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Land Prices and Fundamentals

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Abstract

This paper examines the long-term relationship between macro economic fundamentals and the weighted-average land price indicators, which are supposed to be more appropriate than the official land price indicators when analyzing their impacts on the macro economy. In many cases, we find the cointegrating relationships between the weighted-average land price indicators and the discounted present value of land calculated based on the macro economic fundamentals indicators. We also find that the demographic factor has impacts on real land prices. The error-correction analysis using the cointegrating relationships shows that not only the changes in the discounted present value of land, but also the changes in the demographic factor and bank lending have an influence on the fluctuations of real land prices. Based on the analysis, the recent change in the trend of land prices in Japan is explained by the increase in the discounted present values of land in the accommodative monetary environment, the convergence of the actual land prices to the long-term equilibrium level, and the changes in bank lending.

Key words: weighted-average land price indicators, discounted present value of land, cointegration analysis, error-correction model

JEL Classification: C32, E39

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1. Introduction

The surge in land prices in the mid 1980s induced the increase in speculative land transactions and bank lending. After that, we saw a plunge in land prices, which in turn has caused an increase in non-performing loans and the destabilization of the Japanese financial system. During this process, commentators and economists had argued whether there were "bubbles" in land prices, how large the bubbles were in the mid 1980s, and what the appropriate levels of land prices were in line with economic fundamentals. There seems to be a consensus so far that the levels of land prices in the mid 1980s cannot be explained by economic fundamentals and that there were bubbles in land prices.[1] The criteria of the analysis and the degrees of the impact of the land price bubble vary, however. Recently, there seems to be changes in the trend of land prices after the long-time stagnation. Some economists suggest that the recent change in the land price trend reflect the recovery in the real economy, while others claim that the excessive monetary easing has contributed to the resurgence in land bubbles.

Given the above arguments in the past, this paper will provide a basis to measure whether the actual land prices are in line with fundamentals or not. Specifically, this paper will examine: (a) how much the discounted present values of land are, based on the economic fundamentals; (b) whether the demographic and other factors have affected the land price fluctuations; and (c) how much the land prices should be once taking into account of those factors in (a) and (b). In this paper, we use "the weighted-average land price indicators," which are supposed to be the appropriate land price indicators when comparing with other macro economic indicators. We use the weighted-average land price indicators for the cointegration and error-correction analyses. Compared with the past cointegration analyses on Japanese land prices, this paper is unique in using: (a) the weighted-average land price indicators, and not the official land price indicators; (b) the long-term time series data over 50 years; and (c) the discounted present values of land in line with theoretical formation of land prices.

The conclusions are summarized as follows. First, in many specifications, we find the cointegrating relationships between the real land price indicators and the discounted present values of land calculated by using the real GDP, interest rates, the expected growth rates of the GDP, tax rates, and risk premiums. We also find that the demographic factor has impacts on land prices in many cointegration specifications.

Second, we find that the error-correction models using the identified cointegrating relationship fit the short-run fluctuations of the real land prices very well.

[1] The comprehensive studies on land prices during the bubble period include Bank of Japan (1990), Iwata (1992), Nishimura (1995 a), Yoshikawa (1996, 2004), and Uemura and Sato (2000).

These error-correction models include not only the discounted present values of land, but also bank lending and the changes in the demographic factor. Based on the error-correction model analyses, we identify the following factors contributing the surge in land prices during the mid 1980s: (a) the myopic expectations that the high nominal GDP growth would continue with the low interest rate environment: (b) bank lending; and (c) error terms, which are not explained by the models.

Third, the error-correction models show that the recent turnaround of land price trends is attributable to: (a) the error-correction of the actual land prices to the long-term equilibrium levels of land; (b) the sustainable growth in the GDP with the continued low interest rate environment; and (c) the downward trend in bank lending coming to a halt.

The paper is organized as follows. In section 2, we look into land price indicators in Japan in detail. In section 3, we overview the theory of land price determination. In section 4, we survey previous empirical researches on Japanese land prices. In section 5, we test the cointegrating relationship and estimate the error-correction models. Finally, section 6 provides conclusions and some remarks on the bubbles in land prices.

2. Land Price Indicators in Japan

In this section, we will look into how the official Japanese land prices indicators are constructed and what modifications are needed when analyzing them in comparison with other macro economic indicators. We, then, discuss other important issues for the empirical researches on land prices.

(1) Issues on Construction of Land Price Indicators

Representative land price indicators in Japan are the Urban Land Price Index by the Japan Real Estate Institute and the Published Land Prices by the Ministry of Land, Infrastructure and Transportation. They aggregate annual growth rates of each check points with equal weights. Therefore, the weights are the same in high valued land price areas and low valued land price areas. In the past, large fluctuations had occurred in the high valued land price areas. If we used the official land price indicators, we would underestimate the impact of land price fluctuations for high land price areas such as the Tokyo metropolitan area. While specialists of land price evaluation carefully investigate whether each check point is representative for the area’s land price trend, the number of observation points does not match the relative importance of each point in terms of land values. Therefore, when analyzing land price fluctuations with macro economic indicators such as the GDP and bank lending, it is appropriate to use different weights in aggregating the annual growth rates of each survey point.

To address this weight issue, we calculate the weighted-average land price indicators and use them for this paper's analysis.[2] The weighted-average land price indicators are calculated using the price levels as weights for aggregation of the annual growth rate of each observation point. P_{jt} (j=1…J) is the land price level of time t of the observation point j, and P_t is the aggregate land price index level. Δp_t is the annual growth rate of the aggregate land price index calculated as follows.

$$\Delta p_t = \sum_{j=1}^{J} \frac{P_{j,t-1}}{\sum_{j=1}^{J} P_{j,t-1}} \Delta p_{j,t} \,. \tag{1}$$

The lower case is the natural logarithm multiplied by 100 in percent, and Δ is the difference operator.

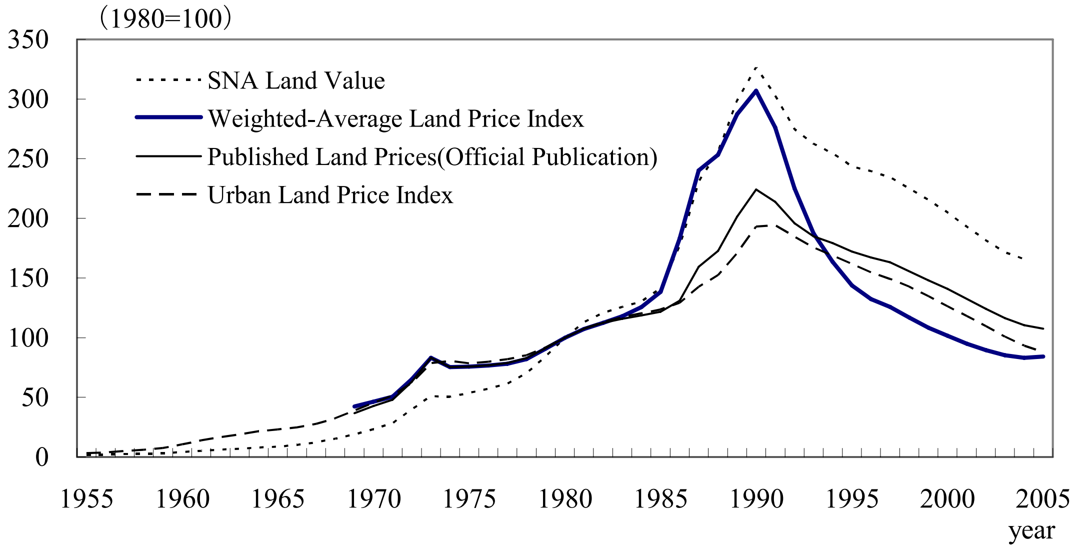
The different weights are used for each year's aggregation, and therefore the weighted-average land price indicators are the chain-weight price indexes. By doing this, we can eliminate the bias coming from simple aggregation in the official land price indicators, and compile the appropriate land price indicators for macro economic analysis.[3] The movements of the weighted-average land price indicators are very much in line with the anecdotal evidences during the bubble period and the fluctuations of the SNA land values (Figure 1).[4] On the other hand, the official land price indicators such as the Urban Land Price Index and Published Land Prices showed a gradual increase during the bubble period, and this suggests that those indicators underestimated the actual surge in land prices at that time.

[2] Details of the weighted-average land price indicators are described in Saita et al. (2004), Bank of Japan (2006). Saita et al. (2004) used the values (=square measures ×unit prices), not prices as weights for aggregation. After checking the developments of square measures of several areas, however, there were some outliers. Therefore, the Bank of Japan (2006) and this paper use prices as the alternative weights as the second best choice. A detailed discussion on this issue is in footnote 5 of Saita et al. (2006).

[3] A detailed discussion on the comparison of the weighted-average land price indicators and other land price indicators is described in appendix 1.

[4] However, the trend of land values of SNA diverged from that of the weighted-average land price indicators since the mid 1990s. Particularly, the divergence is significant in local areas where the weighted-average land prices declined while the land values of the SNA increased during the period. Appendix 1 looks into this issue in detail.

(Figure 1) Long-Term Trends of Land Price Indicators[5]



Sources: Cabinet Office, "National Accounts"; Ministry of Land, Infrastructure and Transportation, "Published Land Prices,"; Japan Real Estate Institute, "Urban Land Price Index."

(2) Issues on Transaction Prices and Evaluation Prices of Land

Real-estate appraisers evaluate the land of the observation points, and their evaluations are used for the Urban Land Price Index and Published Land Price Index. These evaluated prices may differ from the actual transaction prices. In the case of the Published Land Index, real-estate appraisers evaluate land based on either (a) the discounted present value evaluation of the land, or (b) transaction prices nearby the observation points. As Nishimura (1995b) pointed out, this kind of land evaluation is appropriate when land price fluctuations are insignificant. The evaluated prices ,however, tend to underestimate the actual price fluctuations when the actual land prices move by a large margin as was the case in the bubble period. In addition, it is essentially difficult to assert that the transaction prices of land represent the actual trends in land prices since land is not transacted frequently.

This paper will not deal with this issue. In the past, there were some research papers where land price indicators were constructed by using the actual transaction prices. Saita (2003) collected auction prices of land in the Tokyo metropolitan area, and constructed land price indicators with quality adjustments by the hedonic approach. The Ministry of Land, Infrastructure and Transportation collects land transaction data and has started to publish them on its web site. While these are very useful to capture the

[5] The data of Published Land Prices by the Ministry of Land, Infrastructure and Transportation are observed as of January 1 each year. We treat them as year-end data of the previous year.

actual trend of land prices, sufficient amounts of time-series data are not accumulated and therefore, they are not used for the time-series data analysis such as the cointegration analyses.

(3) Issues on Data Frequency

The publication frequency of the official land price indicators is low; the Urban Land Price Index is published semiannually, and the Published Land Prices are published annually lagging a few months behind the observation time. It is, therefore, difficult to capture the actual situation of prices in real time. Only recently, private-sector institutions have started to publish high-frequency data of land prices on a quarterly or even monthly basis with fewer lags.[6] However, these data are not sufficient enough to conduct a time-series data analysis at this point.

This issue may not be problematic for our analysis in this paper. It is possible to interpolate the annual data by using the spline function to match the data frequency of the GDP or other economic data. Such modification of the data, however, will not provide additional information, and the results of the time-series analysis will not be changed by using such an artificial data series.[7]

(4) Issues on Investigation Period

The fluctuation cycle of land prices are longer than those of other economic indicators. In the past 50 years after the World War II, Japan experienced 13 business cycles, while it only has four episodes of land price fluctuations which were in; the early 1960s, early 1970s, late 1970s, and mid 1980s. Existing research on land prices mainly focused on the land price fluctuation in the mid 1980s and in this case only one episode is included in the time-series analysis. Such a treatment is not enough to figure out the stable relationship between land prices and other macro economic indicators.

This paper uses the long-term time series data of land prices in the past 50 years including four episodes of land price fluctuations in Japan. The weighted-average land price indicators are only available after 1970. We use the Urban Land Price data before 1969 and connect them to the weighted-average land price indicators.

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[6] These include "Research on real estate market" by Misawa MRD Inc. and "Residential Land Prices" by Nomura Estate Urban Net Inc.

[7] A more fundamental problem is that we have only a few episodes of land price fluctuations for the last 50 years. We have no way but to only wait for further accumulation of the land price data in the future.

3. Determinants of Land Prices

In Section 3, we overview the theory of land price determination, that is, the discounted present value model of land and look into the determinant factors of land prices. We also check the actual developments of the determinant factors. Furthermore, we consider whether the factors not taken into account in the standard theory of land price determination could have any impacts on land price fluctuations.

(1) Discounted Present Value Model

(Derivation of the Discounted Present Value of Land)

The determinant theory of land prices is the same as that of stock prices; the value of land is equal to the discounted present value of future income streams the land users will have as follows;

$$P_t = \frac{Y_t + E_t P_{t+1}}{1 + r_t}, \tag{2}$$

$$\text{and} \quad r_t = i_t + \tau_t + RP_t, \tag{3}$$

where P_t denotes the land price at period t, P_{t+1} denotes the land price at period t+1, E_t denotes the expectation operator based on the information set at period t, Y_t denotes the income (rent) at period t, r_t denotes the cost of funds at period t, i_t denotes the nominal interest rate at period t, τ_t denotes the tax rate at period t, and RP_t denotes the risk premium at period t.

