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Disaggregation of Housing into Structure and Garden
—— Empirical Studies of Microeconomic Residential Land Use ——

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Abstract

This paper is a report on the empirical studies of microeconomic residential land use in Japan. First, parameters concerning housing consumer's preference between structure and garden will be calibrated, together with construction technology parameters, from the prefecture based data source. Secondly, housing will be measured in terms of the yardstick that takes account of both structure and garden, running a comparison with the results of the conventional yardstick, floor space. Thirdly, the demand parameters of housing, income and price elasticities of housing will be estimated with the new yardstick.

Keyword: Disaggregation of housing, Residential land use, Garden preference parameter and climate, Housing Service Generating function

I. Introduction

In a country where residential land is very scarce and its price is therefore exorbitant, the way each residential lot is used is very important. In this paper I report on my empirical studies of microeconomic residential land use in Japan. As to the theoretical framework of the discussion, I heavily draw on the model of optimum intensity of horizontal land use by Shimizu (1981), in which housing service, it is assumed, is generated by both structure and garden. First, parameters concerning housing consumer's preference between structure and garden will be calibrated, together with construction technology parameters, from the prefecture based data source. Then, an attempt will be made to see how the variation in the garden preference parameter values may be accounted for by climatic and economic factors. Secondly, we will measure housing in terms of the yardstick that takes account of both structure and garden, running a comparison with the results of the conventional yardstick, floor space. Thirdly, damand parameters of housing, income and price elasticities of housing, will be estimated with the new yardstick.

II. Parameters of Housing Service Generating Function

Given housing service generating function which is assumed to generate the flow of housing service (H) from the two sources of housing factors, structure (S) and garden(G),

$$
\begin{aligned}
\text{(1)}\quad H &= S^{a}G^{b} \\
&= (AK^{\alpha}L^{\beta})^{a}G^{b} && a+b=1 \\
&= A^{a}\,K^{a\alpha}\,R^{a\beta+b}\,m^{a\beta}(1-m)^{b}, && \alpha+\beta=1
\end{aligned}
$$

in which K is construction capital (including labor), L is construction land, R is the lot size ($L=mR$ and $G=(1-m)R$), a and b are housing consumer's preference parameters, and A, α and β are construction parameters, it may be possible to try to calibrate values of these parameters with an appropriate set of data.

For the calibration, two data sources played extremely important roles. One is Housing Survey which is conducted and published every five years. The Survey carries data concerning the ratio of build up area to the lot size of detached and terraced dwelling units by prefecture. The ratio of build up area to the lot size as presented in the survey is used as the optimum intensity of horizontal land use, m, which each housing consumer has chosen. Since most dwelling units are bespoken in Japan, it may be reasonable to assume that the ratio of actual build up area to the lot size reflects the consumer's real preference regarding the residential land use. Since this study is about single family dwelling units built in particular years and that the data collected in the survey (1973) covers not only various types of housing units other than single family housing units but also all existing units of various vintages, I have made some adjustments to the data on the ratio of build up area to lot size so that the cross prefecture average of build up ratio to lot size is equal to that of the national average of the single family dwelling units built in 1970 and 1977, which is the concern of this study, using some auxiliary data in the same survey and other data sources (1). Another major source of data for this study is Statistical Reports by the Japan Housing Loans Corporation (JHLC), a government agency solely responsible for housing loans. JHLC data which is tabulated on prefecture basis is desirable for two reasons. First, JHLC loans are the single most popular financial means available to individuals who intend to have their houses custom built, so much so that three dwellings out of every ten were built with a loan from JHLC in 1975 (2), enabling one to rely on the data for its wide coverage and generality. Second, since JHLC data on single family dwelling units is collected on the basis of information supplied by the individuals when they make an application for loans with JHLC, the data is most likely to be a genuine reflection of housing consumers' preference. However, the limitations of the JHLC data must be mentioned. First, the JHLC data covers only those new houses whose building standards have met those set by JHLC, which are supposedly quite strict in terms of housing quality. Therefore the housing data from JHLC entirely excludes that of low quality housing. Secondly, as JHLC extends housing loans preferentially to those who have already obtained building lot or who intend to replace the old house with a new one, the simultaneous response of the housing consumer with respect to the change in land price may not always be possible to obtain from the data.

Since the total expenditure on a house and its breakdown, the amount of construction expenditures (which include labor costs), iK and that of residential land price, rR, are given in JHLC data, and the ratio of built up area to the lot size (m) has been obtained as explained above, parameters a, and α in [1) may be solved in terms of the given data within the framework of consumer's optimization behavior as,

$$[2) \quad a=\frac{iK+mrR}{y}$$

$$\alpha=\frac{iK}{iK+mrR}$$

in which $y=iK+rR$.

Table 1 gives the parameter values of "a" calculated for 1970 and 1977. An "a" will show the magnitude of housing service generating elasticity with respect to structure and "b" or (1-a) with respect to garden. The mean value of a is 0.6994 (0.7207) for 1970 (1977), implying that the housing consumer spends about 70% of his housing expenditure on structure and 30% on garden to maximize the utility he derives from his housing. An "α" shown in Table 2 indicates the share of the capital (including labor) costs in the production of housing structure. The mean value for α is 0.8150 for 1970. After all, about 57% of the total housing expenditure is for capital (and labor) costs and 43% for land cost in the breakdown of housing expenditure for 1970 (3).

