LAND VALUES AND HOUSING RENTS IN URBAN JAPAN

(Proposed Running Head - LAND AND HOUSING PRICES IN JAPAN)

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ABSTRACT

This paper describes and systematically explains observed variation in land values and housing rents in urban Japan. It fits a structural model's reduced form equations to intertemporal data over 35 years, intercity data across 27 major cities, and intracity data in the three largest metropolitan areas. Explanatory variables are population, income, their growth rates, the interest rate, the inflation rate, urban land supply, and distance from the city center.

LAND VALUES AND HOUSING RENTS IN URBAN JAPAN¹

Since 1952 real urban residential land values in Japan increased 30-fold, and real housing rents increased 2-to 4-fold. There are intercity differences in these prices. In 1985 mean residential land values in 27 major cities excluding Tokyo varied between 56,000 and 260,000 yen per sq. m.; the mean Tokyo land value was 736,000 yen, six times higher than the average of the 27 cities' mean land values.² In the same 27 cities, 1983 housing rents varied between 1200 and 3100 yen per tatami (1.7 sq. m.) per month; the Tokyo rent was approximately 4200 yen, twice as high as the average of the 27 cities' mean housing rents. There is also intraurban price variation. Within the three major metropolitan areas of Japan, 1986 land values declined at rates of 2-4% per km. from the city center, and 1983 housing rents declined at 1% per km.

The purpose of this paper is to explain the observed intertemporal, intercity and intracity variation in residential land values and housing rents. To this end we specify a structural model and estimate its reduced form equations. This establishes the relationship between the prices and their underlying causes.³

The subject commands attention partly because land values are so high. In 1984 the aggregate value of land in all of Japan was 317% of GNP, whereas in the much larger United States it was only 80% of GNP.⁴ In 1986 the unit value of residential land in Tokyo was 150 times the unit value in New York.⁵

The subject also commands attention because the prices and their underlying causes are relevant to economic stabilization, housing, and wealth distribution policies. Although the development of policy

implications is beyond the scope of our empirical study, we should at least note these three areas of policy relevance. First there is the possibility of general economic instability due to the collapse of a speculative bubble in a land market linked to financial, stock and other markets. Noguchi (36) holds that about half of the Japanese land value is due to speculation. On the other hand, Ito (10) argues that land values could be correctly based on fundamentals.⁶ Whether or not there should be controls on land market speculation, or regulations to ensure that other markets are protected from a land market collapse, depends partly on the causes of the land values.

Second, for a developed economy, Japan has a low housing stock. In 1980 the ratio of the housing stock to GDP was .56, whereas in the United States it was .96.⁷ The extent to which government should intervene in the housing market, and the means by which it might induce greater housing production, depend partly on the causes of the high prices and the relevant elasticities and gradients. This paper will add to the useful findings of Horioka (9) who estimates structural parameters of Japanese housing demand, and Hayashi, Ito, and Slemrod (8) who simulate the interaction among savings, taxes, and housing purchases in Japan.

Finally, policies relating to the distribution of wealth must be much more concerned with urban land value in Japan than elsewhere. The importance of land in the Japanese household's portfolio is apparent in Sato's (45) calculation of the ratio of household land value to disposable income; in Japan it is 2.90, whereas in the United States it is only .33. Takayama and Togashi (46) find the most important factor contributing toward wealth inequality in Japan is the appreciation of land values. In view of this, it is not surprising that the Japanese government is currently considering reform of the land tax system.

The paper will proceed as follows. Section I provides a simple theoretical model as the basis for estimating reduced form equations.

Sections II and III analyze land value and housing rent data over time, respectively. Sections IV and V analyze land value and housing rent data across cities, respectively. Section VI estimates land value and housing rent gradients within three metropolitan areas. In each section where data permits, standard statistical tests are performed on the reduced form equations and coefficients, and appropriate interpretations and comparisons with previously published results on United States cities are made. Section VII summarizes.

I. THEORETICAL FRAMEWORK

In the following sections we estimate regressions to explain variation in (a) land value indexes for groups of cities over time, (b) mean land value and housing rent across cities, and (c) land value and housing rent within cities. With very few clearly noted exceptions, all variables are real rather than nominal. Here we outline a simple theory that yields the required estimating equations.

Assume that consumers rent in the housing market. Demand in city i in year t is

$$(1) \quad HD_{it} = HD(\underline{R}H_{it}, Y_{it}, N_{it})$$

where $\underline{R}H$ = mean housing rent, Y = mean per capita income, N = population, $dHD/d\underline{R}H < 0$, $dHD/dY > 0$, and $dHD/dN > 0$. Income and population are exogenous. Housing service producers use land which they rent from landowners. Housing supply is

$$(2) \quad HS_{it} = HS(\underline{R}H_{it}, \underline{R}L_{it})$$

where RL = mean land rent, $dHS/d\bar{R}_H > 0$, and $dHS/d\bar{R}_L < 0$.⁸

Further assume that in the land market, housing producers' demand for rental land is

$$(3) \quad LD_{it} = LD(\bar{R}_{L_{it}}, \bar{R}_{H_{it}})$$

where $dLD/d\bar{R}_L < 0$ and $dLD/d\bar{R}_H > 0$. Land supply is

$$(4) \quad LS_i = k A_i$$

where A = the exogenous amount of land nature has provided and $1 > k > 0$. The absence of a t subscript on A in (4) indicates no variation in nature's provision over time.⁹