Solving the above equation forward, we have the following equation.

$$P_t = E_t\left[\sum_{h=0}^{\infty}\left\{\prod_{k=0}^{h}\left(\frac{1}{1+r_{t+k}}\right)\right\}Y_{t+h} + \lim_{h\to\infty}\prod_{k=0}^{h}\left(\frac{1}{1+r_{t+k}}\right)P_{t+h}\right]. \tag{4}$$

In order to exclude the explosive bubble solutions, the second term in equation (4) needs to be zero. Therefore, the land price should be the discounted present value of future incomes shown as follows:

$$P_t = E_t\left[\sum_{h=0}^{\infty}\left\{\prod_{k=0}^{h}\left(\frac{1}{1+r_{t+k}}\right)\right\}Y_{t+h}\right]. \tag{5}$$

Further, we assume; (a) static expectation for future income growth, that is, income will grow at a constant growth rate (g_t^e), and (b) the cost of funds for the future period (r_{t+k}) is the same as the current one ($r_{t+k} = r_t$). Then, the theoretical price of land is simplified as follows;[8]

$$P_t = \frac{Y_t}{r_t - g_t^e}. \tag{6}$$

(Nominal and Real Land Prices)

We did not distinguish the nominal land prices from the real land prices in derivation of the theoretical land prices above. Here, we consider the difference. In equation (6), we assume that both the land price and income are nominal. By dividing both sides of equation (6) by the general price level (Π_t), let the real land price be $p_t = \frac{P_t}{\Pi_t}$, the real income $y_t = \frac{Y_t}{\Pi_t}$. Then we have the following equation (7). As you see, the numerators of the both sides are real, but the denominators of both sides are the same as before.

$$p_t = \frac{y_t}{r_t - g_t^e}. \tag{7}$$

When we conduct the time-series analysis in this paper, we use the real GDP as a proxy of real income ($= y_t$), and the weighted-average land price indicator denominated by the GDP deflator as a proxy of the real land price.

(Interest Rate Gap)

Next, we consider the denominator of equation (7). The Fisher identity shows the following relationship;

$$i_t = q_t + \pi_t^e. \tag{8}$$

Here, q_t denotes the real interest rate, and π_t^e denotes the expected inflation rate. The

[8] In general, expectation for future income growth is strongly affected by the current income growth rate. Such myopic expectation has contributed to the large fluctuations in land prices.

expected growth rate of the nominal income is g_t^e and it is decomposed into the expected growth rate of the real income (f_t^e) and the expected inflation rate (π_t^e) ;

$$g_t^e = f_t^e + \pi_t^e . \tag{9}$$

By using the relationship of equation (8) and (9), then the denominator of equation (7) is arranged as follows;

$$i_t - g_t^e + \tau_t + RP_t = q_t + \pi_t^e - \left(f_t^e + \pi_t^e \right) + \tau_t + RP_t = q_t - f_t^e + \tau_t + RP_t . \tag{10}$$

This means that the nominal discount factor is the same as the real discount factor. The nominal interest rate in the above equations is considered as the average value of the future short-term interest rates, and therefore it is equivalent to the nominal long-term interest rate. Excluding the tax rate and the risk premium, the left-hand side of equation (10) is considered as the "nominal long-term interest rate gap" calculated as the difference between the nominal long-term interest rate and the expected growth rate of nominal income. The right-hand side of equation (10), on the other hand, is the difference between the real long-term interest rate and the expected growth rate of the real income, and can be named as the "real long-term interest rate gap." Equation (10) shows that the "nominal long-term interest rate gap" is equal to the "real long-term interest rate gap."[9]

(2) Developments of Factors of the Discounted Present Value Model

In this subsection, we look into the developments of determinant factors of the discounted present value of land.

(Real GDP and Real Land Prices)

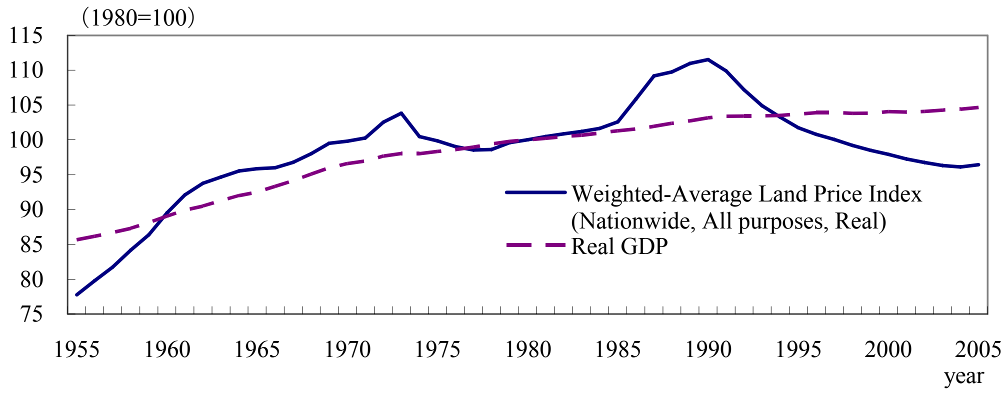
The numerator of the discounted present value model is the real income obtained from the land owned. When analyzing land prices in terms of the macro economy, the real GDP is used as a proxy of real income. This is because the appropriate indicators of real income from land are not available. This is appropriate when we assume that the income share of land users is constant over time.

[9] We assume that the term structure of future inflation expectations reflected in the long-term nominal interest rate is the same as that reflected in the expected growth rate of the nominal income.

The long-term time series data of the real GDP and real land prices show the following developments. The growth rates of real land prices are much higher than those of the real GDP until the first half of the 1970s when Japan experienced exceptionally high growth and the Plan for Remodeling the Japanese Archipelago was implemented. In the mid 1970s, real land prices declined to the same level of the real GDP and both increased moderately until the first half of the 1980s. During the bubble period since the mid 1980s, real land prices surged much faster than the real GDP. After the burst of the bubble in the early 1990s, real land prices started to decline while the real GDP grew steadily. In the mid 1990s, real land prices declined to the same level as the real GDP. Real land prices, however, continued to decline after that.

This paper analyzes not only the nationwide land prices, but also the regional land prices. Therefore, we use the real income data of prefectures in addition to the nationwide real GDP data.[10]

(Figure 2) Real GDP and Real Land Price Indicator[11]



Sources: Cabinet Office, “National Accounts”; Ministry of Land, Infrastructure and Transportation, “Published Land Prices.”

(Interest Rate Gap)

Figure 3 shows the nominal interest rate gap, which is the difference between the nominal long-term interest rate[12] and the expected growth rate of the nominal GDP.[13]

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[10] We do not estimate the factor income for each usage of land since such an estimate is difficult. Therefore, the parameters of the cointegrating regressions show the degree of the elasticity of real land prices to the overall real income of the region or nationwide. Since the prefecture income data are available until fiscal 2003, we estimate the income data of 2004 and 2005 by using effective job offers data.

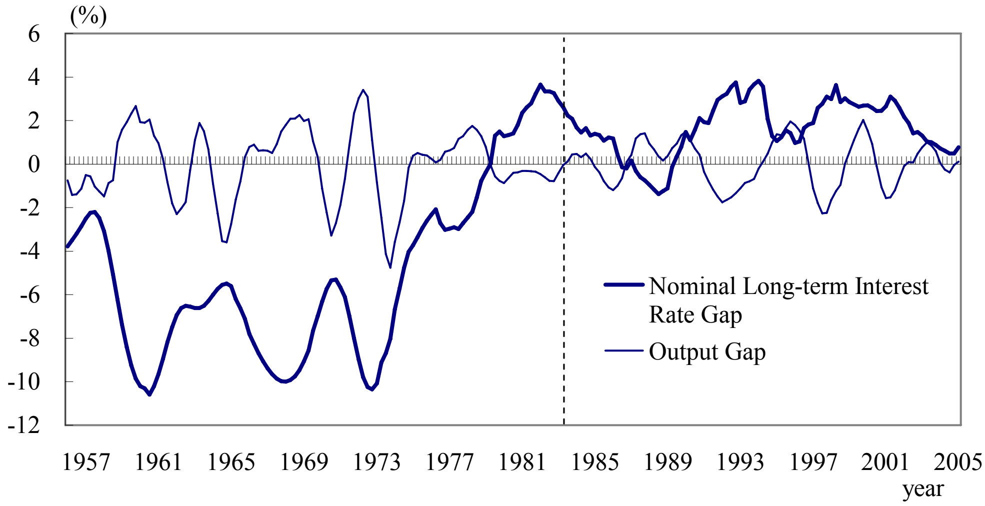
[11] The real GDP and the real land price indicator are in the natural logarithm.

[12] The long-term prime rate of bank lending is used.

[13] The expected growth rate of the nominal GDP is the growth rate of the quarterly nominal GDP

The nominal interest gap has an obvious inverse correlation with the output gap; when the nominal interest gap increases, the output gap declines (Figure 3).

(Figure 3) Nominal Interest Rate Gap and Output Gap



Such a relationship, however, has been observed only after the Japanese financial market was liberalized in the early 1980s. Before the early 1980s, the Japanese financial market was heavily regulated and interest rates were controlled by the authorities. Therefore, the demand-supply conditions of the economy were not reflected in the movements in the nominal long-term interest rates. The data shows that (a) the levels of the long-term interest rate gap before the early 1980s are different from those after the mid 1980s, and (b) the cyclical movements of the nominal long-term interest rate gap before the liberalization of the financial market are much larger than those after the liberalization. In this paper, we estimate the nominal long-term interest rate gap consistent with the economic development during the regulation and use it for calculation of the discounted present value of land.[14]

(Tax Rate and Land Prices)

Since various taxes are levied on possessions and transactions of land, the changes in the tax system have affected land prices. This paper explicitly takes into account the impact of tax rate changes of land possessions since they can be easily estimated.

There are three taxes: (a) municipal property tax; (b) city planning tax; and (c) land price tax. The land price tax was introduced in 1991 to curb the surge in land prices.

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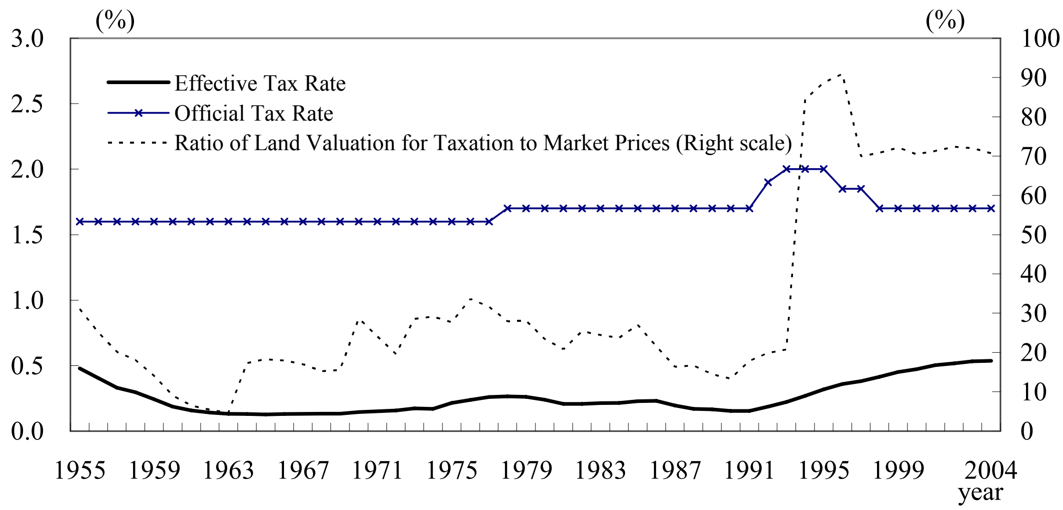
filtered by Hodrick-Prescott filter ($\lambda=100$). Usually, $\lambda=1{,}600$ is chosen for quarterly data. We, however, find that the survey data ("Survey on Corporate Activities" by the Cabinet Office) show that the filtered series of $\lambda=100$ match with the expected growth rates of nominal income.

[14] Appendix 2 shows how to estimate the nominal long-term interest rate gap.

It, however, was suspended in 1998 since land prices continued to decline. On the other hand, the official tax rates of property tax and city planning tax have been constant since 1978. The official evaluation rates[15] of land for the property tax were around 20 percent of the market prices until the early 1990s. Therefore, the effective tax rates of land possessions were stable, about 0.5 percent of the market prices. Since there was a strong view that the large difference between the tax base of land and market prices should be narrowed, the authorities amended the tax code in 1993 to raise the tax base so as to match market prices. The increase in the tax base of land led to the hike in the effective tax rate of land holding and induced a further decline in land prices (Figure 4). Municipal governments, however, had introduced measures to alleviate such an abrupt hike in the effective tax rates such as special tax exemptions. Thanks to these measures, the actual increase in the effective tax rates was fairly moderate. The effective tax rate of land holding based on the actual tax amount increased moderately since 1991. We use the effective tax rate based on the actual tax amount paid by tax payers when we calculate the discounted present value of land.[16,17]

(Figure 4) Land Tax Rates



Sources: Ministry of Internal Affairs and Communications, “Records of Property Prices,” “Reference on Municipal Taxes”; Cabinet Office, “National Accounts.”

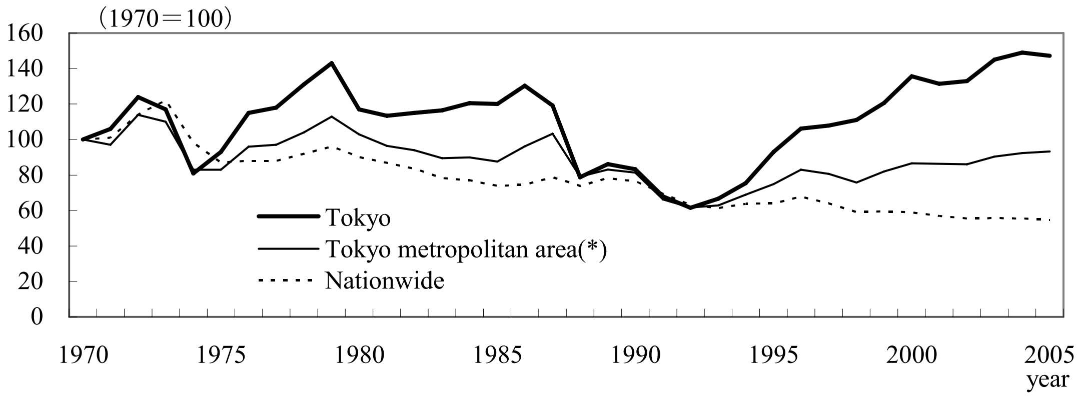
The impacts of tax rate changes of land transactions, such as transfers, acquisitions, and inheritances, are difficult to measure since the actual tax amounts vary

[15] It is the share of the official evaluation value of land to the current market value of land.
[16] The effective tax rates are available until fiscal 2004. We assume that the effective tax rate is the same in 2005 and use it for the present value calculation.
[17] Mera et al. (1992) describes the role of land holding tax on land prices in detail.

due to; (a) the difference in the transaction amounts and capital gains, and (b) the different tax rates and tax deductions calculated together with the other incomes. This paper, therefore, gives up estimating the impacts of those transaction tax rates on land prices. The estimation residuals are assumed to contain such impacts.

