LAND VALUES AND HOUSING RENTS IN URBAN JAPAN

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

Louis A. Rose

89-11

Department of Economics

Porteus Hall 542
University of Hawaii
Honolulu, Hawaii 96822

ABSTRACT

An explanation of land values and housing rents is central to our understanding of Japanese urban land use allocation, housing production and consumption, and wealth distribution. This paper describes and systematically explains some of the observed intertemporal, intercity, and intracity variation in these prices. It fits theoretically based 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, the interest rate, the inflation rate, urban land supply, and distance from the city center.

LAND VALUES AND HOUSING RENTS IN URBAN JAPAN[1]

Since 1952, five years following the conclusion of World War II and the redistribution of land from large estates to tenant farmers, urban residential land values in Japan have increased 30-fold, and housing rents have increased 2- to 4-fold. These increases are nationwide, in constant yen. Today there are interesting intercity differences in these prices. In a 1986 survey, 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] (At an exchange rate of 140 yen per dollar, a 10,000 sq. ft. lot in Tokyo would cost $4,881,000.) 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. Of course, there is also intraurban price variation. Within the three major metropolitan areas of Japan, land values decline at rates of 2-4% per km. from the city center, and housing rents decline at 1% per km..

As we shall see later in the paper the intertemporal, intercity and intracity variation of these prices in Japan is, with two notable exceptions, somewhat similar to that in the United States. The exceptions are (a) that increases in housing rent and especially land value have been greater in Japan than in the United States, and (b) that Tokyo is unique: its housing rent and especially its land value are extreme outliers in the Japanese intercity price distributions, and there is no comparable outlier among the major cities of the United States.

An explanation of these observations about urban Japanese housing rent and especially land value is important as a basis for at least two major policies. First, Japanese national and local governments are charged with responsibilities for land use planning including the allocation of land between disproportionately powerful farming interests and the consumers of housing; the prices are central to the determination of efficient land use, including housing. Second, land values are important determinants of the distribution of income and wealth -- to a far greater extent in Japan than in other countries.

Japanese urban land use planning attempts to address the same problems that exist in other developed nations. However, in Japan conditions are somewhat different. According to OECD (33) and Bronfenbrenner and Yasuba (1), among nations with high per capita incomes, Japan's urban infrastructure and housing stock are relatively deficient. Although the size of household dwelling units has been steadily rising, the national average, including houses, apartments and rented rooms, still averages little more than 600 sq. ft. of floor space.[3] This is reflected in a relatively low ratio of housing stock to gross domestic product; Sato (40) calculates a 1980 ratio of .56, whereas in the United States it was .96.

Policies relating to the distribution of wealth and income must be much more concerned with urban land value in Japan than elsewhere. According to Goldsmith (5) urban land value in 1977 comprised 78% of the total land value in Japan. He also reports the value of all land in Japan in 1977 (a year of depressed land values) was 2.32 times its GNP, whereas the value of all land in the United States was only .98 times its GNP. This is reflected in the importance of land in the Japanese household portfolio. Sato calculates that, as a multiple of household disposable income, household land value is 2.90; in the United States it is only 0.33. In view of this, it is not surprising that

Takayama and Togashi (41) find the most important factor contributing toward wealth inequality in Japan is the appreciation of land values.

The pace of research on land and housing in urban Japan has recently accelerated. An OECD volume, "Urban Policies in Japan," surveys land use planning and housing policies. Horioka (8) uses household-level data to estimate tenure choice and structural parameters of Japanese housing demand. Hayashi, Ito, and Slemrod (7) present a life-cycle simulation analysis of the interaction among savings decisions, housing purchase decisions, and the tax system in Japan and the United States. Fujita and Kashiwadani (4) model efficient land development and associated land prices in Tokyo, and compare them with Tokyo's actual spatial growth and land prices.

The purpose of this paper is different from any prior research relating to urban Japan. It is to explain observed intertemporal, intercity, and intracity variation in aggregated data on residential land values and housing rents. 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 permit, 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 briefly concludes.