Equilibrium conditions in the housing and land markets are $HD_{it} = HS_{it}$ and $LD_{it} = LS_i$, respectively. A part of the solution to these six equations can be expressed as two reduced form equations,

$$(5) \quad \bar{R}_{H_{it}} = \bar{R}_H(Y_{it}, N_{it}, A_i)$$

with comparative static properties $d\bar{R}_H/dY > 0$, $d\bar{R}_H/dN > 0$, and $d\bar{R}_H/dA < 0$; and

$$(6) \quad \bar{R}_{L_{it}} = \bar{R}_L(Y_{it}, N_{it}, A_i)$$

with properties $d\bar{R}_L/dY > 0$, $d\bar{R}_L/dN > 0$, and $d\bar{R}_L/dA < 0$.

Land value is the present value of future land rents:

$$(7) \quad \underline{V}_{L_{it}} = \int_0^{\infty} \bar{R}_{L_{it}} \cdot e^{-rt} dt$$

where $\underline{V}L_{it}$ = mean land value, and r_t = the exogenous current and future real interest rate. The absence of an i subscript on r_t indicates negligible intercity variation in the interest rate. According to (6), future rents depend on future income, population, and land supply. Future income and population depend, in turn, on their current values and their rates of change. The land supply and interest rate vectors are set at current values. Thus, the substitution of (6) into (7) enables us to write:

$$(8) \quad \underline{V}L_{it} = \underline{V}L(Y_{it}, N_{it}, A_i, r_t, \dot{Y}_i, \dot{N}_i)$$

with comparative static properties $d\underline{V}L/dY > 0$, $d\underline{V}L/dN > 0$, $d\underline{V}L/dA < 0$, $d\underline{V}L/dr < 0$, $d\underline{V}L/d\dot{Y} > 0$, and $d\underline{V}L/d\dot{N} > 0$.

An alternative specification of land's present value could include expected capital gains as well as rents. We omit capital gains because (a) they are ultimately explained in terms of future rents, and (b) the exogenous determinants of future rents are already specified in (8).

In accord with the simplest version of Mills' (31) model of the monocentric city, intracity variation in both land value and housing rent are explained by distance u from the city center. At location j , land value V_{Litj} (u_{ij}) and housing rent $RH_{Litj}(u_{ij})$ are determined by the exogenous arguments in (8) and (5), respectively. In other words,

$$(9) \quad V_{Litj} = L(\underline{V}L_{it}, u_j), \quad dV_{Litj}/du < 0$$

and

$$(10) \quad RH_{Litj} = H(\underline{R}H_{it}, u_j), \quad dRH_{Litj}/du < 0.$$

These simple long run relationships are based on the assumption of perfect markets with perfect foresight. They have only a few essential explanatory variables. Population, income, land supply, and rates of change in income and population will explain much of the variation in prices across cities. Distance will explain some of the variation within cities. The stable pattern of change in population and/or income will explain some of the trend in prices, while the interest rate may explain some of the deviations from the trend.

II. LAND VALUE OVER TIME

This part of the study analyzes three real (CPI-deflated) urban residential land value indexes between 1952 and 1987. The underlying nominal indexes, published by the Japan Real Estate Institute (20,21), are based on surveys of informed land market agents. The indexes are for 140 major Japanese cities, the six largest of these, and the 134 remaining cities. The six cities are Tokyo, Osaka, Nagoya, Kyoto, Yokohama, and Kobe. They comprise the central parts of three urban concentrations with 10% of the nation's land and 47% of its population.

Figure 1 shows how the index for all 140 cities has varied between 1952 and 1987. The indexes for six and 134 cities follow the same pattern. All three indexes exhibit a 35-year upward trend interrupted briefly in 1963 and again in 1975-77.¹⁰ A comparison with United States residential land values is possible beginning in 1966, after the Japanese rate of increase slowed from its torrid pace of 1952-62. Between 1966 and 1987, Japanese values increased 2.3 times, a rise somewhat greater than that of FHA-insured lots in the United States, which increased 1.4 times.¹¹

To explain variation in the three Japanese real land value indexes, we

estimate a variant of (8),

$$(11) \quad VL_t = VL(Y_t, N_t, r_t, \dot{Y}_t, \dot{N}_t)$$

where the three dependent variables are indexes of mean land values VL_{it} over six, 134, and 140 cities, with year 1952 = 1. The independent variables Y_t and N_t are mean income and population figures for these groups of cities.¹² Land supply is invariant over time so it is absent from (11).

All data on explanatory variables are taken from the "Japan Statistical Yearbooks". Income per capita for the nation is available for 1952-87, and after deflating it with the CPI, we use it as a variable in the 140-city regression. Income per capita by prefecture is readily available for a shorter period, 1969-84. We use it as a variable in the six- and 134-city regressions.¹³ We calculate annual population means for six, 134, and 140 cities from 1952 through 1987.¹⁴ The rate of change variables in (11) are annual averages over the preceding five years. The real interest rate is "all banks' average agreed interest rate on loans and discounts", which is available for 1954-87, net of the rate of increase in CPI.