We, however, could make qualitative assessments of the impacts of the land transaction tax rates as follows. First, it is suggested that the income tax rate on capital gain of land transactions induced a delay in sales of lands since the tax rate on the short-term holdings of lands was higher than that of long-term holdings. This effect, the so called "lock-in effect," was particularly strong during the bubble period since many land owners expected a further surge in land prices and larger capital gains. This led to a further tightening of the land market, a decline in land sales, and an increase in land demand, as evidenced in the transaction numbers declining during the bubble period especially in the Tokyo metropolitan area (Figure 5).

(Figure 5) Number of Land Transactions



Note(*): Tokyo metropolitan area includes Tokyo, Kanagawa, Chiba and Saitama.

Source: Ministry of Justice, "Monthly Report."

Second, the inheritance motivation increased land demand during the bubble period. The effective tax rate of inheritance of land is lower than that of financial assets, and such a tendency became stronger during the bubble period since the market prices of land were much higher than the evaluation prices. The turnaround of land prices inversely affected land prices. Such impacts will be captured in the fluctuations of estimated residuals.

(Risk Premiums)

Next, we consider risk premiums. It is assumed that the risk premium in the long term is constant, while the risk premium in the short term fluctuates sharply reflecting investors' risk tolerance. In this paper, we assume that the risk premium is constant and the constant risk premium is used for calculating the discounted present value of land. When we use such a discounted present value of land and estimate land prices, the residuals should contain the variable part of the risk premium fluctuating in the short term. If the variable risk premium moves procyclically with business cycles, land prices move much more than the discounted present value of land.

We use the constant risk premium of six percent in this paper based on past studies. Using actual land price data, Fujiwara and Shinke (2003) estimated the variable risk premium, which fluctuates from about one to seven percent, and on average about six percent. Their estimation result of six percent is consistent with our assumption in this paper. The risk premium of six percent is also consistent to the risk premium observed in the stock market in the United States[18] (Kocherlakota (1996)).

(3) Other Factors Affecting Land Prices

Based on the discounted present value model, land prices are determined by the income level, the expected growth of future income, interest rates, tax rates, and risk premiums. There are, however, other factors affecting land prices. In this subsection, we review such factors; i.e. demographics, industrial structure, bank lending, and motive for a store of value.

(Demographics and Land Prices)

How does the demographic factor affect land prices? The simplest idea is that, if the country's territory is constant, the increase in population leads to the rise in demand for land. If a particular cohort of the population has a preference for land and residential assets, then the changes in the demographic structure, not necessarily coinciding with that in the total population, can change the demand for land. A survey shows that the acquisition of land and houses is only limited to the cohort from ages 15 to 65 years old, and in the cohort of population aged over 65 years old, the share of land and house holding remains unchanged (Figure 6).[19]

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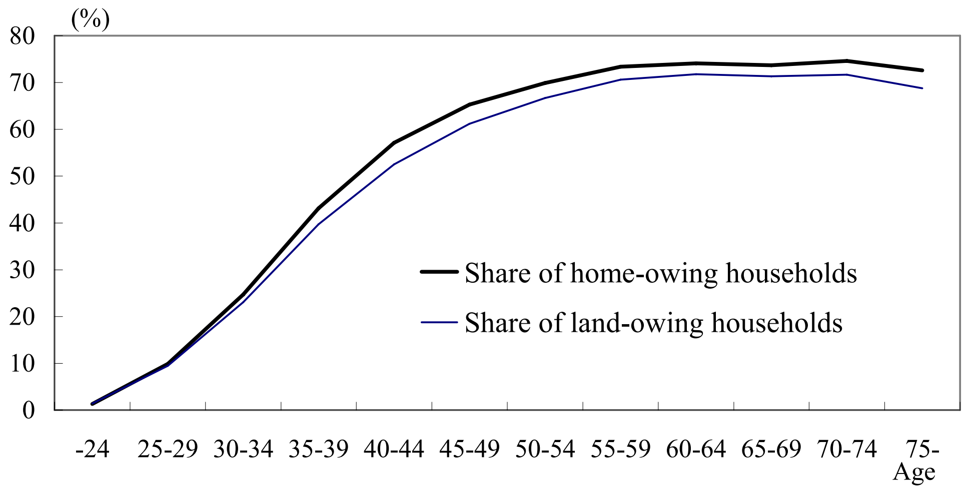
[18] It is difficult to judge whether the risk premium of land is higher or not than that of stocks. In terms of liquidity and transaction costs, stocks are assumed to have lower risk premiums. In Japan, however, land has been long been indentified to be a superior asset than stocks, and in this regard stocks are not necessarily advantageous assets, and therefore the risk premium of stocks may or may not be higher than that of land.

[19] This does not necessarily mean that population aged over 65 years old never purchase land and houses. In fact, there is a trend that these people, who used to live in the suburban areas around the Tokyo metropolitan area, are now moving into the downtown area by selling their own houses in the

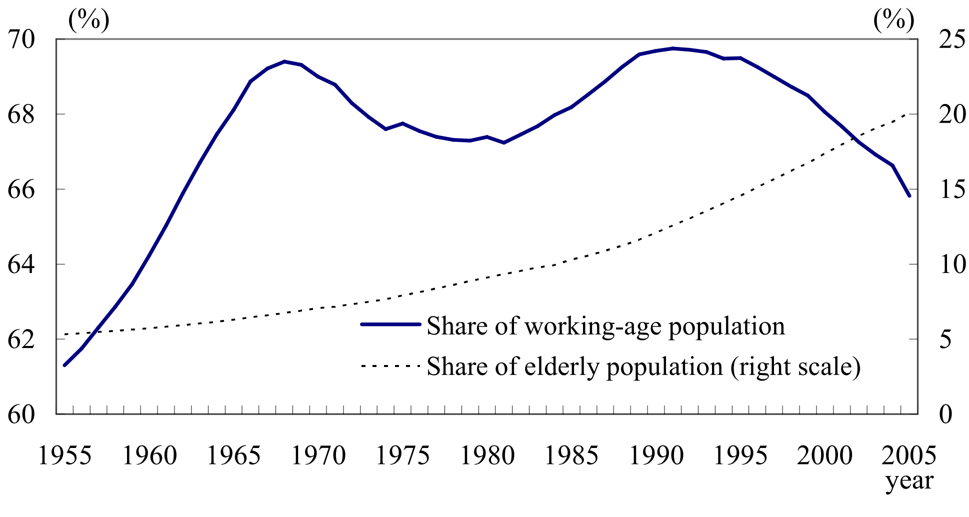
(Figure 6) Share of House and Land Owners (2003)



Source: Ministry of Internal Affairs and Communications, "Housing and Land Survey, 2003."

Demand for houses and land are high, when the share of the population aged 15 -64 is high (Figure 7). Even for commercial real estate properties, there are some concerns for the future deterioration of the market condition due to the aging population.

(Figure 7) Population Share: Aged 15-64 and Over 65



Sources: Ministry of Internal Affairs and Communications, "Population Estimates," "Report on Internal Migration in Japan."

Demand for land comes from demand for services of land-use. Based on the

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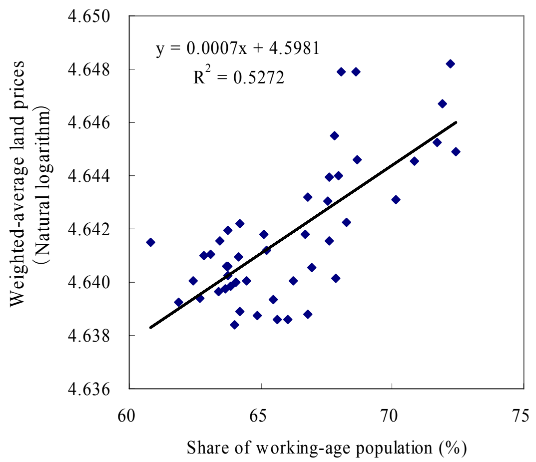
suburban areas.

theory of land price determination, this means that the increase in demand for land-use leads to the increase in rent, the numerator of the discounted present value equation. If the rent is accurately measured and is reflected in the land prices, the changes in the demographic structure should be reflected only through the changes in rent.

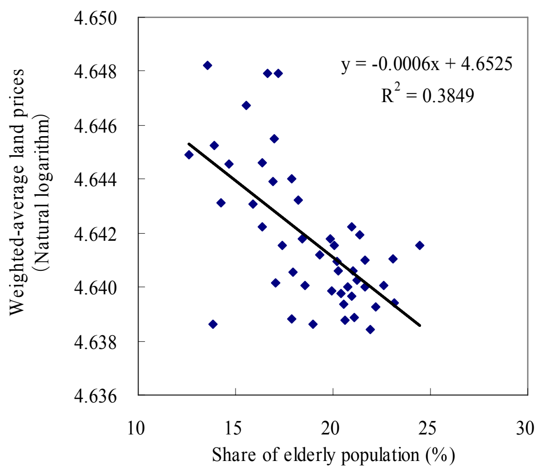
Usually, the GDP is used for a proxy for rent when analyzing land prices in terms of macro economic analysis. As mentioned earlier, the income distribution share of land to GDP is assumed to be constant over time. The GDP, however, changes due not only to the changes in demand for land, but also to other factors. Therefore, when we analyze land prices using the GDP as a proxy for rent, we may not capture the changes in demand for land due to the demographic changes. In this regard, we need to consider the possibility that the demographic changes may have impacts on land prices not through the changes in the GDP. Furthermore, since the supply of land is inelastic in a short-term period, the surge in demand for land in a short time period tends to lead to an abrupt increase in land prices. Taking this possibility into account, we conduct a quantitative analysis including the demographic factor.

The municipal data show that (a) there is a positive correlation between the share of the population aged 15-64 and land prices, and (b) there is a negative correlation between the population aged over 65 and land prices (Figures 8 and 9).

(Figure 8) Population Aged 15-64 and Land Prices

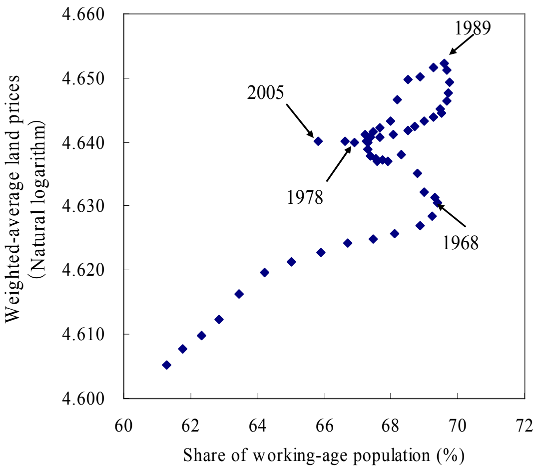


(Figure 9) Population Aged over 65 and Land Prices

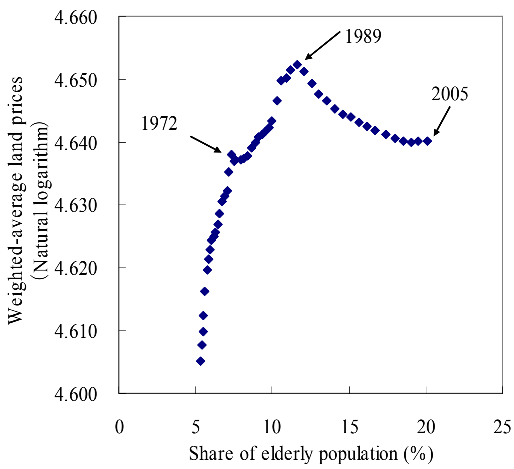


Time series data show that (a) there is a positive correlation between the population aged 15-64 and land prices (Figure 10), and (b) the pace of increase in land prices tends to be slower as the share of the elderly population rises (Figure 11).

(Figure 10) Share of Population Aged 15-64 and Land Prices



(Figure 11) Share of Population Aged over 65



In this paper, we use the share of people aged 15-64 to the total population as a proxy for the demographic factor when we conduct quantitative analysis since the correlation between them seems to be most robust.[20]

Mankiw and Weil (1988) initiated the analysis on the relationship between property prices and the demographic factor. They estimated the demand for housing of each age cohort and conducted a quantitative analysis on whether the changes in demographics had impacts on housing prices. They found that the share of the population aged 15-64 was an important determinant of housing prices, and predicted that housing prices would decrease due to the declining share of the cohort in the 1990s. Contrary to their prediction, housing prices during the 1990s soared in the United States. Martin (2005) analyzed housing prices by the general equilibrium framework, and found that the declines in the long-term interest rate during the 1990s had contributed to the increase in housing prices. Otake and Shintani (1996) analyzed housing prices in Japan using the same research strategy as Mankiw and Weil (1988). They found that the demographic factor had impacts on housing prices in the short run, but not in the long run due to the flexible supply of housing. Iwata and Hattori (2003), on the other hand, claimed that the aging population had an impact on the land value to GDP ratio since the workforce population declines and the time preference of households increases based on the basic growth model analysis.