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 over distance within cities. With 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 in the housing market, consumers demand rental housing. Demand in the ith city in the tth year is

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

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

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

where $\underline{R}L$ = mean land rent, $dHS/d\underline{R}H > 0$, and $dHS/d\underline{R}L < 0$.[4]

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

(3) $LD_{it} = LD(\underline{R}L_{it}, \underline{R}H_{it})$

where $dLD/d\underline{R}L < 0$, and $dLD/d\underline{R}H > 0$. Land supply is

(4) $LS_i = k\ A_i$

where A = the exogenous amount of land nature has provided and $0 > k > 1$. The absence of a t subscript on A in (4) indicates no variation in nature's provision over time.[5]

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) $\underline{R}H_{it} = \underline{R}H(Y_{it}, N_{it}, A_i)$

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

(6) $\underline{R}L_{it} = \underline{R}L(Y_{it}, N_{it}, A_i)$

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

Land value is related to land rent by

(7) $\underline{V}L_{it} = \underline{R}L_{it} / r_t$

where $\underline{V}L$ = mean land value, and r = the exogenous real interest rate. There is negligible intercity variation in the interest rate, so there is no i subscript on variable r. The substitution of (6) into (7) yields land's value as

$$(8) \qquad \underline{V}L_{it} = \underline{V}L(Y_{it}, N_{it}, A_i, r_t)$$

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

In accord with the simplest version of Mills' (28) model of the monocentric city, intracity variation in both land value and housing rent are explained by distance u from the city center. At the jth location, land value VL_{itj} (u_{ij}) and housing rent $RH_{itj}(u_{ij})$ are also determined by the exogenous arguments in (8) and (5), respectively. In other words,

$$(9) \qquad VL_{itj} = VL(\underline{V}L_{it}, u_{ij}) , \qquad dVL/du < 0$$

and

$$(10) \qquad RH_{itj} = RH(\underline{R}H_{it}, u_{ij}), \qquad dRH/du < 0.$$

II. LAND VALUE OVER TIME

We begin with an analysis of three real (CPI-deflated) urban residential land value indexes between 1952 and 1987. The underlying nominal indexes, published by the Japan Real Estate Institute (17,18), are for 140 major Japanese cities; the six largest of these, which are Tokyo, Osaka, Nagoya, Kyoto, Yokohama, and Kobe; and the 134 remaining cities. The six cities 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 140 cities real land value index 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 briefly interrupted in 1963 and again in 1975-77.[6] A comparison with certain United States residential land values over time 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-fold, a rise somewhat greater than that of FHA-insured lots in the United States, which increased 1.4-fold.[7]

To explain variation in the three Japanese real land value indexes, we estimate a variant of (8),

$$(11) \qquad \mathbf{VL}_t = \mathbf{VL}(\mathbf{Y}_t, \mathbf{N}_t, r_t)$$

where the three dependent variables are indexes of the average of mean land values $\underline{V}L_{it}$ over six, 134, and 140 cities, with the 1952 values equal to 1. The independent variables $\mathbf{Y}_t$ and $\mathbf{N}_t$ are corresponding mean income and population figures for these groups of cities.[8] Except for the essentially constant six cities population figures, these variables all trend upward over time. The interest rate r_t is invariant across cities. 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 cities index 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 cities index regressions. 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.

Population is available for each of the 140 cities every five years between 1952 and 1987. We calculate population means for six, 134, and 140 cities for each of the nine years, and fit a second degree polynomial regression of population on time to predict the intermediate annual mean populations. The nominal interest rate is all banks' average agreed interest rate on loans and discounts, which is available for 1954-87. The real interest rate is this figure net of the concurrent CPI rate of increase.

Table 1 presents regression coefficients for 1954-87 when all variables except income in six and 134 cities are observable; and Table 2 presents coefficients for 1969-84 when income is observable in six and 134 cities. The upper part of each table shows linear equations and the lower part shows log-linear equations.[9] All regressions include either income or population, but not both; in the 140 and 134 cities data sets this is due to a high correlation between the two variables.[10]

The (expected) positive sign of all, and the (.05 level) statistical significance of all but one, of the income and population coefficients are consistent with results obtained by Kau and Sirmans (21) and Rose (36). However, the collinearity prevents us from separating the effects of these two variables. For partial reduced form elasticities of land value with respect to these two variables, we must await analysis of the cross section data later in the paper.[11]

The (expected) negative sign of all of the interest rate coefficients, and their significance over the 1969-84 period, are consistent with Just's (19) finding that the real interest rate exerts some negative influence on land value. Although the sizes of the coefficients are small, the variable is expressed in percentage units (rather than fractions) which varied substantially between -13 and +10 during the period of study. 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.