Table 1 presents regression coefficients for 1954-87 when all variables except income in the six- and 134-city samples are observable. Table 2 presents coefficients for 1969-84 when income is observable in the six- and 134-city samples. The upper part of each table reports linear equations and the lower part reports log-linear equations.¹⁵ All regressions include either income or population. There is a high correlation between the two variables in the 140- and 134-city samples, which prevents us from separating their effects.¹⁶ The rate of change variables are not reported in the tables, as they do not improve the adjusted R^2 s. All of the income and population coefficients are positive, and all except one are statistically significant at the 5% level. These results are consistent

with similar findings of Kau and Sirmans (24) and Rose (40). All of the interest rate coefficients are negative, and those in the 1969-84 period are statistically significant. These results are consistent with Just's (22) finding that the real interest rate exerts a negative influence on land value.

However, before accepting the interest rate hypothesis, we ought to note an alternative explanation for these results: general price inflation is negatively correlated with the real interest rate (the correlation coefficient is $-.99$ for the years 1969-84), and inflation may be interacting with income tax rules to cause an increase in real land value.¹⁷ In view of the near-perfect correlation between the real interest rate and the inflation rate, it is not surprising that when we substitute the annual rate of increase in CPI for the interest rate in the 1969-84 regressions, we obtain almost precisely the same results as before, only with a positive sign on the inflation variable. The positive sign is consistent with Rose and LaCroix's (42) simulation for the United States, and with Just's empirical analysis of the United States.¹⁸

In summary, our empirical results suggest that per capita real income and/or population, and the real interest rate and/or the inflation rate, exert some influence over land value in the directions implied by theory.¹⁹

III. HOUSING RENT OVER TIME

Uninterrupted time series data on urban housing rent for the period 1952-87 are unavailable. The figures that we have do permit a rough description of the pattern of change over portions of this period. Table 3 summarizes the extent of our findings in terms of real (CPI-deflated) rent. The first two rows of the Table show that for the nation and for cities over 50,000, the rent indexes follow essentially the same pattern: there is an

upward trend with a 2- to 4-fold increase over 35 years, interrupted by the oil crisis of the early 1970s.²⁰ The fourth row of Table 3 suggests a similar trend for rent in the six largest cities.²¹ The long term rise in Japanese rent is perhaps moderately higher than that of the housing shelter component of the United States CPI, which increased 2.2-fold between 1953 and 1986.

There is a striking difference between the increases in housing rent and land value. For example, the 140 cities real residential land value index increased 33-fold between 1950 and 1975. Even after the rapid rise during the first five years of this period, the land value index increased almost eight-fold between 1955 and 1970, and 11-fold between 1955 and 1986. This is consistent with the doubling of Japan's urban population and its six-fold increase in real per capita income since 1950. It is also consistent with the plausible notions that land for housing is in more inelastic supply than is capital, and that there is a low elasticity of substitution of capital for land in housing production.²² Finally, the relatively slow increase in rent may be partly explained by the traditional reluctance of Japanese landlords and tenants to periodically renegotiate rents. Many rents observed today have not increased since they were set one or two decades ago.²³

IV. LAND VALUE ACROSS CITIES

Japan's National Land Agency (13) annually reports the average value of housing land in residential planning areas in all of the nation's larger cities. We compiled the 1986 values for the 37 most populous cities, and then reduced the sample to 28 by eliminating nine smaller cities dominated by nearby larger ones. The 28 cities comprising the sample are listed in Table 4. The mean 23-ku Tokyo value is 735,600 yen per sq. m., almost three times as high as the next highest value. The mean value in the next five

largest cities is 205,200 yen. The 27 cities' values range from 56,500 yen to 259,400 yen; their mean is 117,000 yen.

In the United States the values of FHA-insured residential lots for 1980 in the 40 largest urban areas ranged from \$.48 to \$5.57 per sq. ft., with a mean of \$1.72. Although the highest value is three times the mean value, there are other values almost as high; in other words, there is no extreme outlier in the United States distribution of major city values comparable to Tokyo in the Japanese distribution.²⁴

To explain the Japanese variation we estimate a variant of (8),

$$(12) \quad \underline{V}L_i = \underline{V}L(Y_i, N_i, A_i, \dot{Y}_i, \dot{N}_i).$$

Measurement of the demand variables is straight forward. We use the 1985 population of each city and the (latest) 1983 income per capita of the prefecture that contains each city, both from the "Japan Statistical Yearbooks". The rates of change in income and population are annual averages over the preceding five years.

Measurement of the land supply variable deserves brief explanation. The ocean and seas, mountainous terrain, and government reduce the availability of feasible residential building sites. Our method for measuring land supply in this paper, which is fully explained in Rose (41), takes into account only the water restrictions. To measure the supply of land in each urban area, we first determine from a map the number of acres of land, net of water, at various distances from the city center. Then we weight these acres and sum them. The weights decline with distance to reflect the decreasing contribution of more remote acres to the urban land supply. The weights for this study are based on Mills and Ohta's (32) estimated population density gradients for Japanese cities. The resulting urban land

supplies for 28 cities should be of interest in their own right, and since they are not otherwise available, we report them in Table 4. The numbers are in index form, where 1.000 represents the supply for a waterless city.