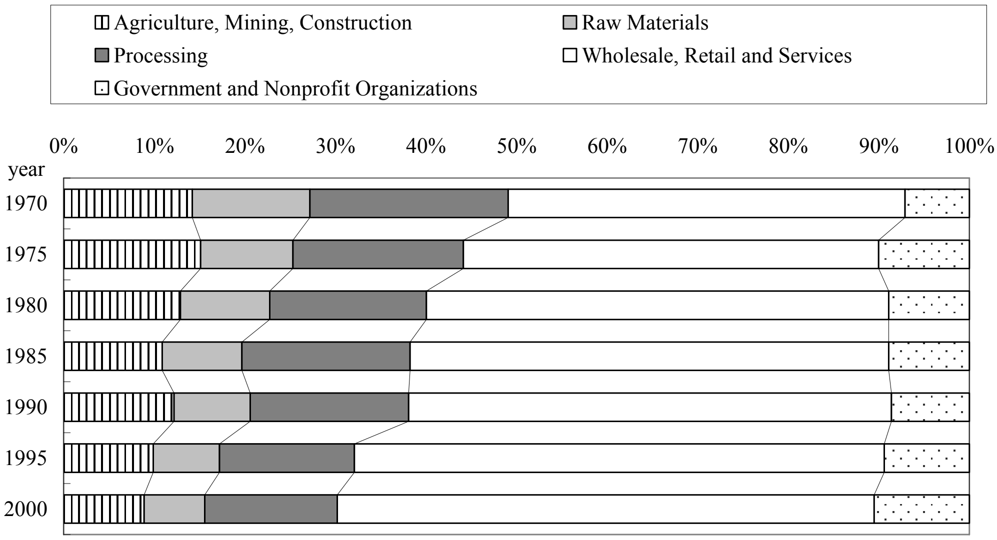
[20] The share of the population aged over 65 shows the trend increase (Figure 7). The cointegration analysis later in this paper includes equations with the trend term, which may capture the impact of the increase in the elderly people. The trend term, however, may reflect other structural changes such as the increase in land supply and the change in the industrial structure.

As shown above, research results vary on whether the change in demographics has impacts on property prices such as land and housing prices. In this paper, we will conduct a quantitative analysis with and without the demographic factor in the cointegration analysis and include the demographic changes in the error-correction analysis.

(Changes in Industrial Structure and Land Demand)

Next, we consider the changes in the industrial structure of Japan and their impacts on land demand. After World War II, Japan started rebuilding its economy from heavy industry such as steel and chemical industries. Then, the machinery industry increased its share in Japan. Later, the service industry has become the major industry in Japan (Chart 12).

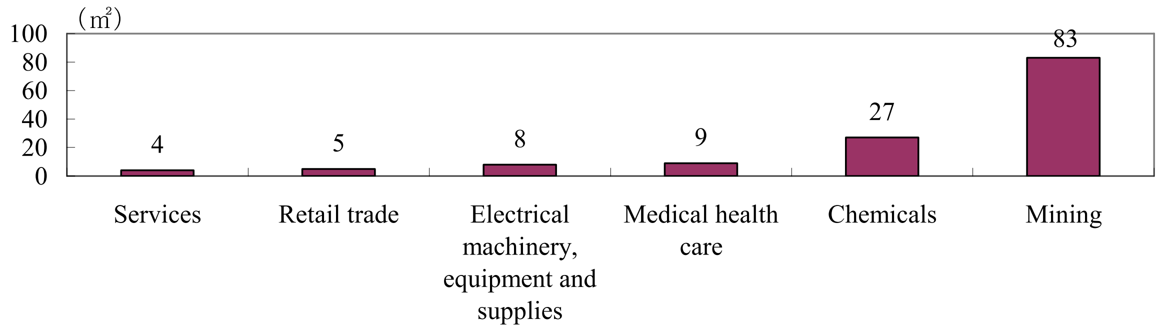
(Figure 12) Changes in Industrial Structure



Source: Ministry of Land, Infrastructure and Transportation, “White Paper on Land, 2006.”

Such structural changes in industries may have had impacts on land demand. The required land area producing value added of one million yen is 83 ㎡ for the steel industry, but is only 5 ㎡ for the retail and service industries (Figure 13).

(Figure 13) Required Land per One Million Yen of Value Added



Sources: Ministry of Land, Infrastructure and Transportation, "Survey on Land Purchases by Firms"; Ministry of Finance, "Financial Statements Statistics of Corporations by Industry, FY2003, 2004."

The increasing share of the service industry in the Japanese economy has possibly induced the declining trend in land demand. Therefore, this change may have exerted downward pressure on land prices in Japan. Such an impact will be captured by the trend term in the cointegration analysis. Furthermore, many manufacturing firms have been actively investing in overseas with the backdrop of globalization. Such a trend may have a negative impact on land prices in Japan.

(Bank Lending and Changes in Land Prices)

It has been pointed out that there is a close correlation between bank lending and land prices in addition to the impact through the interest rate channel. It is conceivable that (a) the changes in land prices cause the changes in bank lending, and (b) bank lending provokes the changes in land prices. With regard to (a), the changes in land prices cause the changes in the collateral value of bank lending, leading to the fluctuations in bank lending[21]. With regard to (b), banks provide financing to firms, which are actively engaged in speculative land transactions, encouraging further fluctuations in land prices. In the real world, both mechanisms work. It would be appropriate, however, to consider that such an impact may not have long-term impacts on land prices. As seen before, the theoretical value of land is determined by income levels, interest rates, and the demographic factor together with tax rates and risk premiums. In this regard, bank

[21] Firms will possibly make more investments when they feel that financing conditions become accommodative as collateral values increase with the surge in land prices. The mechanism, however, implies that the declines in land prices will put further downward pressure on the economy when the economy is in a recession. Changes in the collateral value of land, therefore, can destabilize the economy. Kiyotaki and Moore (1997) analyzed this mechanism with the general equilibrium framework and called this mechanism "financial accelerator."

lending is not supposed to be a factor to have impacts on land prices in the long-term period. In the following quantitative analysis, we exclude bank lending in the cointegration analysis, but include it in the error-correction analysis for the short-run fluctuation.[22]

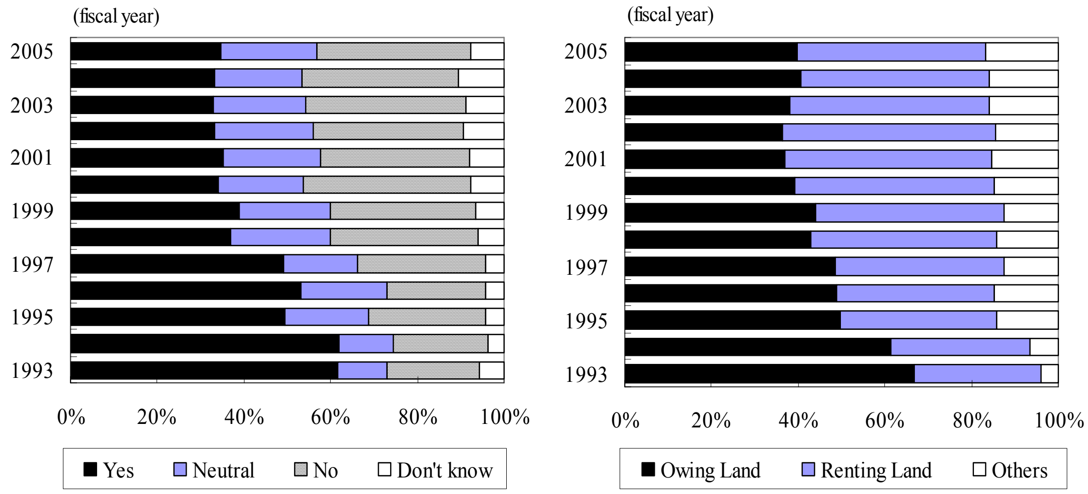
(Land Demand as Store of Value)

The notion that land prices should be determined based on their discounted present value of land comes from the idea that the fundamental value of land is future rents. The benefit that the land owners have by holding land is equivalent to what they would have by renting land. This means that there is no unique benefit by holding land. However, there may be demand for land as a store of value, which does not necessarily correspond to the value of using lands. In 1993, a survey on households shows that more than 60 percent of households regard land to be a more favorable asset than financial assets such as deposits and stocks (Figure 14(1)). In addition, firms also think that holding land is more advantageous than renting land (Figure 14 (2)).

(Figure 14) Attitude toward Land-holding

(1) Is land a more advantageous asset than deposits and stocks? (Households)

(2) Is holding land more advantageous than renting land? (Corporations)



Sources: Ministry of Land, Infrastructure and Transportation, “White Paper on Land, 2006,” “Survey of land ownership and usage by corporations, 2005.”

[22] The later analysis shows, however, that commercial land in the local areas is affected by bank lending even in the long-term period.

The share of which land is more advantageous declined as land prices decreased and recorded its lowest level in fiscal 2002 and 2003. The share, however, reversed when the trend in land prices changed recently. Such demand for land as a store of value cannot be captured by the original land price determination theory, and therefore this may be obtained in the estimated residuals.

4. Literature on Empirical Research on Japanese Land Prices

In this section, we review the previous empirical analysis on Japanese land prices. This paper is unique with the following features: (a) data used for the cointegration analysis; (b) specifications of estimation models and explanatory variables; (c) critical values of cointegration tests; and (d) specifications of error-correction models.

First, this paper uses the different land price data comparing the previous empirical analyses. The previous empirical studies such as Idee (1992), Yoshioka (2002), and Imagawa (2002) used the Urban Land Price Indexes as the macro land price indicators. As described in detail in section 2, the Urban Land Price Indexes may not be appropriate land price indicators since they are the simple sum average of the changes in land prices, and therefore they tend to underestimate the actual fluctuations of land prices. The weighted-average land price indicators used in this paper correct such a bias and reflect the actual large fluctuations in land prices.

Second, this paper is unique in specifications of the estimation of the cointegrating regressions and the explanatory variables. The previous studies such as Idee (1992) used the estimation equation (11) as follows. This specification is different from the original theoretical land price specification in that (a) the elasticity of land prices to the real GDP is different from that to the real interest rate, and (b) equation (11) does not take into account the expected growth of future income.

$$p_t = \beta_0 + \beta_1 y_t + \beta_2 r_t \,, \tag{11}$$

where p_t denotes the real land price in the natural logarithm, y_t denotes the real GDP in the natural logarithm, and r_t is the real interest rate.

This paper calculates the discounted present values of land first, and then estimates the cointegrating relationship between them to the real land prices in line with the original theoretical specification of land prices. Yoshioka (2002) and Imagawa (2002) calculate the "fundamental value," which is the real GDP denominated by real interest rate. While this specification is fine with respect to (a), it does not include the expected growth rate of income[23]. It would be better to include both interest rates and the expected growth rate of income for calculation of the fundamental values of land.

There is another problem in choosing interest rates. Before the liberalization of the financial market in the early 1980s, previous studies used the observed interest rates when calculating the discounted present values of land. Such a calculation, however, is problematic since the observed interest rates did not reflect market conditions and economic fundamentals. In order to evaluate asset prices such as of land at that time, it is necessary to estimate the interest rates, which would have realized if the financial market had been liberalized.

Third, we use the appropriate critical values for cointegrating tests. Idee (1992), for example, used -2.6 as ten percent critical value for the ADF test. It is necessary, however, to use the critical values provided by MacKinnon (1991) when the cointegrating vectors are unknown, taking into account (a) the numbers of estimated variables, (b) total observations, and (c) inclusion/exclusion of the trend term[24]. Imagawa (2002) used the critical value of 15 percent for cointegration tests, which is rather high.

Fourth, we have the different error-correction model specifications. For example, Idee (1992) included the level of real interest rates both in the cointegrating equations and the error-correction equations. If the interest rates are included in the cointegrating regression in the level, the first difference in the interest rates should be included in the corresponding error-correction models. The parameter on the interest rate in the error-correction model is positive, implying that the rise in interest rates leads to the increase in land prices. This mechanism is contrary to the original theory of land price determination and the results of the cointegration analysis.

Housing prices, rather than land prices, are investigated in the cointegration analyses of the United States. While Capozza, Hendershott, Mack, and Mayer (2002), and Meen (2002) concluded that there were cointegrating relationships between housing prices and economic fundamentals indicators, Gallin (2003) claimed that there were no cointegrating relationships.

Other than cointegration analyses, there were several empirical analyses on the changes in land prices. For example, Nishimura (1995a) used the year-on-year changes in the Urban Land Price Indexes as dependent variables and the differences in the real GDP growth and changes in real interest rates as independent variables. He estimated

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[23] Both Yoshioka (2002) and Imagawa (2002) used nominal rather than real indicators.
[24] We used the program for calculation of the critical values and p-values provided by Professor MacKinnon on his web site (http://qed.econ.queesu.ca/faculty/mackinnon/).

the equations by ordinary least square, and claimed that, while the fits before 1984 were very good, the fits of the equations deteriorated considerably once including the data after 1985. Based on the results, he claimed that there were bubbles in land prices after 1985. The specifications of Nishimura (1995a) are rather ad hoc in terms of the theoretical foundation of land prices. Based on the theory of land price determination, the levels of land prices are explained by the real income level divided by the difference between the expected growth rate of income and interest rates as suggested by equation (7). Alternatively, taking natural logarithm of equation (7) and the difference from the previous period, the year-on-year growth rate in land prices can be explained by the growth rate of income and the change in the natural logarithm of the difference between the expected growth rate of real income and real interest rates. If cointegrating relationships are detected, inclusion of such relationships would improve the efficiency of estimation as an error-correction term. Based on previous studies as mentioned, this paper uses the estimation specifications in line with the original theory of land price determination.

5. Cointegration and Error-Correction Analysis

(1) Unit Root Tests

First, we will check the results of unit root tests for real land prices. The null hypothesis of the existence of unit roots for the indicators' levels of any purposes and any regions were not rejected at the 5 percent significance level (Table 1).