The effect of inflation is explained in three theoretical papers. According to Feldstein (3) inflation interacts with nominal depreciation allowances to raise the price of land relative to capital. According to Rose (35) and Rose and LaCroix (36), 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.

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 simulation for the United States, and with Just's empirical analysis of the United States. However, the magnitude of inflation's effect in Japan is smaller than that suggested by these papers for the United States.[12]

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 (40) 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 (32) suggest the bubble burst when pricked by the condition of the economy following the oil shock of late 1973. Income, the interest rate, and the inflation rate did indeed change following the oil shock. However, when we used regressions based on pre-shock data, along with post-shock values of these variables, their variation was insufficient to forecast the steep temporary decline in land values.

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 consistent with theory.

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 4 summarizes the extent of our findings in terms of real (CPI-deflated) rent. A brief discussion, all in terms of real indexes, follows.

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 standard consumer price index 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 an then decreased to 3.5 in 1975. These 2 indexes follow essentially the same pattern, a plausible trend in view of Japan's rising per capita income, with a pause following the oil crisis of the early 1970s. The long term rise in Japanese rent is apparently 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. The 140 cities real residential land value index increased 33.3-fold between 1950 and 1975. Even after the rapid rise during the first five years of this period, the land value index increased 7.5-fold between 1955 and 1970, and 10.9-fold between 1955 and 1986.

This is, of course, consistent with an almost doubling of Japan's urban population since 1950, and a six-fold increase in real per capita income. It is consistent with the plausible notion that land for residential use is in more inelastic supply than is capital for housing. Moreover, it is consistent with a low elasticity of substitution of capital for land in the production of housing. While there are no published estimates of substitution elasticities for Japan, several estimates in the United States are all well below unity.[13] 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.[14]

The Housing Survey of Japan provides data on rent per tatami for the largest cities every five years. These data are available, in one form or another, for 1953, 1958, 1968, 1978, and 1983. According to the

Survey, between 1953 and 1968, the average of the six cities' mean housing rents rose 3.3-fold. Between 1978 and 1983, rent remained essentially constant. 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. Again, the comparison with land value increases is striking. Between 1953 and 1968, the six cities real residential land value index increased 14.7-fold; and between 1978 and 1983 it increased 1.35-fold. We emphasize that all the changes reported in this section are real, deflated by the CPI.

IV. LAND VALUE ACROSS CITIES

Japan's National Land Agency (10) annually reports the average value of housing land in residential planning areas of 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, eliminating nine smaller cities dominated by nearby larger ones.[15] The 28 cities comprising the sample are listed in Table 4. The mean 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 (Osaka, Nagoya, Kyoto, Yokohama, and Kobe) 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.[16]

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

$$(12) \qquad \underline{V}L_i = \underline{V}L(Y_i, N_i, A_i)$$

The expected signs of the reduced form regression coefficients are positive for population and income, and negative for land supply.

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". Measurement of the land supply variable deserves brief explanation. The ocean and seas and mountainous terrain, along with government, all reduce the availability of feasible residential building sites. Our method for measuring land supply in this paper, which is fully explained in Rose (37), 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 (29) 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. The indexes range between .487 for Kobe and .999 for Utsunomia. Setting aside the other supply determinants for which measures are not available, we find that Kobe has only half as much urban residential land as does Utsunomia.

Descriptive statistics for the four variables in the model are summarized in Table 5. Because Tokyo is an outlier in the land value distribution, we show it separate from the other 27 cities, and we exclude it from the regression data set.

A Box-Cox test at the .05 level rejects neither linear nor log-linear functional forms. Table 6 shows regressions of (12) fit to both forms using 27 cities data. (In the log-linear form, only the interest rate is not a logarithm, since it is already a relative.) All of the coefficients have signs consistent with the comparative statics of the model; the population and income coefficients are significant at the .05 level.