Table 5 summarizes descriptive statistics for the six variables in the model. Because Tokyo is an outlier in the land value distribution, we show it apart from the other 27 cities, and we exclude it from the regression data set. Table 6 shows regressions of (12) fit to both linear and log-linear functional forms using 27 cities data. These are the two regressions with highest adjusted R^2 . The coefficients have signs consistent with the comparative statics of the model, and the population and income coefficients are significant at the 5% level.²⁵

The reduced form elasticities of land value with respect to population, income and land supply implied by our log-linear regression are .25, 1.20, and -.56, respectively. The corresponding elasticities estimated by Rose (40) for 40 major United States cities are .18, 1.76, and -1.01, respectively.

It is possible that Tokyo's extremely high residential land values are well explained by the regression. Although the regression equations with Tokyo's 23-ku population of 8,354,000 predict a land value far below the observed mean, this underprediction may be largely due to an error in the measurement of population. In theory the population that bids up the value of residential land is that which resides in the entire metropolitan area. The linear regression with Tokyo's 50 km. radius population of 22,000,000 actually overpredicts land value.²⁶

On the other hand, Tokyo's high residential land values may be partly due to unspecified explanatory variables. One important variable in the United States is government restrictions on residential land use, and it is omitted from the model. Another omission is the demand for commercial land; without this the model cannot provide evidence regarding the extent

to which the recent centering of international commerce in 23-ku Tokyo has driven up the value of residential land.

V. HOUSING RENT ACROSS CITIES

From Japan's most recently published nationwide housing survey (18) in 1983, we have taken privately owned house rents for the same 28 cities selected for the land value analysis.²⁷ Our rent variable is a quantity-weighted average of reported mean rents for wooden and non-wooden houses, in yen per tatami per mo.. Table 5 shows the rent for Tokyo is 4221 yen. Excluding Tokyo, the 27 cities' rents range from 1252 to 3040 yen, and average 2052 yen. This range, relative to the mean, probably differs little from that in the United States.²⁸ However, there is no extreme outlier like Tokyo in the United States distribution.

Table 5 shows that the ratio of land value to housing rent in Tokyo is three times the ratio of the mean value to mean rent in the 27 cities. This parallels the observation of a preceding section that land value increased 11 times more than housing rent over the past 30 years. Both observations are consistent with the pressure of a higher urban population and/or a higher real per capita income, an inelastic land supply, an elastic capital supply, and a low elasticity of substitution of capital for land in housing production.

To explain intercity housing rent we estimate a variant of (5),

$$(13) \quad \underline{R}H_i = \underline{R}H(Y_i, N_i, A_i, \dot{N}_i).$$

Although the population rate of change variable is not specified in the equilibrium model of Section I, we include it here to account for the

possibility, argued at the end of Section III, that current observed rents differ from the equilibrium rents corresponding to current income and population. The variables in (13) are measured in the same way as those used in the intercity land value analysis. As in the preceding section, we exclude Tokyo from the regression data set, and fit linear and log-linear functional forms to the 27 cities data.²⁹

The results are displayed in Table 7. In both regressions the adjusted R^2 is close to .50. Coefficients on all four variables have the expected signs and, except for population, all coefficients are significant at the 5% level. Here as in the previous section on land value, we attempt to predict the outlying Tokyo rent. The linear and log-linear equations predict rents of 4589 and 2669 yen, respectively. Recall that the observed rent is 4221 yen. The log-linear regression implies elasticities of rent with respect to population, income, and land supply of .05, .58, and -.32, respectively. These results are consistent with those reported for the United States.³⁰

VI. LAND VALUE AND HOUSING RENT WITHIN CITIES

Land values in 1985 in Tokyo, Osaka, and Nagoya are available from the National Land Agency (13).³¹ Each observation is an average of values (in thousands of yen per sq. m.) in a residential area in the vicinity of a train station, at a reported distance (in km.) from the central station, which approximates the city center. Values are reported at distances well beyond the central city. Sample characteristics are summarized in Table 8.

The estimating equation for each city is a form of (9):

$$(14) \quad \ln VL_j(u_j) = \ln VL(0) + k \cdot u_j.$$

The plausible conditions for this functional form were derived by Muth (30) and Mills (31).³²

Regressions fit to data segregated by city and within 50 km. of the center yield a range of distance coefficients between $-.020$ and $-.038$. All coefficients are significant at the 5% level. These results, which are corrected for heteroskedasticity, are shown in Table 8. The coefficients are land value gradients, showing the relative decline in value per km. of distance from the city center. The Tokyo gradient is roughly twice that of Osaka and Nagoya, and distance has roughly twice the explanatory power in Tokyo. Our estimated land value gradients for 1985 are within the range of McDonald and Bowman's (28) gradients for Chicago; these are $-.042$ in 1960 and $+.012$ in 1970.