(Table 1) Results of Unit Root Tests

(1) Real Land Prices

		Nationwide			Six Large City Areas			Local Areas		
All	Level	-2.25	<0.455>		-2.85	<0.189>		-2.32	<0.418>	
	1^{st}difference	-2.95	<0.004>	***	-2.63	<0.010>	***	-3.00	<0.003>	***
Residential	Level	-2.00	<0.588>		-2.58	<0.289>		-2.14	<0.514>	
	1^{st}difference	-3.61	<0.009>	***	-3.18	<0.027>	**	-3.34	<0.001>	***
Commercial	Level	-2.38	<0.385>		-2.86	<0.184>		-2.09	<0.541>	
	1^{st}difference	-2.63	<0.010>	***	-2.46	<0.015>	**	-2.74	<0.007>	***
Industrial	Level	-2.59	<0.286>		-3.24	<0.090>	*	-2.85	<0.189>	
	1^{st}difference	-3.05	<0.003>	***	-2.84	<0.006>	***	-2.82	<0.006>	***

(2) Discounted Present Values of Land

	Nationwide			Six Large City Areas			Local Areas		
Level	-1.54	<0.799>		-1.62	<0.767>		-1.74	<0.719>	
1st difference	-4.94	<0.000>	***	-5.03	<0.001>	***	-3.82	<0.005>	***

(3) Share of Working-Age Population to the Total Population

	Nationwide			Six Large City Areas			Local Areas		
Level	-1.74	<0.715>		-4.94	<0.001>	***	-3.03	<0.136>	
1st difference	-3.42	<0.016>	**	-3.94	<0.004>	***	-3.93	<0.019>	**

(4) Share of Bank Lending to the Nominal GDP

	Nationwide			Six Large City Areas			Local Areas		
Level	-1.77	<0.704>		-2.20	<0.477>		-1.37	<0.859>	
1st difference	-5.02	<0.001>	***	-5.16	<0.001>	***	-5.61	<0.000>	***

(Note 1) ADF τ -values are reported above. The values in < > are p-values.

(Note 2) *, **, and *** respectively indicates a rejection of the null hypothesis with 10%, 5%, and 1% significance level.

The unit root tests for the first difference of any indicators suggest that the null hypotheses of the existence of unit roots were rejected at most 5 percent level. Therefore, the real land price indicators are I(1).[25][26]

The unit root tests for the discounted present values of land are conducted. The discounted present values of land (NPV_t) are calculated using the following equation (12)[27]. As mentioned before, if we assume that the expected inflation rates are the same in both the nominal long-term interest rates and the expected growth rate of nominal income, then the nominal long-term interest rate gaps are the same as the real long-term interest rate gaps. We, therefore, construct the nominal long-term interest rate gap using the nominal long-term interest rates and the expected growth rate of nominal income;

$$NPV_t = \frac{y_t}{i_t - g_t^e + \tau_t + RP}, \tag{12}$$

where y_t denotes the real GDP, i_t denotes the nominal long-term interest rate, g_t^e denotes the expected growth rate of nominal income, τ_t denotes the tax rate, and RP denotes the risk premium (= 6 percent).

25 The six large city areas includes prefectures including the six large cities (Tokyo, Yokohama, Nagoya, Kyoto, Osaka, and Kobe) in Japan; Tokyo, Kanagawa, Aichi, Kyoto, Osaka, Hyogo. The local areas includes all the other prefectures.

26 We conducted the Dickey-Fuller GLS tests for all indicators and had similar results.

27 For the unit root and cointegration tests, we used three-year moving average of NPV.

The unit root tests for the discounted present values of land indicate that these indicators are I(1). We also have the similar results for other indicators of I(1).

(2) Specifications of the Cointegrating Regressions

We assume the following four specifications of the cointegrating relationship. The simplest one is that the real land prices are regressed by the discounted present values of land, constant term and the trend term. In this specification, the trend term can represent the structural decline in demand for lands due to the changes in the economic structure, particularly the steady increase of the service industry, and increasing share of the elderly population, and/or the gradual increase in land supply.

Specification 1 assumes that there is one-to-one relationship between real land prices and the discounted present value of land.

(Specification 1)

$$p_t = \beta_0 + \beta_1 Trend_t + NPV_t + e_t, \tag{13}$$

where p_t denotes the real land price in the natural logarithm, NPV_t denotes the discounted present value of land in the natural logarithm, $Trend_t$ denotes the trend term, e_t denotes the estimation residuals.

Specification 2 assumes the one-to-one relationship between real land prices and the discounted present value of land as in specification 1. Furthermore, specification 2 includes the demographic factor, which is the share of working-age population to the total population, assuming that it would have an independent influence on land prices besides the discounted present value of land.

(Specification 2)

$$p_t = \beta_0 + \beta_1 Trend_t + NPV_t + \beta_2 pop_t + e_t, \tag{14}$$

where p_t denotes the real land prices in the natural logarithm, $Trend_t$ denotes the trend term, NPV_t denotes the discounted present value of land in the natural logarithm, pop_t denotes the share of working-age population to the total population in the natural logarithm, and e_t denotes the estimation residuals.

Specification 3 relaxes the restriction on the coefficient of the discounted present value of land of one. The coefficients are estimated by OLS using equation (15) as follows.

(Specification 3)

$$p_t = \beta_0 + \beta_1 Trend_t + \beta_2 NPV_t + e_t \tag{15}$$

Finally, specification 4 assumes that the coefficients of the discounted present value of land are estimated by OLS and includes the demographic factor.

(Specification 4)

$$p_t = \beta_0 + \beta_1 Trend_t + \beta_2 NPV_t + \beta_3 pop_t + e_t \tag{16}$$

(3) Critical Values of the Cointegration Tests

We use the Engle-Granger (1987) method for cointegration tests, that is, first we estimate the above equations (13), (14), (15), and (16), and then conduct the unit root tests for estimation residuals ($\hat{e}_t$).[28] It is not appropriate, however, to use the critical values for one-variable unit root test. In this regard, we use critical values for cointegration tests proposed by MacKinnon (1991), taking into account; (a) sample size, (b) numbers of cointegrating vectors, and (c) existence of the constant and trend terms. It is rare to have large sample size more than 100 observations for macro economic indicators. Therefore, we need to use the critical values with small sample proprieties as MacKinnon (1991) provided.

For specification 1 and 2, we conduct the cointegration tests as follows.

(a) Calculate the series $x_t = p_t - NPV_t$, the difference between the real land prices and the discounted present value of land.
(b) For specification 1, conduct the usual unit root test for x_t with the constant and trend terms.
(c) For specification 2, estimate the cointegrating regression with x_t as a dependent variable and the demographic factor, the constant term and the trend term as independent variables. Use the estimated residuals for the cointegration tests with the appropriate critical values provided by MacKinnon (1991).

[28] The cointegration test proposed by Johansen (1988) is also popular. Johansen (1988) assumes that all of the cointegrating vectors are endogenous variables. For the analysis on land prices, the discounted present values of land and changes in demographics are supposed to be exogenous to land price fluctuations, therefore we use the Engle-Granger procedure here.

(4) Results of Cointegration Tests

The results of the cointegration tests are reported as follows.

(Nationwide)

(Table 2) Results of Cointegration Tests

		(1)All				(2)Residential			
		Specification 1	Specification 2	Specification 3	Specification 4	Specification 1	Specification 2	Specification 3	Specification 4
ADF(t-value)		**-2.69**	**-3.38**	**-3.52**	**-3.45**	**-2.80**	**-3.93**	**-4.00**	**-5.05**
p-value		0.245	0.163	0.127	0.263	0.204	0.056	0.048	0.011
Critical Value	1%	-4.171	-4.665	-4.665	-5.074	-4.171	-4.665	-4.665	-5.074
	5%	-3.511	-3.984	-3.984	-4.375	-3.511	-3.984	-3.984	-4.375
	10%	-3.186	-3.648	-3.648	-4.028	-3.186	-3.648	-3.648	-4.028

		(3)Commercial				(4)Industrial			
		Specification 1	Specification 2	Specification 3	Specification 4	Specification 1	Specification 2	Specification 3	Specification 4
ADF(t-value)		**-2.43**	**-2.97**	**-3.25**	**-3.14**	**-4.35**	**-4.32**	**-4.66**	**-5.71**
p-value		0.360	0.311	0.204	0.396	0.006	0.023	0.010	0.002
Critical Value	1%	-4.171	-4.665	-4.665	-5.074	-4.171	-4.665	-4.665	-5.074
	5%	-3.511	-3.984	-3.984	-4.375	-3.511	-3.984	-3.984	-4.375
	10%	-3.186	-3.648	-3.648	-4.028	-3.186	-3.648	-3.648	-4.028

(Note) Shaded figures indicate that the null hypotheses are rejected with the associated critical values.

The null hypotheses of no cointegration are not rejected for nationwide-commercial land with at most 10 percent level of significance. This result suggests that the land price determination of the local areas, particularly commercial lands, is different from those of other regions and usages. For residential lands, the null hypothesis was rejected at 5 percent level in the specification 3 and 4. For industrial lands, the null hypotheses are rejected at 1 percent level in the specification 1, and 5 percent level in the specification 2, 3 and 4.

(Six Large City Areas)

Next, we conduct the cointegration analyses for the regional data with four specifications as in nationwide. The results for the six large city areas are as follows (Table 3).

(Table 3) Results of Cointegration Tests for the Six Large City Areas

		(1)All				(2)Residential			
		Specification 1	Specification 2	Specification 3	Specification 4	Specification 1	Specification 2	Specification 3	Specification 4
ADF(t-value)		**-3.778**	**-4.058**	**-5.060**	**-5.671**	**-3.432**	**-3.664**	**-4.634**	**-4.665**
p-value		0.026	0.043	0.004	0.002	0.059	0.097	0.011	0.026
Critical Value	1%	-4.158	-4.665	-4.665	-5.074	-4.158	-4.665	-4.665	-5.074
	5%	-3.504	-3.984	-3.984	-4.375	-3.504	-3.984	-3.984	-4.375
	10%	-3.182	-3.648	-3.648	-4.028	-3.182	-3.648	-3.648	-4.028

		(3)Commercial				(4)Industrial			
		Specification 1	Specification 2	Specification 3	Specification 4	Specification 1	Specification 2	Specification 3	Specification 4
ADF(t-value)		**-3.294**	**-3.552**	**-4.565**	**-5.169**	**-4.745**	**-5.206**	**-4.746**	**-5.040**
p-value		0.079	0.120	0.013	0.002	0.002	0.002	0.008	0.011
Critical Value	1%	-4.158	-4.665	-4.665	-5.074	-4.158	-4.665	-4.665	-5.074
	5%	-3.504	-3.984	-3.984	-4.375	-3.504	-3.984	-3.984	-4.375
	10%	-3.182	-3.648	-3.648	-4.028	-3.182	-3.648	-3.648	-4.028

(Note) Shaded figures indicate that the null hypotheses are rejected with the associated critical values.

The null hypotheses of no-cointegration are rejected at 5 percent level of significance in the specification 1 and 2, and at 1 percent level in the specification 3 and 4 on the data of all use of lands. The null hypotheses are rejected at 10 percent level in the specification 1 and 2, and at 5 percent in the specification 3 and 4 on the data of residential lands. On the data of commercial lands, the null hypotheses are rejected at 10 percent level in the specification 1, 5 percent in the specification 3, and 1 percent in the specification 4. Finally, the cointegration test results for industrial lands show that the null hypotheses are rejected at 1 percent level in the specification 1, 2, and 3, and at 5 percent in the specification 4.

(Local Areas)

The results of the cointegration analysis for the local areas are reported as follows (Table 4).

(Table 4) Results of Cointegration Analysis (Local Areas)

		(1)All				(2)Residential			
		Specification 1	Specification 2	Specification 3	Specification 4	Specification 1	Specification 2	Specification 3	Specification 4
ADF(t-value)		**-2.830**	**-3.168**	**-3.004**	**-3.412**	**-3.537**	**-5.347**	**-3.814**	**-5.602**
p-value		0.194	0.232	0.296	0.278	0.047	0.002	0.072	0.003
Critical Value	1%	-4.158	-4.665	-4.665	-5.074	-4.158	-4.665	-4.665	-5.074
	5%	-3.504	-3.984	-3.984	-4.375	-3.504	-3.984	-3.984	-4.375
	10%	-3.182	-3.648	-3.648	-4.028	-3.182	-3.648	-3.648	-4.028

		(3)Commercial				(4)Industrial			
		Specification 1	Specification 2	Specification 3	Specification 4	Specification 1	Specification 2	Specification 3	Specification 4
ADF(t-value)		**-2.142**	**-2.463**	**-2.463**	**-2.727**	**-3.641**	**-3.626**	**-3.788**	**-5.539**
p-value		0.510	0.561	0.561	0.602	0.037	0.104	0.076	0.003
Critical Value	1%	-4.158	-4.665	-4.665	-5.074	-4.158	-4.665	-4.665	-5.074
	5%	-3.504	-3.984	-3.984	-4.375	-3.504	-3.984	-3.984	-4.375
	10%	-3.182	-3.648	-3.648	-4.028	-3.182	-3.648	-3.648	-4.028

(Note) Shaded figures indicate that the null hypotheses are rejected with the associated critical values.

As are the cases for the nationwide results, the null hypotheses are not rejected at 10 percent level of significance in the all purposes and commercial lands. Particularly, the p-values for the commercial lands are high, indicating that there are no cointegrating relationships. On the other hand, the null hypotheses are rejected at 1 percent level in the specification 2 and 4. The results for industrial lands show that the null hypotheses are rejected at 5 percent level in the specification 1, at 10 percent in the specification 3, and at 1 percent in the specification 4.

It is conceivable that the determinant factors other than those considered in section 2 may have affected the commercial land prices in the local areas so that the cointegrating relationships can be resumed once those factors are taken into account. We now consider the possibilities that, even in the medium term, the regional commercial lands can be affected by (a) bank lending, and (b) the fluctuations of land prices in the six large city areas.[29] We set up the following specifications for the commercial lands in the local areas.

[29] Kamada, Hirata, and Wago (2007) shows that Japanese land prices have high spatial correlation in a prefecture level by using spatial econometrics method.

$$p_t = \beta_0 + \beta_1 Trend_t + NPV_t + \beta_2 pop_t + \beta_3 c_t + \beta_4 pu_t + e_t, \quad (17)$$

where p_t denotes the real land prices in the natural logarithm, $Trend_t$ denotes the trend term, NPV_t denotes the discounted present value of land in the natural logarithm, pop_t denotes the share of working-age population to the total population in the natural logarithm, c_t denotes the share of bank lending to the income within the prefecture, pu_t denotes the weighted-average real land price indicator of the six large city areas in the natural logarithm, e_t denotes the estimation residuals.

