(0.25) **	-1.72	(0.59) ***
D2002	-1.22	(0.13) ***	-2.89	(0.40) ***	-0.74	(0.34) **	-1.86	(0.59) ***
R^2	0.60		0.74		0.68		0.65	
σ	0.86		0.76		0.77		0.80	
RESET	2.34	[0.13]	4.06	[0.04]*	0.62	[0.43]	2.81	[0.09]
Variables	29		29		28		28	
Observations	1,997		990		234		271	

Note: See notes for Table 4.

Supplementary Table 2
Estimation Results for Hedonic Function for *Land*
For Each Region

	(1) Tokyo		(2) Kanagawa, Chiba, Saitama	
Dependent variable: log (Closing bid value)				
Independent variables	Coefficient	HCSE	Coefficient	HCSE
Constant	11.52	(0.47) ***	16.59	(0.41) ***
log (Time to the Yamanote line)	-0.18	(0.02) ***	-0.75	(0.05) ***
log (Time to the nearest station)	-0.22	(0.04) ***	-0.23	(0.03) ***
Use of a bus dummy	-0.51	(0.08) ***	-0.23	(0.06) ***
log (Land space)	1.02	(0.04) ***	0.69	(0.02) ***
log (Building volume to lot ratio)	0.49	(0.06) ***	0.02	(0.05)
Sloping land dummy	0.58	(0.32) *	-1.16	(0.17) ***
Breach of adjoining road duty dummy	-0.38	(0.17) **	-0.48	(0.10) ***
Zoning dummy				
Residential	0.61	(0.16) ***	0.91	(0.08) ***
Commercial	0.62	(0.16) ***	1.31	(0.09) ***
Industrial	0.11	(0.17)	1.22	(0.11) ***
Land category dummy				
Forest and plow land	-0.41	(0.12) ***	-0.37	(0.06) ***
Miscellaneous land	-0.21	(0.12) *	-0.22	(0.06) ***
Current use dummy				
With building structure	-0.43	(0.06) ***	-0.15	(0.05) ***
Parking	0.19	(0.05) ***	0.44	(0.06) ***
Forest and plow land	0.02	(0.31)	-1.14	(0.13) ***
Miscellaneous land	-0.51	(0.16) ***	-0.31	(0.07) ***
Claims on the property dummy				
Long-term leasehold	-0.93	(0.08) ***	-0.67	(0.13) ***
Legal superficies	-0.57	(0.17) ***	-0.54	(0.15) ***
Time dummy				
D1993	-0.05	(0.17)	-0.37	(0.20) *
D1994	-0.36	(0.12) ***	-0.22	(0.17)
D1995	-0.68	(0.11) ***	-0.56	(0.17) ***
D1996	-0.87	(0.11) ***	-0.64	(0.17) ***
D1997	-1.02	(0.11) ***	-0.77	(0.17) ***
D1998	-1.21	(0.10) ***	-1.04	(0.16) ***
D1999	-1.41	(0.11) ***	-1.28	(0.16) ***
D2000	-1.39	(0.11) ***	-1.43	(0.16) ***
D2001	-1.48	(0.12) ***	-1.42	(0.16) ***
D2002	-1.89	(0.25) ***	-1.45	(0.17) ***
R^2	0.70		0.60	
σ	0.79		0.88	
RESET	3.45	[0.06]	1.74	[0.19]
Variables	29		29	
Observations	1,622		1,870	

Note: See notes for Table 4.