One can also compare our Tokyo land value gradients with previously published population density gradients, since Mills (31) shows that under plausible conditions the theory of the monocentric city implies the two gradients are equal. Mills and Ohta estimate Tokyo population density gradients in the range of $-.063$ to $-.082$ using 1950-70 data. Our smaller Tokyo land value gradient of $-.038$ for 1985 is not inconsistent with their results, as density gradients tend to fall over time.

We also estimate an "average" gradient by (a) pooling all observations and (b) fitting an equation (9) that also includes dummy variables for Tokyo ($DT = 1$) and Osaka ($DO = 1$). This yields a land value gradient of -0.027 and an adjusted R^2 of $.621$. The regression is reported in the lower portion of Table 9.

A plot of the land values and distances in each city suggests that land values are better explained by distance out to intermediate distances of (say) 25 km. than they are out to lower or especially higher distances. To confirm this we fit the same regression to subsets of the data that include only land values within u km. of the city center. We allow u to vary from 10

to 75 km., well beyond the usual bounds for estimation of population or employment density gradients. The results displayed in Table 10 show that the adjusted R^2 slightly increases to a maximum of .797 at 25 km., and then substantially decreases as more distant observations are included in the data. The high R^2 values within 40 km. are consistent with the theory of the monocentric city. The lower R^2 values at greater distances are consistent with higher land values around some smaller cities and employment centers at those distances.

Housing rents at various distances in Tokyo, Osaka and Nagoya are taken from the 1983 Housing Survey of Japan (19).³³ The rents are reported for privately owned houses of two types, wooden and non-wooden. Because the 34 observations are pooled, the basic regression (10) also incorporates five dummy variables to capture the separate effects of the three metropolitan areas and two types of houses, along with the effect of distance, on the dependent variable. Table 11 summarizes the sample characteristics and shows the specification of these dummy variables.

In the resulting regression shown in the lower portion of Table 11 all coefficients have the expected sign and are significant at the 5% level; the adjusted R^2 is .93.

VII. CONCLUSION

In this paper, we have described and systematically analyzed three types of aggregated observations of land values and housing rents in urban Japan. The pattern of prices in urban Japan somewhat resembles that in the United States, with two notable exceptions: prices have risen faster in Japan, and Tokyo prices are extreme outliers without a counterpart among major cities in the United States.

In our analysis we first estimated reduced form equations to explain the behavior of six-city and 140-city land value indexes since 1952. Second, we estimated equations to explain the variation in mean city land values and housing rents across 27 major cities. Third, we estimated land value and rent gradients with respect to distance in three major metropolitan areas.

Our findings are consistent with the specified model. Land values and housing rents are positively related to population and/or per capita income, inversely related to the interest rate and/or positively related to the inflation rate, inversely related to the supply of land, and inversely related to distance from the city center. Rates of growth in income and population generally do not contribute significantly to the explanation of prices. Finally, our estimated reduced form coefficients are similar to those reported in intertemporal, intercity, and intracity empirical studies of major United States cities.

Finally, our findings are relevant to policy issues. In closing, we mention two. First, there are fundamental economic reasons why Japanese prices have risen faster than those in the United States, and in particular why Tokyo prices are higher than those in the rest of Japan. This suggests that caution is advisable in the legislation of regulations designed to control speculation in the Tokyo land market. Second, the estimated income elasticities indicate that land prices increase more rapidly than income, whereas housing rents increase less rapidly than income. Thus as Japan's income increases in the future, although land ownership will become more costly, housing services will become more affordable. This may obviate the need for government to intervene in land and housing market processes for the purpose of encouraging future housing consumption.

FOOTNOTES

1. I am thankful for research support from the Center for Japanese Studies at the University of Hawaii, and Resource Systems Institute at the East-West Center. I also appreciate helpful comments by Sumner LaCroix and Moheb Ghali.
2. Sources and explanations for these and other statistics in the introduction are provided later in the paper. The usual definition of Tokyo is 23 ku (wards) with a 1985 population of 8,354,000. In contrast, Greater Tokyo, which includes Yokohama and other cities, had a 1985 population of almost 22,000,000.
3. Sophisticated time series analysis of intertemporal data can sometimes yield better forecasts than structural models. However, our purpose is to relate intertemporal, as well as intercity and intracity, price variation to the underlying causes.
4. See Sachs and Boone (44). Goldsmith (6) states that urban land value comprised 78% of the total land value in Japan in 1977.
5. There was relatively little difference between Tokyo and New York rents on apartments and buildings. See Iwata and Yoshida (11) and Boone (1).
6. Frankel (5) summarizes these contrasting arguments.
7. This point is presented in Sato (45). Additional descriptive statistics are provided in OECD (37) and Bronfenner and Yasuba (2).
8. The simplifying omission of capital rent from the model reflects (a) our lack of reliable data on this variable, (b) the plausible assumptions that the housing services production function is the same in all cities, and capital is mobile, and (c) the evidence that land rent is a major portion of housing rent in urban Japan. (Over 1978-83, land accounted for 42% of

the total cost of a new dwelling. Kawakami (25), pp. 31-41.)