We conduct the cointegration tests with the above new regression setup for the regional commercial lands with/without the constraint on the discounted present value of land and/or the inclusion of the demographic factor.

(Table 5) Results of Cointegration Tests (Local Areas, Commercial)

		Specification 1	Specification 2	Specification 3	Specification 4
ADF(t-value)		**-4.254**	**-4.274**	**-3.719**	**-4.583**
p-value		0.064	0.122	0.291	0.127
Critical Value	1%	-5.074	-5.460	-5.460	-5.826
	5%	-4.375	-4.740	-4.740	-5.086
	10%	-4.028	-4.384	-4.384	-4.721

(Note) A shaded figure indicates that the null hypothesis is rejected with the associated critical value.

The results show that the null hypothesis is rejected at 10 percent level of significance in the case with the restriction on the cointegrating vector of the discounted present value and without the demographic factor (Table 5).

(5) Estimation of Cointegrating Vectors

We estimate the cointegrating vectors in this section. If two variables are identified as cointegrated, the cointegrating vectors estimated by OLS are consistent. The estimated residuals and vectors, however, are not normally distributed and therefore a usual t-distribution is not used for any tests for the coefficients. In order to overcome this shortcoming, Stock and Watson (1993) proposed the dynamic ordinary least squares method (DOLS). The DOLS is the ordinary least squares method with leads and lags of the dependent variables. Leads and lags are decided based on the Schwarz information criteria (SIC). The estimated cointegrating vectors by the DOLS are efficient and tested with the normal distribution using the heteroskedasticity and autocorrelation consistent variance-covariance errors. The results are reported as follows (Table 6 and 7). The DOLS estimations are estimated for the specification 3 and 4 where the vectors on the discounted present values are not restricted to one. Here we only estimate the vectors for the six large city areas and the local areas, not nationwide, since the cointegrating relationships are different from region to region.

(Six Large City Areas)

All the coefficients of the estimated regressions are significant at the conventional significance levels. The sizes of the cointegrating vectors are different from the DOLS and the OLS. The DOLS coefficients of the discounted present values for residential and commercial land are larger than those of the OLS, while the DOLS coefficients of the share of the working-age population to the total population are smaller than those of the OLS. The DOLS coefficients of the discounted present values for industrial lands are somewhat smaller than those of the OLS.

(Local Areas)

The DOLS coefficients of the discounted present values for residential lands are smaller than those of the OLS, while the DOLS coefficients of the share of the working-age population to the total population are larger than those of the OLS. These results are opposite to those in the six large city areas. While the coefficients of the discounted present values for commercial land are not significant in the specification 4, those are significant in the specification 3. The DOLS coefficients of the discounted present values for industrial land are not significant. The recent developments of industrial lands in the local areas, particularly after 2000, showed the accelerated declines contrasted with other uses and regions. Such developments may reflect the pessimistic view on the manufacturing industry in the local areas with the backdrop of expanding globalization and associated movement of the Japanese firms to expand the overseas operations, particularly of labor intensive sectors.

(Table 6) Results of Cointegrating Vectors (Six Large City Areas)

(1)Residential

	Specification1		Specification2		Specification3		Specification4	
OLS								
Y	—		—		1.36	(0.18) ***	1.27	(0.12) ***
D	—		0.08	(0.02) ***	—		0.07	(0.03) **
Constant	-5.33	(0.08) ***	-10.71	(1.44) ***	-8.43	(1.57) ***	-12.44	(2.41) ***
Trend	-0.01	(0.00) ***	-0.01	(0.00) ***	-0.03	(0.01) ***	-0.02	(0.01) ***
Adj. R-squared	0.32		0.47		0.83		0.86	
S.E.	0.25		0.22		0.23		0.21	
DOLS								
Y	—		—		1.50	(0.10) ***	1.49	(0.08) ***
D	—		—		—		0.06	(0.02) ***
Constant	—		—		-9.33	(0.88) ***	-13.35	(1.62) ***
Trend	—		—		-0.04	(0.00) ***	-0.04	(0.00) ***
Adj. R-squared	—		—		0.95		0.96	
S.E.	—		—		0.10		0.08	

(2)Commercial

	Specification1		Specification2		Specification3		Specification4	
OLS								
Y	—		—		1.72	(0.24) ***	1.56	(0.15) ***
D	—		0.14	(0.03) ***	—		0.13	(0.04) ***
Constant	-5.52	(0.11) ***	-15.70	(1.90) ***	-11.71	(2.03) ***	-19.24	(3.21) ***
Trend	-0.03	(0.00) ***	-0.03	(0.00) ***	-0.06	(0.01) ***	-0.05	(0.01) ***
Adj. R-squared	0.61		0.75		0.64		0.77	
S.E.	0.36		0.29		0.32		0.26	
DOLS								
Y	—		—		2.06	(0.29) ***	1.90	(0.14) ***
D	—		—		—		0.11	(0.03) ***
Constant	—		—		-14.41	(2.54) ***	-20.81	(1.95) ***
Trend	—		—		-0.08	(0.01) ***	-0.07	(0.01) ***
Adj. R-squared	—		—		0.76		0.88	
S.E.	—		—		0.24		0.17	

(3)Industrial

	Specification1		Specification2		Specification3		Specification4	
OLS								
Y	—		—		0.99	(0.17) ***	0.84	(0.13) ***
D	—		0.11	(0.02) ***	—		0.11	(0.02) ***
Constant	-4.96	(0.09) ***	-12.69	(1.45) ***	-4.89	(1.45) ***	-11.70	(1.68) ***
Trend	-0.03	(0.00) ***	-0.03	(0.00) ***	-0.03	(0.01) ***	-0.02	(0.01) ***
Adj. R-squared	0.65		0.78		0.52		0.71	
S.E.	0.28		0.22		0.28		0.22	
DOLS								
Y	—		—		0.79	(0.10) ***	0.79	(0.07) ***
D	—		—		—		0.09	(0.02) ***
Constant	—		—		-2.75	(0.90) ***	-9.44	(1.23) ***
Trend	—		—		-0.03	(0.00) ***	-0.03	(0.00) ***
Adj. R-squared	—		—		0.77		0.92	
S.E.	—		—		0.12		0.07	

(Note 1) Y: Discounted present value of land in the natural logarithm, D: Share of working-age population.

(Note 2) Leads and lags of the DOLS are chosen based on the SIC.

(Note 3) *, **, and *** respectively indicate that coefficients are significant at 10 percent, 5 percent, and 1 percent level. The numbers in the above parentheses are standard errors.

(Table 7) Results of Cointegrating Vectors (Local Areas)

(1)Residential

	Specification1		Specification2		Specification3		Specification4	
OLS								
Y	—		—		1.09	(0.12) ***	0.84	(0.16) ***
D	—		0.04	(0.01) ***	—		0.06	(0.03) *
Constant	-5.71	(0.04) ***	-8.27	(0.85) ***	-6.50	(1.02) ***	-8.41	(1.34) ***
Trend	-0.01	(0.00) ***	-0.02	(0.00) ***	-0.02	(0.01) ***	-0.01	(0.01) *
Adj. R-squared	0.69		0.74		0.93		0.94	
S.E.	0.14		0.13		0.14		0.13	
DOLS								
Y	—		—		1.00	(0.10) ***	0.51	(0.16) ***
D	—		—		—		0.16	(0.05) ***
Constant	—		—		-5.59	(0.82) ***	-11.85	(2.07) ***
Trend	—		—		-0.02	(0.01) ***	0.00	(0.01)
Adj. R-squared	—		—		0.94		0.97	
S.E.	—		—		0.11		0.07	

(2)Commercial

	Specification1		Specification2		Specification3		Specification4	
OLS								
Y	—		—		0.81	(0.11) ***	0.50	(0.12) ***
D	—		0.02	(0.02) ***	—		0.07	(0.02) ***
C	0.02	0.00 ***	0.02	(0.00)	0.02	(0.00) ***	0.01	(0.00) ***
Pu	0.33	0.03 ***	0.29	(0.04) ***	0.41	(0.05) ***	0.41	(0.05) ***
Constant	-7.03	(0.12) ***	-8.34	(0.92) ***	-5.54	(0.86) ***	-7.09	(0.85) ***
Trend	-0.06	(0.00) ***	-0.06	(0.00)	-0.05	(0.01) ***	-0.03	(0.01) ***
Adj. R-squared	0.96		0.96		0.93		0.95	
S.E.	0.11		0.11		0.11		0.10	
DOLS								
Y	—		—		0.95	(0.12) ***	0.06	(0.15)
D	—		—		—		0.08	(0.02) ***
C	—		—		0.03	(0.00) ***	0.01	(0.00) ***
Pu	—		—		0.36	(0.07) ***	0.58	(0.07) ***
Constant	—		—		-6.56	(0.91) ***	-4.00	(1.41) **
Trend	—		—		-0.06	(0.01) ***	-0.02	(0.01) ***
Adj. R-squared	—		—		0.98		0.99	
S.E.	—		—		0.05		0.03	

(3)Industrial

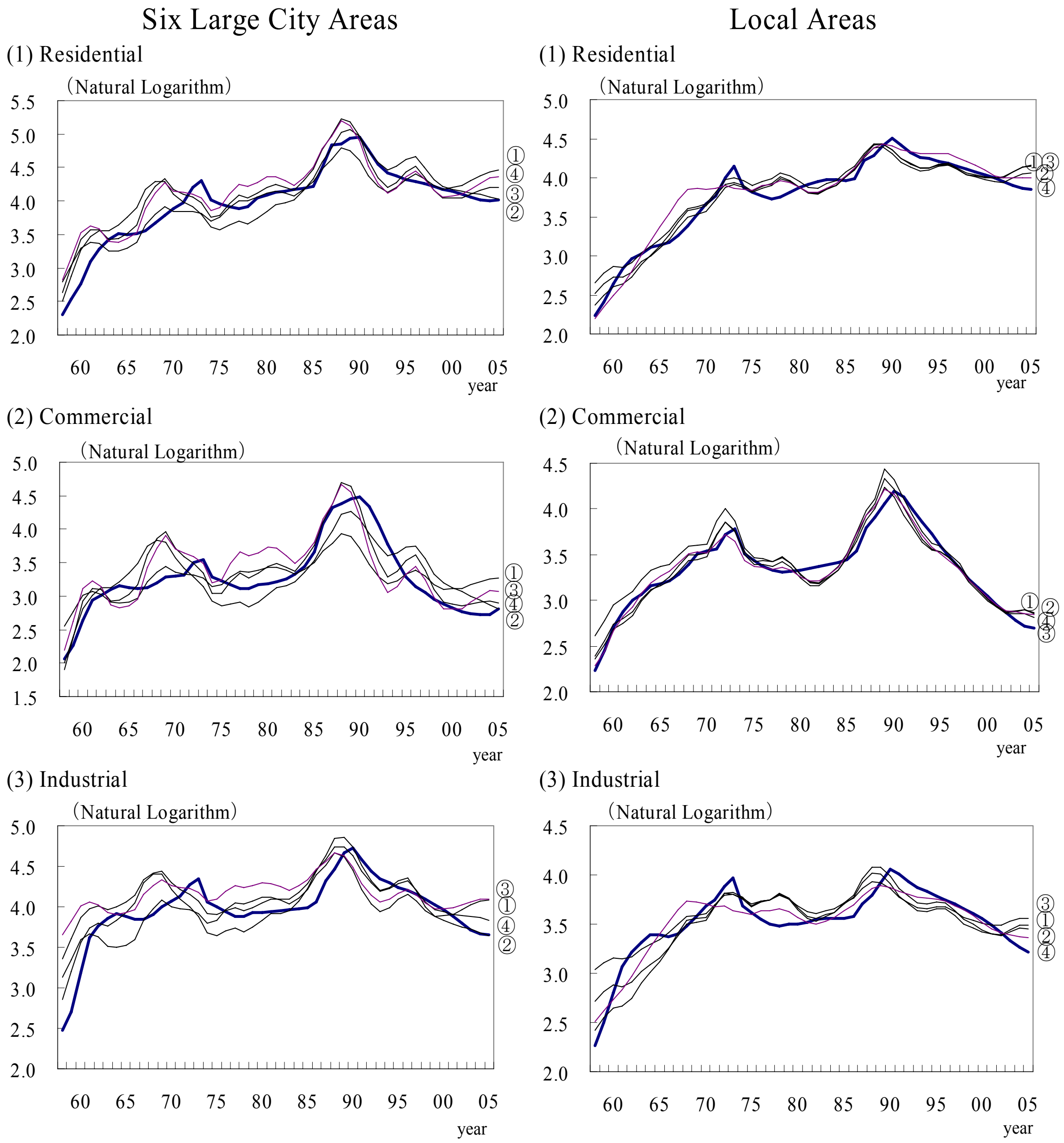
	Specification1		Specification2		Specification3		Specification4	
OLS								
Y	—		—		0.88	(0.10) ***	0.32	(0.11) ***
D	—		0.04	(0.02) **	—		0.14	(0.02) ***
Constant	-5.46	(0.06) ***	-8.24	(1.21) ***	-4.43	(0.88) ***	-8.73	(0.90) ***
Trend	-0.03	(0.00) ***	-0.04	(0.00) ***	-0.03	(0.00) ***	-0.01	(0.00) **
Adj. R-squared	0.86		0.87		0.69		0.84	
S.E.	0.19		0.18		0.19		0.14	
DOLS								
Y	—		—		0.69	(0.09) ***	-0.11	(0.13)
D	—		—		—		0.24	(0.04) ***
Constant	—		—		-2.62	(0.83) ***	-11.32	(1.57) ***
Trend	—		—		-0.02	(0.00) ***	0.00	(0.00)
Adj. R-squared	—		—		0.63		0.84	
S.E.	—		—		0.15		0.09	

(Note1) C: Ratio of credit to the nominal GDP, Pu: Land price of commercial area in the six large city areas.
(Note 2) Leads and lags of the DOLS are chosen based on the SIC.
(Note 3) *, **, and *** respectively indicate that coefficients are significant at 10 percent, 5 percent, and 1 percent level. The numbers in the above parentheses are standard errors.