Supplementary Table 3
Estimation Results for Hedonic Function for *Buildings with Land*
For Each Zoning Category

	(1) Residential		(2) Commercial		(3) Industrial		(4) Non-urbanized	
Dependent variable: log (Closing bid value)								
Independent variables	Coefficient	HCSE	Coefficient	HCSE	Coefficient	HCSE	Coefficient	HCSE
Constant	14.66	(0.11) ***	14.98	(0.22) ***	14.55	(0.25) ***	17.11	(0.52) ***
log (Time to the Yamanote line)	-0.28	(0.01) ***	-0.19	(0.01) ***	-0.18	(0.02) ***	-0.68	(0.08) ***
log (Time to the nearest station)	-0.11	(0.01) ***	-0.20	(0.02) ***	-0.11	(0.02) ***	-0.18	(0.03) ***
Use of a bus dummy	-0.25	(0.01) ***	-0.40	(0.05) ***	-0.26	(0.04) ***	-0.32	(0.08) ***
log (Land space)	0.58	(0.02) ***	0.49	(0.03) ***	0.60	(0.04) ***	0.36	(0.05) ***
log (Floor space)	0.35	(0.02) ***	0.46	(0.02) ***	0.26	(0.05) ***	0.36	(0.09) ***
log (Building age)	-0.15	(0.01) ***	-0.14	(0.02) ***	-0.17	(0.03) ***	-0.16	(0.04) ***
With building structure dummy	-0.18	(0.03) ***	-0.02	(0.06)	-0.23	(0.06) ***	-0.35	(0.13) **
Accommodation road dummy	-0.14	(0.02) ***	0.05	(0.07)	-0.13	(0.04) ***	-0.01	(0.34)
Breach of adjoining road duty dummy	-0.32	(0.03) ***	-0.27	(0.08) ***	-0.18	(0.10) *	-0.27	(0.12) **
Region dummy								
Tokyo district court	0.44	(0.01) ***	0.51	(0.06)	0.44	(0.05)	0.07	(0.17)
Yokohama district court	0.35	(0.01) ***	0.47	(0.07) ***	0.16	(0.05) ***	0.08	(0.08)
Chiba district court	-0.04	(0.02) ***	0.00	(0.08)	-0.22	(0.06) ***	-0.22	(0.05) ***
Land category dummy								
Forest and plow land	-0.13	(0.02) ***	-0.20	(0.09) **	-0.01	(0.12)	-0.12	(0.12)
Miscellaneous land	-0.03	(0.03)	0.23	(0.16)	0.11	(0.08)	0.28	(0.18)
Structural type dummy								
House	0.09	(0.08)	-0.25	(0.14) *	0.19	(0.15)	0.14	(0.24)
Office	0.03	(0.08)	-0.13	(0.14)	0.33	(0.16)	0.10	(0.25)
Work area and yard	-0.08	(0.08)	-0.37	(0.14) **	0.16	(0.15)	-0.16	(0.27)
Shop	0.00	(0.08)	-0.19	(0.14)	0.28	(0.16) *	0.04	(0.27)
Factory and warehouse	-0.16	(0.10) *	-0.28	(0.17) *	0.11	(0.16)	0.00	(0.32)
Hotel	-0.61	(0.17) ***	-0.35	(0.15) **	0.28	(0.20)	-0.40	(0.35)
Apartment house	-0.04	(0.08)	-0.37	(0.14) ***	0.26	(0.16) *	-0.13	(0.29)
Claims on the property dummy								
Short or Long leasehold duumy	-0.07	(0.01) ***	0.04	(0.02) **	-0.02	(0.04)	0.05	(0.09)
Time dummy								
D1993	-0.09	(0.04) **	-0.24	(0.15)	-0.15	(0.15)	0.04	(0.28)
D1994	-0.23	(0.04) ***	-0.46	(0.15) ***	-0.19	(0.12)	-0.26	(0.28)
D1995	-0.37	(0.03) ***	-0.67	(0.14) ***	-0.45	(0.11) ***	-0.53	(0.27) **
D1996	-0.49	(0.03) ***	-0.83	(0.13) ***	-0.54	(0.11) ***	-0.62	(0.26) **
D1997	-0.54	(0.03) ***	-0.89	(0.13)	-0.58	(0.11)	-0.50	(0.26)
D1998	-0.64	(0.03) ***	-1.00	(0.13) ***	-0.73	(0.11) ***	-0.92	(0.25) ***
D1999	-0.75	(0.03) ***	-1.09	(0.13) ***	-0.82	(0.11) ***	-0.89	(0.25) ***
D2000	-0.79	(0.03) ***	-1.08	(0.13) ***	-0.81	(0.11) ***	-1.14	(0.25) ***
D2001	-0.84	(0.04) ***	-1.16	(0.13) ***	-0.88	(0.11) ***	-1.07	(0.25) ***
D2002	-0.90	(0.04) ***	-1.14	(0.14) ***	-0.95	(0.12) ***	-1.03	(0.26) ***
R^2	0.70		0.67		0.73		0.57	
σ	0.48		0.60		0.52		0.56	
RESET	47.86	[0.00]**	43.25	[0.00]**	0.32	[0.57]	17.98	[0.00]**
Variables	33		33		33		33	
Observations	18,933		4,561		2,135		756	