9. A noteworthy argument omitted from the land supply function is urban monopoly zoning power. Rose (40) argues that this variable raises the value of land in U. S. urban areas. Although Japanese cities have a system of land use regulation under the National Land Use Planning Act of 1974, the variable is omitted because we have no data.
10. Over this 35 year period, average urban residential land values in the 140 cities rose much more than urban commercial land values; and the latter rose much more than agricultural land values.
11. The source is U. S. Department of Housing and Urban Development (46), Table 20S. The 1.4 index is based on the median price of existing home sites in the U. S., deflated by the consumer price index. The well-known limitations of these data on FHA-insured homes are explained in Muth (34) and Greenlees (7).
12. Income and population explanatory variables are employed by Kau and Sirmans (24) in their intercity, intertemporal, empirical analysis of U. S. land values, and by Rose (40) in his intercity empirical study of U. S. land values. Just (22) uses the interest rate as a key variable to explain variation in U. S. farm land values over time.
13. For the six cities regression, we calculate the mean of the six corresponding prefecture per capita incomes each year and deflate with the (national) CPI; we follow the same procedure to obtain incomes for the 134 cities, only we use incomes of the 41 prefectures that contain these cities.
14. Population is available for each of the 140 cities every five years. We fit a second degree polynomial regression of population on time to predict the intermediate annual mean populations.
15. Box-Cox tests at the 5% level fail to reject either linear or log-linear functional forms. Our initial regressions employed the ordinary least

squares procedure. However, Durbin-Watson tests consistently indicated auto-correlation, so we resorted to the Cochrane-Orcutt procedure.

16. Simple correlation coefficients between income and population are .93 in the 140 cities data and .86 in the 134 cities data. The problem does not arise in the six cities because they exhibit negligible variation in population. As a result, none of the regressions that incorporate both explanatory variables yield statistically significant coefficients on both of them at the 5% level.
17. The effect of inflation is explained in three theoretical papers.

According to Feldstein (4) inflation interacts with nominal depreciation allowances to raise the price of land relative to capital. According to Rose (39) and Rose and LaCroix (42), inflation additionally interacts with nominal capital gains taxes to decrease the relative price of land. Thus the net effect of inflation's interaction with these two tax rules is theoretically indeterminate. Japan's income tax incorporates both tax rules, so it is reasonable to test for the net effect of inflation on land's real value.
18. The size of inflation's effect in Japan is smaller than that suggested by these papers for the United States. For example, the coefficients imply that in Japan an increase from a 5% inflation rate to a 10% rate will increase land's real value less than 1%.
19. The reader will note that no explanation has been provided for an obvious feature of the land value time series, viz., the steep decline in land values following their peak in 1973-74. Sato (45) argues that the exceptionally high values of 1972-73 were the outcome of a speculative bubble caused by the Plan for the Remodeling of the Japanese Archipelago of Prime Minister Kakuei Tanaka. Nagourney and Beinhacker (35) suggest the bubble burst when pricked by the condition of the economy following the oil shock of late 1973.

Although this paper is not about forecasting, we nonetheless ran a forecasting test. Specifically, we fit the reduced form equation using data up to 1973, and attempted to forecast the upward trend's temporary interruption of 1974. The test failed. An alternative, more complete specification of expectations formation in imperfect markets might be better able to explain and forecast the sharp decline of land values. However, in general, economists have not been very successful in modelling short-term price fluctuations. Also see footnote 3.

20. For Japan as a whole, there is a special group consumer price index for private house and room rent available every five years. From 1955 until 1970 the index increased from 1.0 to 2.3, then slightly decreased to 2.0 in 1975 and only recently in 1986 increased again to 2.3. For cities over 50,000, the rent component of the CPI is also available every five years, but only from 1950 to 1975. From 1950 to 1970 this component increased from 1.0 to 4.0 and then decreased to 3.5 in 1975.
21. The Housing Survey of Japan provides rent per tatami for the largest six cities every five years. These data are available, in one form or another, for 1953, 1958, 1968, 1978, and 1983. Although rent in Tokyo is 1.5-2.0 times higher than the average rent in the five next largest cities throughout this 30 year period, the relative changes over time are roughly comparable.
22. While there are no published estimates of substitution elasticities for Japan, several estimates in the United States are all well below unity. The range is typically .50 to .75. See Clapp (3).
23. I owe this point to Michael Douglass.
24. Among smaller cities in the United States there was an outlier in 1980. Honolulu had a mean lot value of \$8.60. See Rose and LaCroix (43).

25. A Box-Cox test at the 5% level rejects neither linear nor log-linear forms. In the log-linear form, only the interest rate is not a logarithm, since it is already expressed as a percentage. Inclusion of the rate of change variables does not increase the adjusted R^2 .
26. With the 23-ku population, the linear and log-linear equations predict 482,000 and 357,000 yen, respectively. With the 50 km. radius population, the linear and log-linear equations predict 1,025,000 and 456,000 yen, respectively. Recall that the observed land value is 735,600 yen.
27. See Table 11.
28. Ozanne and Thibodeau (38) report rent indexes for 54 major United States SMSAs. Their smaller range may be entirely due to their careful hedonic control for housing quality variation.
29. A Box-Cox test rejects neither form at the 5% level.
30. Ozanne and Thibodeau estimate elasticities of rent with respect to the number of households and income to be .04 and .25, respectively. They also include a dummy variable equal to one for cities bordering an ocean or one of the Great Lakes, and obtain a positive coefficient consistent with our negative land supply coefficient.
31. See Tables 26,27,28.
32. Mills (29) first used it to estimate the relationship between land value and distance in Chicago. A subsequent paper by Kau and Sirmans (23) reexamines Mills' use of the exponential form. Using post-1900 (though not pre-1900) Chicago data, the authors find it to be consistent with a Box-Cox test for functional form. In another paper, McDonald and Bowman point to shortcomings of the exponential form, and estimate a fourth degree polynomial.
33. See Table 99.