The theoretical values of the real land prices using the estimated cointegrating vectors are shown in Figure 15. Many of the estimated values are above the actual real land prices.[30] The levels of the estimated theoretical values of the real land prices, however, are different by a large margin with different specifications of the estimation models. In addition, it is well known that the end point estimations by the cointegration analysis can be changed very much once the new data are added. Therefore, due considerations are needed to evaluate the difference between the theoretical values of real land prices and the actual prices.

[30] The cointegrating vectors, which are used for the calculations of the theoretical values of the real land prices, are estimated by the OLS for specification 1 and 2, and by the DOLS for specification 3 and 4. We use the vectors estimated by the OLS for regional commercial and industrial lands with specification 4 since the DOLS coefficients of the discounted present values are not significant.

(Figure 15) Theoretical and Actual Values of Real Land Prices



(Note) The numbers in the figures correspond to the specification 1, 2, 3, and 4, respectively. The bold lines are actual real land prices.

(6) Estimation of Error-Correction Models

We estimate the error-correction models to explain the short-term land price fluctuations using the estimated cointegrating vectors. The dependent variables are the year-on-year growth rates of the real land prices. The independent variables are the error-correction term (one quarter lagged), the year-on-year growth rate of the discounted present values of land, the change in the share of the working-age population to the total population, the year-on-year growth rate of real bank lending, and the constant term.

$$\Delta p_t = \beta_0 + \beta_1 EC_{t-1} + \beta_2 \Delta NPV_t + \beta_3 \Delta pop_t + \beta_4 \Delta c_t + \varepsilon_t, \tag{18}$$

where Δp_t denotes the growth rate of the real land prices (y-o-y), EC_{t-1} denotes the error-correction term (lagged), ΔNPV_t denotes the growth rate of the discounted present value of land (y-o-y), Δpop_t denotes the change in the share of the working-age population to the total population, Δc_t denotes the difference between the growth rate of the real bank lending and the growth rate of the discounted present values of land, and ε_t denotes the estimation residuals.

The reason to use the change in real bank lending for an explanatory variable is that there is a high correlation between bank lending and land price fluctuations in the short term. Such a relationship, however, is not supposed to affect the medium to long-term land price developments and therefore the factor is not included in the cointegration analysis except for the commercial lands in the local areas. We conduct the estimation using the difference between the growth rate of bank lending and the growth rate of the discounted present values of land as a bank lending factor in the error-correction models.[31] The reason is that the changes in the economic fundamentals are reflected in the changes in the discounted present values of land, and the further fluctuations in bank lending over the changes in the discounted present values of land are supposed to be a factor affecting the land price fluctuations independently besides the economic fundamentals.

The estimations of the error-correction models are conducted by region and usage. The error-correction terms (EC_{t-1}) are chosen based on the results of the cointegration analysis; the cointegrating vectors with the lowest p-values are chosen. As a result, the followings are chosen[32];

(Six Large City Areas)
Residential: specification 3, Commercial: specification 4, Industrial: specification 1
(Local Areas)
Residential: specification 2, Commercial: specification 1, Industrial: specification 1

[31] For the estimations of the regional land price changes, we aggregate the bank lending by prefectures into the six large city areas or the local areas using "Deposits, Loans and Discount Outstanding of Domestically Licensed Banks by Prefecture (the Bank of Japan)".

[32] While the specification 4 should be chosen for the regional industrial lands based on the result of the cointegration analysis p-value, the estimated cointegrating vector is not consistent with the theory. Therefore, we chose the cointegrating vectors with the lowest p-values among the specification 1, 2 and 3.

The estimation results are shown in table 8. The error-correction terms are significant in all equations. The coefficients of the changes in the discounted present values of land are correct (positive) in signs and significant. The demographic factors are, however, not significant for residential lands in both the six large city areas and the local areas. Based on the results so far, while the demographic factor has impact on the long-term land price developments, it has little influence on the short-term land price fluctuations for residential lands. This is an opposite result to Otake and Shintani (1996).

(Table 8) Estimation Results of Error-Correction Models

(1) Six Large City Areas

	Residential		Commercial		Industrial	
EC(-1)	-0.26	(0.05) ***	-0.25	(0.06) ***	-0.21	(0.05) ***
ΔY	0.80	(0.21) ***	0.94	(0.27) ***	0.83	(0.23) ***
ΔD	0.02	(0.03)	0.13	(0.04) ***	0.06	(0.03)
ΔC	0.49	(0.19) **	0.44	(0.25) *	0.68	(0.20) ***
C	-0.04	(0.01) ***	-0.05	(0.02) ***	-0.01	(0.02)
Adj. R-squared	0.69		0.63		0.63	
S.E.	0.07		0.09		0.08	

(2) Local Areas

	Residential		Commercial		Industrial	
EC(-1)	-0.23	(0.09) **	-0.28	(0.06) ***	-0.15	(0.06) **
ΔY	0.87	(0.21) ***	0.60	(0.13) ***	0.77	(0.19) ***
ΔD	0.03	(0.03)	0.05	(0.02) **	0.07	(0.03) **
ΔC	0.60	(0.18) ***	0.54	(0.11) ***	0.69	(0.18) ***
ΔP_u	—		0.36	(0.06) ***	—	
C	-0.02	(0.01)	-0.03	(0.01) ***	-0.03	(0.01) **
Adj. R-squared	0.49		0.87		0.53	
S.E.	0.07		0.04		0.07	

(Note 1) *, **, and *** respectively indicate that coefficients are significant at 10 percent, 5 percent, and 1 percent level. The numbers in the above parentheses are standard errors.

(Note 2) EC: Error correction term, ΔY: change in the discounted present value of land, ΔD: change in the share of working-age population, ΔC: change in the ratio of credit to the nominal GDP, ΔPu: change in the weighted-average land price indicator of the six large city areas (commercial).

To check the impacts of each factor on the land price fluctuations visually, the factor contributions are calculated using the estimated coefficients of the error-correction models (Figure 16). The results are as follows;

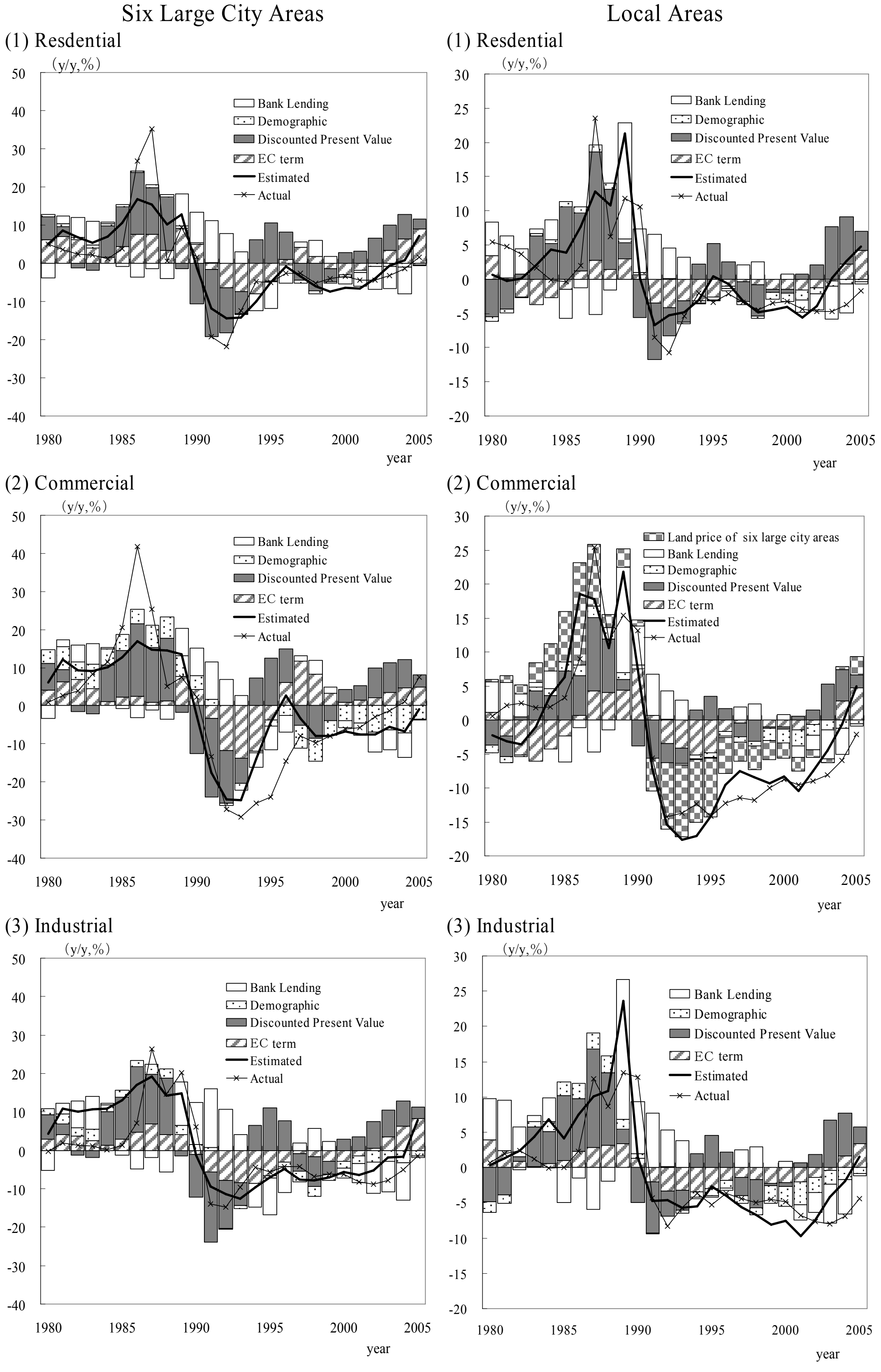
(a) The surges in land prices from the mid 1980s to the late 1980s are attributable to the increase in the discounted present values of land in that the expected growth rate of income increased while the nominal long-term interest rates were kept in low levels. In addition, the unexplained factor (= residuals) has contributed to the surges. For commercial lands in the local areas, the increase in the six large city commercial land prices is a significant factor during the period.

(b) In the late "bubble" period in the early 1990s, the increase in bank lending contributed to the increase in land prices.[33] On the other hand, the changes in the discounted present values of land and the error-correction term show the downward pressure on the land prices. Furthermore, the unexplained factor (= residuals) are shown in the downward pressure on land prices.

(c) The recent developments show that the increase in the discounted present value of land has contributed to the increase in land prices since the real economy has grown steadily with very accommodative financial conditions. In addition, the error-correction term has contributed to the increase in land prices in the recent past. While the bank lending factor has been a downward contributor for the land prices since the mid 1990s, such a movement has finally halted in 2005. The demographic factor has contributed to the declines in the land prices since the mid 1990s.

[33] This tendency is conspicuous in the local areas.

(Figure 16) Contributions of Y-O-Y Land Price Changes



6. Conclusion

This paper conducts the time series analysis on the weighted-average land price indicators, which are supposed to be appropriate indicators in the context of the macro economic analysis. The cointegration analysis shows that there are cointegrating relationships between real land prices and the discounted present values of land, which move in line with economic fundamentals. In addition, the demographic factors have significant impacts on the land prices even in the long term. We have also shown that the error-correction models using the cointegration relationships explain the actual land price fluctuations very well. The short-run fluctuations of land prices are attributable to the changes in economic fundamentals such as income and interest rates, and the changes in bank lending and demographics in addition to the error-correction movements.

We will clarify the relationship between our analysis here and the “bubble.” We exclude the explosive bubble solutions as is obvious in equation (4) and (5). This point is consistent with the results that there are cointegrating relationships between the actual land prices and the theoretical land prices. However, it is true that the actual land prices can deviate from the theoretical land prices. In fact, the error terms in the cointegration analysis show large cyclical fluctuations. We, therefore, need to take into account that the actual land prices can deviate from the theoretical values even during several years. Next, we need to pay attention to the fact that the theoretical value of land calculated here is based on rather myopic expectations of the future income. This is obvious from the fact that we use the nominal long-term interest rates and the expected nominal GDP growth for each period. This specification has pros and cons. The pros are that this specification can describe the anecdotal evidence very well during the “bubble” period, the land prices grew with the expectation that high nominal growth would continue coincided with the low levels of the nominal long-term interest rates. It is highly probable that the actual economic activities were conducted with such expectations at that time. The cons, on the other hand, are that the theoretical values of land with such a myopic expectation can be different from those in the long-run expectations of the economy. In the long run, the denominator of equation (7) should be constant if the cyclical movements are averaged out unless tax rates and long-term risk premium change permanently. The actual data, however, show that the denominator of equation (7), that is the ratio of real land price to the real GDP, is not constant over time. We will leave a research on the long-run trend change in the land price to the GDP ratio as a future topic.

Appendix 1: Weighted-Average Land Price Indexes and Other Land Price Indicators

As described in the main text, the weighted-average land price indexes are appropriate land price indicators when one analyzes land price developments in terms of macro economic perspective. In this appendix, we explain the differences between the weighted-average land price indicators and other land indicators in detail.

(Discussion of Land Price Indicators as Appropriate Macro Economic Indicators)

The weighted-average land price indicators evaluate the change in land prices of the low-priced lands with smaller weights and the changes in land prices of the high-priced lands with larger weights. On the other hand, the official land price indicators such as the Urban Land Price Index by the Japan Real Estate Institute and the Published Land Prices by the Ministry of Land, Infrastructure and Transportation put the same weights on both high-priced lands and low-priced lands. Therefore, the changes in the prices of high-priced lands are underestimated, while those of low-priced lands are overestimated.