Although regression equations are notorious for their inability to predict outliers, we nonetheless attempt to predict the Tokyo land value. The linear and log-linear equations predict 482,000 and 357,000 yen, respectively. Interestingly, when Tokyo's 50 km. radius population of approximately 22,000,000 is substituted for the 23-ku population of 8,354,000, the linear and log-linear equations predict 1,025,000 and 456,000 yen, respectively. Recall the observed land value is 735,600.

Some comparisons can be made between the reduced form elasticities implied by these results and those published elsewhere. The 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 (36) for 40 major United States cities are .18, 1.76, and -1.01, respectively.

V. HOUSING RENT ACROSS CITIES

From Japan's most recently published nationwide housing survey (15) in 1983, we have taken reported privately owned house rents for the same 28 cities selected for the land value analysis.[17] The rent variable for our statistical analysis is actually 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 is, relative to the mean, wider than the range of 54 major United States SMSA indexes constructed by Ozanne and Thibodeau (34) using 1974-76 data. However the smaller variation in United States rent may be entirely due to the authors' careful hedonic control for housing quality variation. The absence of an extreme outlier in the United States distribution is noteworthy.

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),

$$(13) \qquad \underline{R}H_i = \underline{R}H(Y_i, N_i, A_i, N'_i)$$

where N' = the expected rate of change in population. Although this variable is not specified in the long run equilibrium model of Section I, we include it here to account for the possibility that current observed rents differ from the long run equilibrium rents corresponding to current population.[18] It is measured as the annual per cent increase in population over the previous five years. The other three variables in (13) are precisely those used in the intercity land value analysis.

Consistent with our regression analysis in the preceding section, we exclude Tokyo from the regression data set. As in the case of land, a Box-Cox test rejects neither linear nor log-linear functional forms at the .05 level. Therefore, we fit both forms to 27 cities' data. 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 .05 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 can be compared with those obtained by Ozanne and

Thibodeau. They estimate elasticities of rent with respect to the number of households and income to be .04 and .25, respectively. The first of these is particularly close to our result. The authors 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.

VI. LAND VALUE AND HOUSING RENT WITHIN CITIES

Land values in 1985 in Tokyo, Osaka, and Nagoya are available from the National Land Agency (10).[19] 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.

Our land value estimating equation for each city separately is a form of (9). Specifically, it is the logarithm of the exponential function

(14) $$VL_j(u_j) = VL(0)\, e^{ku_j}.$$

The plausible conditions for this form were derived by Muth (30) and Mills (28). Mills (26) first used it to estimate the relationship between land value and distance in Chicago. A Box-Cox test for functional form, applied to our Japanese data, pooled as well as segregated by city, fails to reject the semi-logarithmic form.[20]

Regressions fit to data segregated by city and within 50 km. of the center yield a range of highly significant (.05 level) distance coefficients between -.020 and -.038. These results, which are corrected for heteroskedasticity, are shown in Table 9. 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; the reasons for this are not readily apparent. The table also shows a range of adjusted R^2 values between .28 and .70; distance has roughly twice the explanatory power in Tokyo as in Osaka and Nagoya.

Some useful comparisons can be made between these gradients and those reported elsewhere. Our estimated land value gradients for 1985 are within the range of McDonald and Bowman's (25) gradients for

Chicago; these are -.042 in 1960 and +.012 in 1970.

One can also compare our land value gradients with previously published population density gradients, since Mills (28) shows that under plausible conditions the theory of the monocentric city implies the two gradients are equal. Mills and Ohta estimate population density gradients for selected Japanese cities including Tokyo, but not Osaka or Nagoya. Our Tokyo land value gradient of -.038 for 1985 is smaller than the -.063 to -.082 range of Tokyo density gradient estimates by Mills and Ohta using 1950-70 data. The figures are not necessarily inconsistent, since 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 shown in the lower portion of Table 8.

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, where u varies 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 (16).[21] 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 .05 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 cities and 140 cities 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 all consistent with theory. 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. Finally, our estimated reduced form coefficients are similar to those reported in intertemporal, intercity, and intracity empirical studies of major United States cities.

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 Moheb Ghali and Sumner LaCroix.

2. Sources and explanations for these and other statistics in the introduction are provided later in the paper. The usual meaning of Tokyo, and the one used in this paper, 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. Japan (11).

4. 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 (22), pp. 31-41.)