Note: See notes for Table 4.

Supplementary Table 4
Estimation Results for Hedonic Function for *Buildings with Land*
For Each Region

	(1) Tokyo		(2) Kanagawa, Chiba, Saitama	
Dependent variable: log (Closing bid value)				
Independent variables	Coefficient	HCSE	Coefficient	HCSE
Constant	14.84	(0.11) ***	15.21	(0.14) ***
log (Time to the Yamanote line)	-0.20	(0.01) ***	-0.43	(0.01) ***
log (Time to the nearest station)	-0.14	(0.01) ***	-0.18	(0.01) ***
Use of a bus dummy	-0.36	(0.01) ***	-0.20	(0.01) ***
log (Land space)	0.62	(0.02) ***	0.48	(0.02) ***
log (Floor space)	0.38	(0.02) ***	0.39	(0.02) ***
log (Building age)	-0.14	(0.01) ***	-0.14	(0.01) ***
With building structure dummy	-0.19	(0.04) ***	-0.13	(0.04) ***
Accommodation road dummy	-0.13	(0.03) ***	-0.08	(0.04) *
Breach of adjoining road duty dummy	-0.17	(0.04) ***	-0.45	(0.04) ***
Land category dummy				
Forest and plow land	-0.23	(0.05) ***	-0.11	(0.03) ***
Miscellaneous land	0.02	(0.04)	-0.02	(0.04)
Zoning dummy				
Residential	-0.03	(0.03)	0.55	(0.02) ***
Commercial	0.08	(0.03) ***	0.79	(0.03)
Industrial	-0.17	(0.03) ***	0.43	(0.03)
Structural type dummy				
House	-0.02	(0.07)	0.14	(0.09)
Office	-0.03	(0.08)	0.09	(0.10)
Work area and yard	-0.19	(0.08) **	-0.09	(0.10)
Shop	-0.02	(0.08)	0.04	(0.10)
Factory and warehouse	-0.22	(0.08) ***	-0.13	(0.10)
Hotel	-0.27	(0.10) ***	-0.25	(0.15) *
Apartment house	-0.19	(0.08) **	0.01	(0.10)
Claims on the property dummy				
Short or Long leasehold duumy	-0.03	(0.01) **	0.01	(0.02)
Time dummy				
D1993	-0.15	(0.06) **	-0.16	(0.05) ***
D1994	-0.32	(0.06) ***	-0.26	(0.05) ***
D1995	-0.50	(0.05) ***	-0.33	(0.05)
D1996	-0.60	(0.05) ***	-0.45	(0.05) ***
D1997	-0.64	(0.05) ***	-0.52	(0.05)
D1998	-0.76	(0.05) ***	-0.70	(0.05) ***
D1999	-0.86	(0.05) ***	-0.83	(0.05) ***
D2000	-0.83	(0.05) ***	-0.92	(0.05) ***
D2001	-0.89	(0.06) ***	-1.01	(0.05) ***
D2002	-0.97	(0.06) ***	-1.10	(0.05)
R^2	0.71		0.63	
σ	0.51		0.54	
RESET	7.99	[0.01]**	61.16	[0.00]**
Variables	33		33	
Observations	12,982		13,403	

Note: See notes for Table 4.