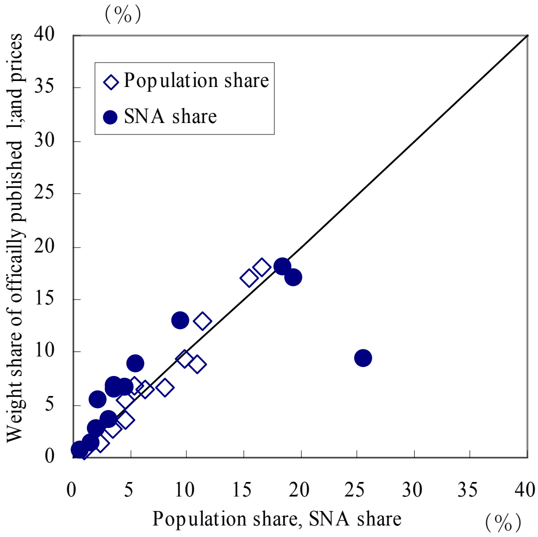
Representative macro land indicators are the land values of the system of the national account (SNA) and they are good benchmarks to compare other land price indicators. First, we compare the regional weights of the SNA land values and those of the Published Land Prices officially published.[34] The weights of the Published Land Prices are almost equivalent to the weights of the populations of the regions (Appendix 1 Figure 1) as the white dots are concentrated along with 45 degree line. If we calculate the weights of the same regions using the SNA land values, we have a different picture. The weights of the low-priced regions' lands are overvalued as the black dots are located above the 45 degree line, while the weights of the high-priced regions' lands are undervalued as the black dots are far below the 45 degree line. Second, we compare the regional weights of the SNA land values and those of the weighted-average land price indicators (Appendix 1 Figure 2). The weights of the SNA land values correspond to those of the weighted-average land price indicators as the black dots are located almost exactly along with the 45 degree line. This shows that the appropriate land price indicators are the weighted-average land price indicators when one analyzes the impacts of land prices on the macro economy.

Some specialists of land evaluation claim that it is unnecessary to recalculate the weights of lands using land prices since the choices of survey spots are evaluated by

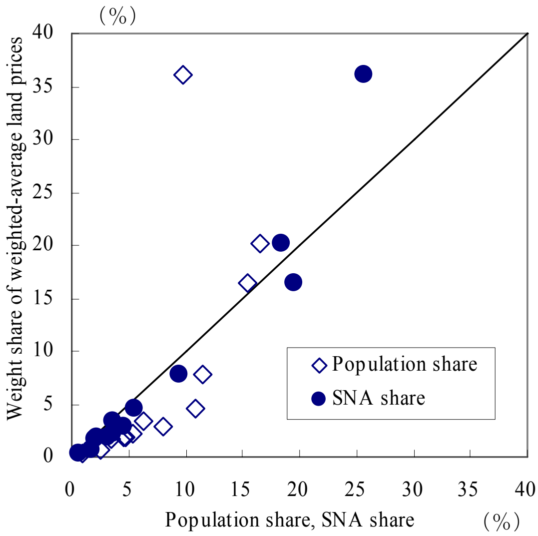
[34] The weights are calculated as the shares of numbers of survey points of the regions to the total numbers of survey points in the nationwide.

specialists and the numbers of the survey spots actually represent their importance.

Appendix 1 Figure 1



Appendix 1 Figure 2



(Note) The weights are calculated for 13 regions (average from 1980 to 1992): Hokkaido, Tohoku, Ibaraki-Tochigi-Gunma, Saitama-Chiba-Kanagawa, Tokyo, Yamanashi and Nagano, Chubu, Hokuriku, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa.

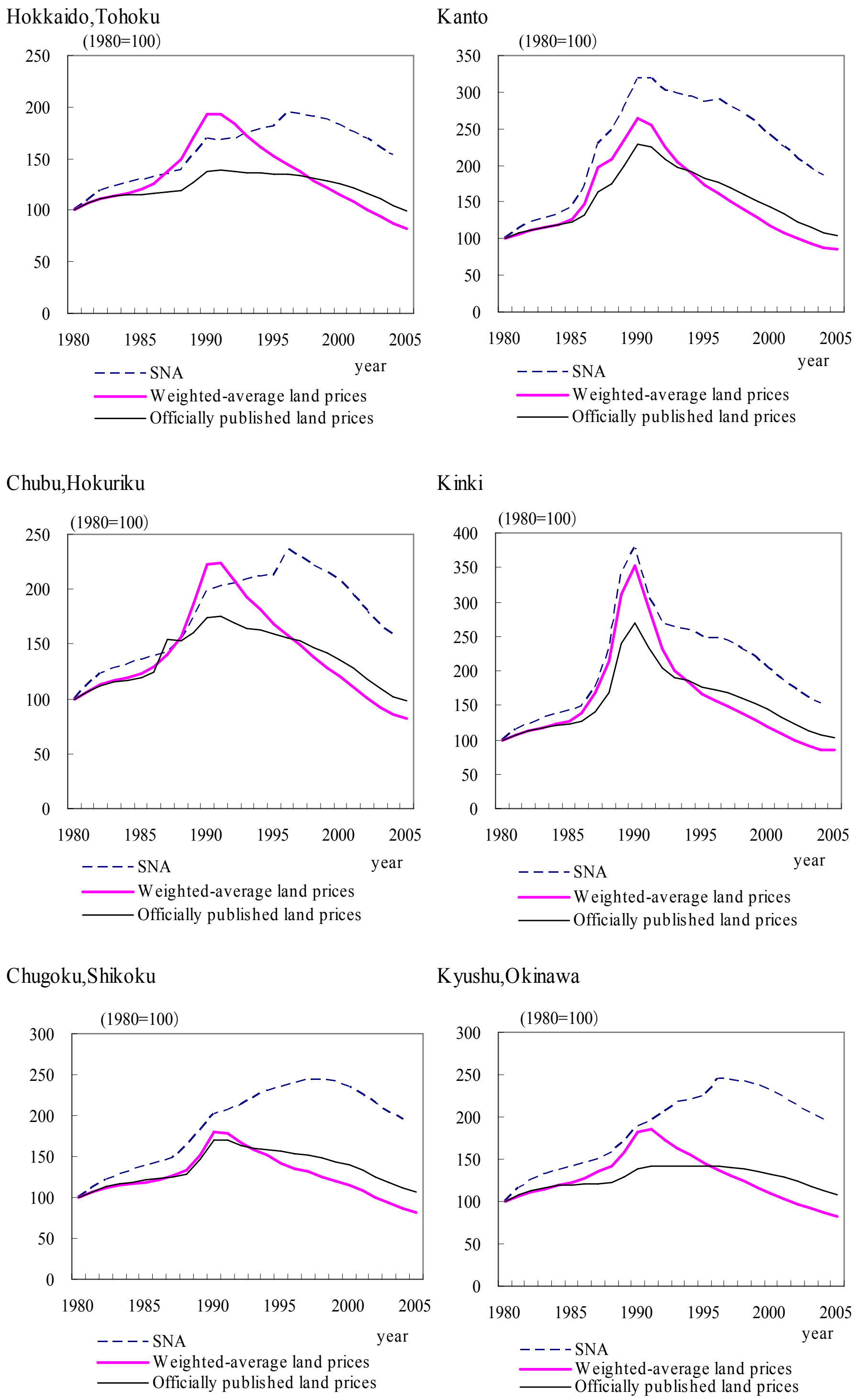
As shown in the previous figures, however, the weights of the official land price indicators are in line with the population weights and they are not necessarily appropriate land price indicators when analyzing their impacts on the macro economy.

(Issues on the SNA Land Values)

It has been considered that the SNA land values were appropriate macro economic indicators to see the developments of land prices and they moved along with the weighted-average land price indicators until the burst of the bubble in the early 1990s. The developments of the SNA land values after the burst of the bubble, however, did not decline so much while the weighted-average land price indicators plunged. In some regions, the SNA land values increased, while the weighted-average land price indicators and even official land price indicators declined (Appendix 1 Figure 3). In the mid 1990s, there were many incidents that uses of lands were changed from agricultural uses to commercial uses in the local areas where constructions of shopping malls were very active. While such a transformation of lands could lead to the increase in the land values in the local areas, the magnitudes of the changes are too large. This could suggest that the estimation of the SNA land values may have problems.[35][36]

[35] Until 1995, the SNA estimation for commercial lands used the land evaluation values used for

Appendix 1 Figure 3



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taxation, which were supposed to be overestimated compared to the market prices of land. This could be a reason to overestimate land values in the SNA until the mid 1990s.

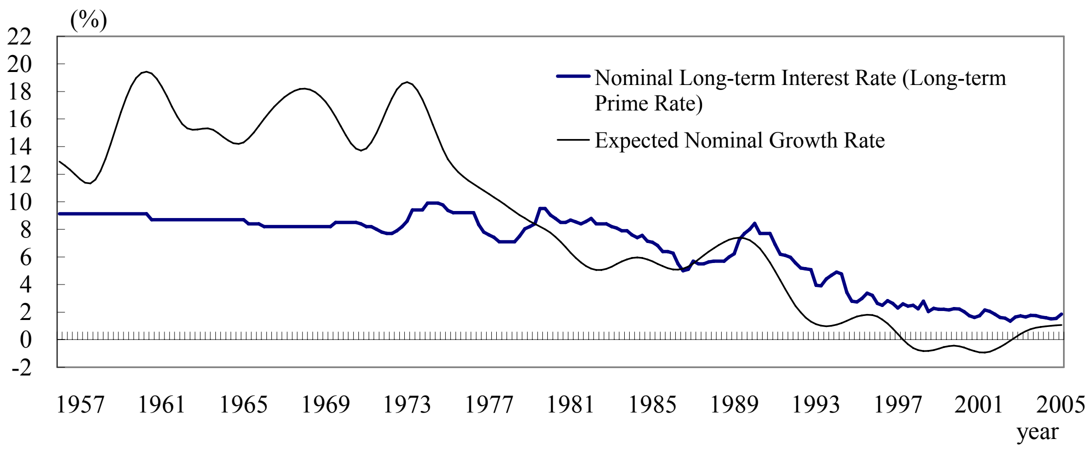
[36] Nishimura and Shimizu (2002) pointed out that the sequence of residential land price data of the Published Land Prices might have a break in the early 1980s since the survey spots were changed during the time.

Appendix 2: Estimation of Interest Rate Gap before Financial Liberalization

In this appendix, we explain how to estimate the interest rate gap before the financial liberalization in the early 1980s. We use it to calculate the discounted present values of land.

Many studies[37] claim that the credit rationings were prevailing before the financial market liberalization and the interest rates were regulated at lower levels than as were supposed to be under the liberalized financial market. In fact, the levels of the long-term nominal interest rates are far below the expected growth rate of the nominal income before the 1980s (Appendix 2 Figure 1).

Appendix 2 Figure 1



Kanemoto (1990) presents three hypotheses that the levels of the interest rates are far lower than the growth rates of land prices as follows; (a) the increases in land prices are not expected in advance, (b) the uncertainty of land price fluctuations is large and the risk premium of lands is high, and (c) since the capital and financial markets are imperfect and heavily regulated, the effective interest rates are much higher than the observed interest rates. He claims that, since the differentials between the growth rates of land prices and interest rates were maintained for a very long time, (c) would be an appropriate reason for such differentials.

Based on the argument above, we estimate the interest rate gap before the liberalization of the financial market as follows.

Step1: The following equation is estimated, assuming that the relationship between the nominal interest rate gap and the output gap is expressed as a liner relationship.

[37] See Tachi and Komiya (1971), Tachi and Hamada (1972), and Ito and Ueda (1982).

$$LG_t = \beta_0 + \beta_1 GAP_t, \tag{19}$$

where LG_t denotes the nominal long-term interest rate gap ($= q_t - f^e_t = i_t - g^e_t$), and GAP_t denotes the output gap.[38]

Step2: Using the estimated parameters ($\hat{\beta}_0$, $\hat{\beta}_1$) and the output gap before the liberalization of the Japanese financial market, the estimated long-term interest gap (*est* (LG_t)) is calculated as follows (Appendix2 Table1)

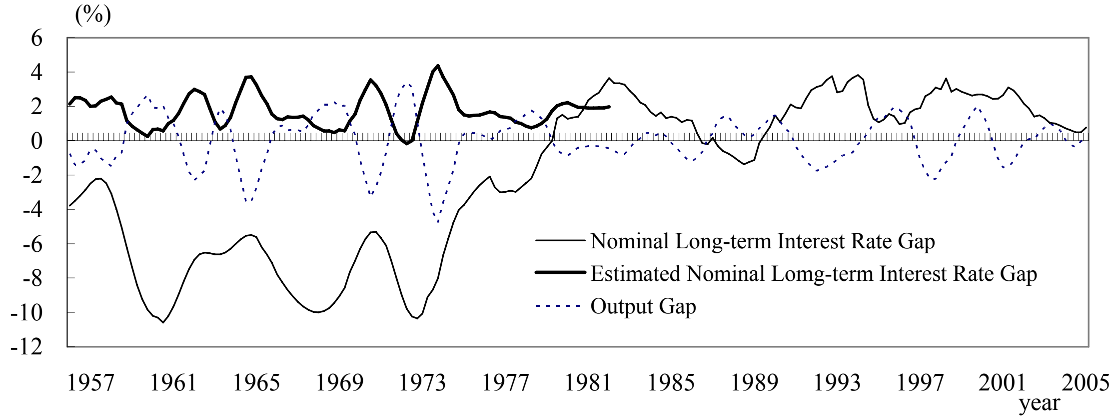
$$est(LG_t) = \hat{\beta}_0 + \hat{\beta}_1 GAP_t \tag{20}$$

Appendix 2 Table 1: Results of the Interest Rate Gap Estimation

	Coefficient	Standard Error
GAP	-0.555	(0.109)
Constant	1.721	(0.113)
Adj. R^2	0.213	
S.E.	1.089	

Using the nominal interest rate gap,[39] we calculate the discounted present value of land (Appendix 2 Figure 2).

Appendix 2 Figure 2: Estimated Interest Rate Gap



[38] The output gap is the difference in percent between the actual GDP and the potential GDP calculated by HP filter (λ=1,600).

[39] In this estimation, we do not specify whether the output gap causes the interest rate gap or the other way around, and we simply use the correlation between them. It would be appropriate that both routes are working.

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