5. A noteworthy argument omitted from the land supply function is urban monopoly zoning power. Rose (36) argues that this variable raises the value of land in U. S. urban areas. Although Japanese cities have "zoning" under the National Land Use Planning Act of 1974, the variable is omitted because we have no data.

6. It is noteworthy that over this 35 year period, average urban residential land values in the 140 cities have risen much more than urban commercial land values; and the latter have risen much more than agricultural land values.

7. The source is U. S. Department of Housing and Urban Development (42), Table 20S, in first and last years. 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 (31) and Greenlees (6).

8. Income and population explanatory variables are employed by Kau

and Sirmans (21) in their intercity, intertemporal, empirical analysis of U. S. land values, and by Rose (36) in his intercity empirical study of U. S. land values. Just (19) uses the interest rate as a key variable to explain variation in U. S. farm land values over time.

9. Box-Cox tests at the .05 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.

10. 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 (standard .05 level) statistically significant coefficients on both of them.

11. Even in the six cities equation, it would not be advisable to interpret the income coefficient as a partial elasticity, because of the likelihood of error in the measurement of the six cities' populations.

In theory, the population that bids up the value of land is that which resides in the entire metropolitan land market. However, our measure of population includes only residents within cities' jurisdictional bounds. It is likely that the proportion of metropolitan population growth outside of these bounds has been greater in the six largest cities than in the other 134. This suggests that the income coefficient in the six cities equation reflects not only growth in income, but unmeasured population as well.

12. 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%.

13. The range of estimates is .50 to .75. See Clapp (2).

14. I owe this point to Michael Douglass.

15. Tables 9, 13, 17-19.

16. Among smaller cities in the U. S. there was an outlier in 1980. Honolulu had a mean lot value of $8.60. See Rose and LaCroix (39).

17. Table 11.

18. This variable was also tried in the prior land value regressions, but here alone it makes an improvement in explanatory power.