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FIGURE 1

LAND VALUE INDEX

Urban Residential Land, Deflated by CPI

TABLE 1
LAND VALUE REGRESSIONS (1954-87)

Data Set	6 Cities	134 Cities	140 Cities	140 Cities
Dependent Variable = Land Value Index				
<u>Independent Variables</u>				
Income Per Capita (1000s 1985 yen)				0.01478* (16.80)
Population (1000s)	0.0007266 (0.48)	0.001416* (11.33)	0.001191* (9.55)	
Interest Rate (%)	-0.3931* (-2.21)	-0.1999* (-2.78)	-0.1720* (-2.42)	-0.1547* (-2.52)
Constant	-8.8529 (-0.37)	-23.846* (-6.45)	-37.521* (-6.39)	-2.2201 (-1.66)
$\bar{R}^2$	.962	.977	.979	.985
Dependent Variable = Ln Land Value Index				
<u>Independent Variables</u>				
Ln Income Per Capita (1000s 1985 yen)				1.4240* (15.21)
Ln Population (1000s)	4.3324* (3.94)	3.6538* (9.36)	4.8989* (14.71)	
Interest Rate (%)	-0.005399 (-0.78)	-0.008116 (-1.35)	-0.006842 (-1.39)	-0.003386 (-0.69)
Constant	-39.164* (-3.67)	-34.913* (-8.73)	-49.995* (-13.99)	-7.463* (-11.26)
$\bar{R}^2$	0.977	0.978	0.986	0.986

Asterisks denote coefficient significance at the .05 level; t-statistics are in parentheses.

TABLE 2
LAND VALUE REGRESSIONS (1969-84)

Data Set	6 Cities	134 Cities	140 Cities
Dependent Variable = Land Value Index			
<u>Independent Variables</u>			
Income Per Capita (1000s 1985 yen)	0.02733* (6.70)	.01309* (5.11)	0.01558* (4.55)
Population (1000s)			
Interest Rate (%)	-0.4647* (-3.85)	-0.1877* (-2.94)	-.2472* (-3.35)
Constant	-14.12 (-1.55)	2.545 (0.61)	-3.688 (-0.60)
$\bar{R}^2$	.922	.888	.866

Dependent Variable
= Ln Land Value Index

Independent Variables

Ln Income Per Capita (1000s 1985 yen)	1.3833* (6.82)	0.8913* (5.34)	1.1671* (4.87)
Ln Population (1000s)			
Interest Rate (%)	-.009894* (-3.49)	-.007374* (-2.58)	-0.009542* (-3.04)
Constant	-6.8308* (-4.40)	-3.4218* (-2.80)	-5.5624* (-3.11)
$\bar{R}^2$	0.924	0.847	0.873

Asterisks denote coefficient significance at the .05 level; t-statistics are in parentheses.

TABLE 3

REAL HOUSING RENT AND LAND VALUE INCREASES

The numbers indicate the multiple by which the rent or value increased during the period.

Period	1950-75	1955-70	1955-86	1953-68	1978-83
Index					
Housing Rent:					
National		2.3 ^a	2.3 ^a		
Housing Rent:					
Cities > 50,000	3.5 ^b				
Land Value:					
140 Cities 33.3	7.5	10.9			
Housing Rent:					
6 Cities		3.3 ^c	0.02 ^d		
Land Value:					
6 Cities				14.7	1.35

a. Source is (14), 1987, Table 14-7, p. 490.

b. Source is (14), 1976, Table 270, pp. 362-3.

c. Sources are (15), Table 27, rents for privately owned houses; and (16), Table 36, rents for dwellings with two types of living arrangements: exclusive and joint. We use a quantity-weighted mean rent of the two types.

d. Source is (19), Table 64, The 1978 and 1983 rents are averages of four types of dwellings: wooden and earthen, each jointly and exclusively used by households.