19. Tables 26, 27, 28.

20. A subsequent paper by Kau and Sirmans (20) 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.

21. Table 99.

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FIGURE 1

LAND VALUE INDEX

Urban Residential Land, Deflated by CPI

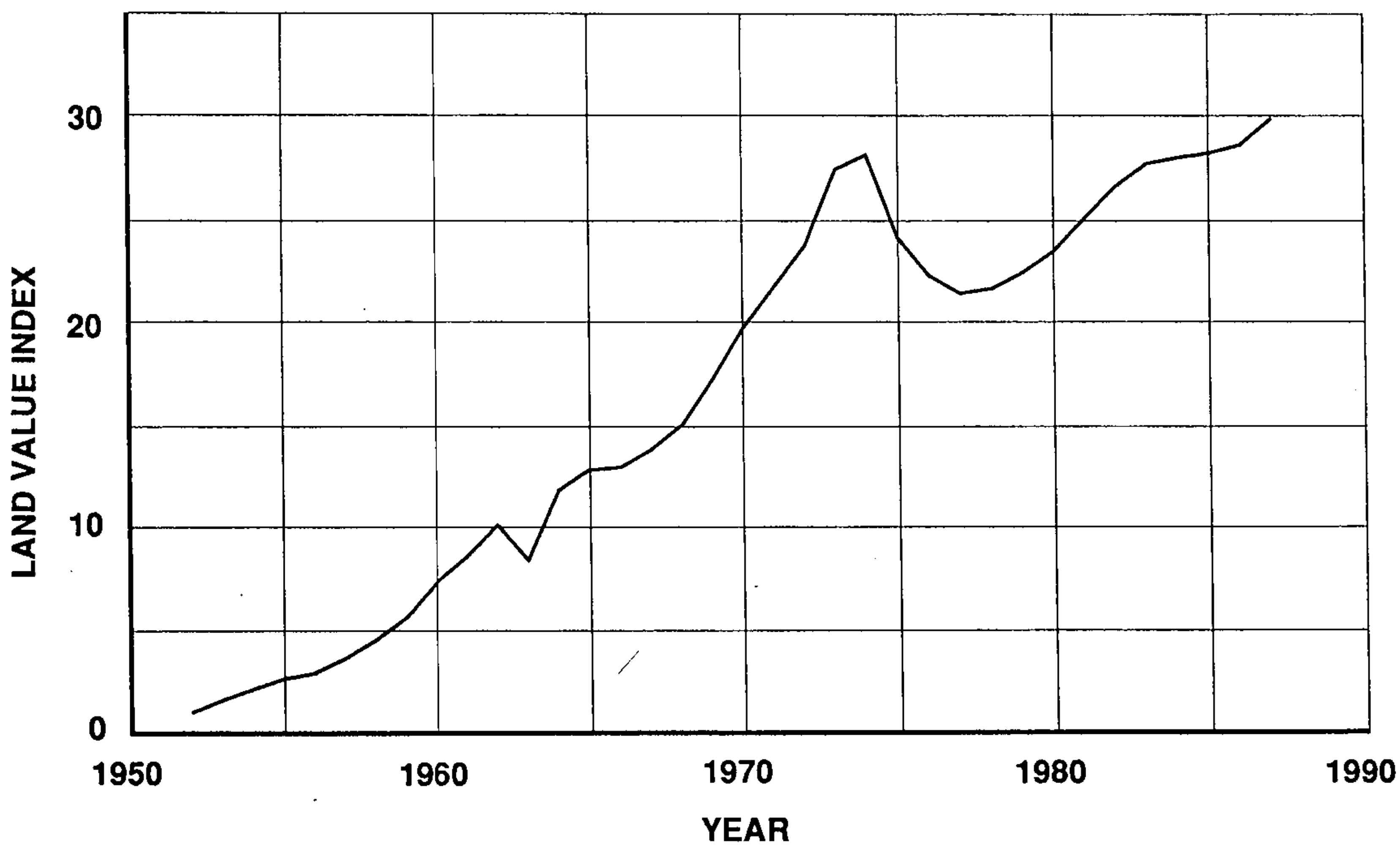

TABLE 1

LAND VALUE REGRESSIONS (1954-87)

Data Set	6 Cities	134 Cities	140 Cities	140 Cities
Dependent Variable = Land Value Index				
Independent Variables				
Income Per Capita (1000s 1985 yen)				0.014478* (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				
Independent Variables				
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			
Independent Variables			
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[a]				
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 (11), 1987, Table 14-7, p. 490.

b. Source is (11), 1976, Table 270, pp. 362-3.

c. Sources are (12), Table 27, rents for privately owned houses; and (13), 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 (16), 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

	Land Value V	Housing Rent R	Population N	Per Capita Income Y	Land Supply A	Population Rate of Growth N'
Units	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 (1980-85)
Tokyo (23-ku)	736	4221	8354	2945	0.765	0.000
27 Other Cities Mean	117	2052	902	1862	0.794	0.896

TABLE 6

LAND VALUE REGRESSIONS

Functional Form	Linear	Log-Linear
Independent Variables		
Population	0.0398*	0.254*
	(3.51)	(2.32)
Income	0.0615*	1.201*
	(2.15)	(2.40)
Land Supply	-67.24	-0.558
	(-1.23)	(-1.63)
Constant	19.79	-6.16*
	(0.37)	(-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
Independent Variables		
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 Pooled

Metro Area	Number of Observations	Land 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

$$\ln V = \underset{(143.60)}{7.276} - \underset{(-12.72)}{0.0270}\, U + \underset{(20.57)}{1.083}\, DT + \underset{(11.82)}{0.700}\, DO \qquad \bar{R}^2 = .621$$

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

TABLE 9

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: Dependent Variable = Ln Land Value		
			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 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 parenthethical figures are t-statistics.

TABLE 11

HOUSING RENTS AND INTRACITY DISTANCE

Metro Area	Number of Observations	Mean Rent (yen per tatami per mo.) Wooden House	Non-Wooden House	Range of Distances of Rent Observations (km.)
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:

$$\ln R = \underset{(222.14)}{7.419} - \underset{(-8.62)}{0.00953}\,U + \underset{(23.30)}{1.058}\,DTE + \underset{(20.36)}{0.783}\,DTW + \underset{(13.04)}{0.781}\,DOE$$

$$+ \underset{(5.87)}{0.257}\,DOW + \underset{(10.78)}{0.435}\,DNE \qquad \bar{R}^2 = .930$$

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