TABLE 4

28 CITIES AND LAND SUPPLY INDEXES

Chiba	0.691	Kitakyushu	0.767	Okayama	0.813
Fukuoka	0.767	Kobe	0.487	Osaka	0.725
Gifu	0.926	Kumamoto	0.895	Sagamihara	0.984
Hachioji	0.924	Kurashiki	0.893	Sapporo	0.983
Hamamatsu	0.782	Kyoto	0.947	Sendai	0.903
Himeji	0.743	Matsuyama	0.700	Shizuoka	0.819
Hiroshima	0.835	Nagasaki	0.519	Tokyo	0.765
Kagoshima	0.680	Nagoya	0.934	Utsunomia	0.999
Kanazawa	0.845	Niigata	0.527	Wakayama	0.633
				Yokohama	0.706

TABLE 5

DESCRIPTION OF 28 CITIES DATA

Units	Land Value V	Housing Rent R	Population N	Per Capita Income Y	Land Supply A	Per Capita		Population Rate of Growth Ṅ
						Income Rate of Growth Ȳ	% annual increase (1978-83)	
	1000s of yen per sq.m. (1986)	Yen per tatami per mo. (1983)	1000s of persons (1985)	1000s of yen per year (1983)	Index 1=no water	% annual increase (1978-83)	% annual increase (1980-85)	
Tokyo (23-ku)	736	4221	8354	2945	0.765	2.70	0.000	
27 Other Cities Mean	117	2052	902	1862	0.794	1.68	0.896	

TABLE 6
LAND VALUE REGRESSIONS

Functional Form	Linear	Log-Linear
<u>Independent Variables</u>		
Population	0.0398* (3.51)	0.254* (2.32)
Income	0.0615* (2.15)	1.201* (2.40)
Land Supply	-67.24 (-1.23)	-0.558 (-1.63)
Constant	19.79 (0.37)	-6.16* (-1.73)
$\bar{R}^2$	.49	.39

Asterisks indicate significance of coefficients at the .05 level; t-statistics are in parentheses.

TABLE 7
HOUSING RENT REGRESSIONS

Functional Form	Linear	Log-Linear
<u>Independent Variables</u>		
Population	0.0943 (1.13)	0.0404 (0.84)
Income	0.671* (3.10)	0.579* (2.57)
Land Supply	-842.28* (-2.07)	-0.320* (-2.10)
Population Rate of Change	230.15* (3.15)	0.111* (3.02)
Constant	1180.7* (2.91)	2.814* (1.77)
$\bar{R}^2$	.53	.46

Asterisks indicate significance of coefficients at the .05 level; t-statistics are in parentheses.

TABLE 8

LAND VALUE AND INTRACITY DISTANCE

Three Cities' Data Segregated Out to 50 Kilometers

Metro Area	Number of Observations	Mean Value (100s of yen per sq. m.)	Regression: <u>Dependent Variable = Ln Land Value</u>		
			Constant	Distance	$\bar{R}^2$
Tokyo	117	2561	8.651* (99.85)	-0.0384* (-13.57)	.705
Osaka	78	1697	7.814* (91.46)	-0.0204* (-4.57)	.286
Nagoya	69	913	7.110* (108.72)	-0.0183* (-6.40)	.401

Asterisks indicate significance of coefficients at the .05 level; t-statistics are in parentheses.

TABLE 9
LAND VALUE AND INTRACITY DISTANCE
 Three Cities' Data Pooled

Metro Area	Number of Observations	Mean Value (1000s of yen per sq. m.)	Range of Distances of Value Observations (km.)
Tokyo	140	22,990	0-75
Osaka	82	16,760	0-55
Nagoya	69	9,130	0-50
Total	291	17,950	0-75

$$\ln V = 7.276 - 0.0270 U + 1.083 DT + 0.700 DO \quad \bar{R}^2 = .621$$

(143.60) (-12.72) (20.57) (11.82)

Coefficients are all significant at the .05 level; t-statistics are in parentheses.

TABLE 10

INTRACITY DISTANCE AND GOODNESS OF FIT

Three Cities' Data, Out to Variable Distance, Pooled

Distance (km.)	Number of Observations	Distance Coefficients	$\bar{R}^2$
10	49	-.0522 (-1.62)	.743
15	83	-.0445 (-3.76)	.782
20	117	-.0476 (-7.05)	.787
25	151	-.0434 (-9.81)	.797
30	178	-.0391 (-10.93)	.779
35	204	-.0343 (-12.24)	.763
40	227	-.0316 (-12.86)	.740
45	247	-.0294 (-12.53)	.703
50	264	-.0281 (-12.42)	.667
55	276	-.0283 (-12.31)	.641
60	283	-.0285 (-13.17)	.641
75	291	-.0270 (-12.72)	.621

The parenthetical figures are t-statistics.

TABLE 11
HOUSING RENTS AND INTRACITY DISTANCE

Metro Area	Number of Observations	Mean Rent (yen per tatami per mo.)		Range of Distances of Rent Observations (km.)
		Wooden House	Non-Wooden House	
Tokyo	14	2696	3522	0-70
Osaka	10	1704	2860	0-50
Nagoya	10	1314	2029	0-50
Total	34			0-70

Dummy Variables:

DTE = 1 if Tokyo, non-wooden
 DTW = 1 if Tokyo, wooden
 DOE = 1 if Osaka, non-wooden
 DOW = 1 if Osaka, wooden
 DNE = 1 if Nagoya, non-wooden

Regression Result:

$$\ln R = 7.419 - 0.00953 U + 1.058 DTE + 0.783 DTW + 0.781 DOE$$

(222.14) (-8.62) (23.30) (20.36) (13.04)

$$+ 0.257 DOW + 0.435 DNE \quad \bar{R}^2 = .930$$

(5.87) (10.78)

All coefficients are significant at the .05 level; t-statistics are in parentheses.