Table 1 PARAMETERS(a)

PREFECTURE	1970	1977			
HOKKAIDO	0.749	0.763	FUKUI	0.753	0.748
AOMORI	0.676	0.699	SHIGA	0.727	0.720
IWATE	0.705	0.737	KYOTO	0.671	0.722
MIYAGI	0.676	0.669	OSAKA	0.696	0.702
AKITA	0.731	0.749	HYOGO	0.700	0.709
YAMAGATA	0.701	0.758	NARA	0.731	0.691
FUKUSHIMA	0.713	0.734	WAKAYAMA	0.739	0.744
TOCHIGI	0.719	0.665	TOTTORI	0.739	0.765
GUNMA	0.636	0.689	SHIMANE	0.798	0.811
NIIGATA	0.658	0.737	OKAYAMA	0.719	0.741
NAGANO	0.744	0.746	HIROSHIMA	0.686	0.726
TOKYO	0.545	0.598	YAMAGUCHI	0.764	0.756
IBARAKI	0.624	0.650	TOKUSHIMA	0.670	0.703
SAITAMA	0.593	0.603	KAGAWA	0.690	0.715
CHIBA	0.595	0.611	EHIME	0.732	0.746
KANAGAWA	0.618	0.609	KOHCHI	0.762	0.766
YAMANASH	0.644	0.683	FUKUOKA	0.706	0.716
SHIZUOKA	0.676	0.703	SAGA	0.759	0.801
GIFU	0.722	0.759	NAGASAKI	0.738	0.768
AICHI	0.699	0.685	KUMAMOTO	0.672	0.738
MIE	0.762	0.768	OITA	0.708	0.777
TOYAMA	0.760	0.762	MIYAZAKI	0.673	0.727
ISHIKAWA	0.742	0.770	KAGOSHIMA	0.650	0.712

Next an effort has been made to calculate the value of A, the scale parameter of structure production function. Before doing so, it was necessary to know the price of construction capital goods, as what is known from the JHLC data is only the average amount of capital spent on construction capital goods including labor costs. The price index of construction capital goods for each prefecture has been generated. The items that are included in my price index are the mean wage index of carpenters, the mean price index of cement and the mean price index of timber cut into a standard size across prefecture (4). The three indexes were simply averaged to obtain the price index of construction capital suppose that structure consists of floor space multiplied by its quality, and that the quality may conveniently be expressed by the total amount of capital spent on structure divided by the floor space (5). With these assumptions, A's have been calculated as shown in Table 2.

Our next concern with these parameters is whether these parameters are stable over time or not. This can be realized by testing if each set of the parameters shows a statistical defference between 1970 and 1977. Table 3 displays, together with the mean value and the coefficient of variation of each parameter, the F value to show whether there is a significant difference between 1970 and 1977. It is known from the table that the parameters related to construction technology are extremely stable over time, while parameters concerning housing consumers' preference between structure and garden are not so stable over time.

Table 2 CONSTRUCTION PARAMETERS

PREFECTURE	1970		1977	
	A	α	A	α
HOKKAIDO	1.245	0.896	1.159	0.894
AOMORI	1.123	0.851	1.152	0.854
IWATE	1.110	0.855	1.078	0.865
MIYAGI	1.355	0.842	1.333	0.823
AKITA	1.235	0.858	1.244	0.859
YAMAGATA	1.303	0.850	1.203	0.878
FUKUSHIMA	1.269	0.856	1.288	0.859
TOCHIGI	1.199	0.905	1.268	0.868
GUNMA	1.444	0.846	1.258	0.868
NIIGATA	1.476	0.798	1.212	0.849
NAGANO	1.344	0.861	1.272	0.850
TOKYO	2.899	0.554	2.564	0.604
IBARAKI	1.278	0.879	1.327	0.884
SAITAMA	1.757	0.797	1.738	0.789
CHIBA	1.678	0.819	1.594	0.817
KANAGAWA	1.936	0.743	2.047	0.707
YAMANASHI	1.254	0.798	1.344	0.815
SHIZUOKA	1.471	0.789	1.445	0.796
GIFU	1.295	0.800	1.287	0.819
AICHI	1.939	0.797	1.971	0.762
MIE	1.246	0.863	1.371	0.855

TOYAMA	1.318	0.872	1.394	0.861
ISHIKAWA	1.387	0.809	1.328	0.819
FUKUI	1.273	0.855	1.466	0.836
SHIGA	1.353	0.834	1.466	0.812
KYOTO	1.987	0.672	1.893	0.714
OSAKA	1.948	0.665	2.023	0.636
HYOGO	1.715	0.742	1.668	0.726
NARA	1.579	0.778	1.740	0.701
WAKAYAMA	1.599	0.771	1.694	0.753
TOTTORI	1.274	0.868	1.224	0.875
SHIMANE	1.332	0.873	1.289	0.872
OKAYAMA	1.275	0.815	1.255	0.818
HIROSHIMA	1.549	0.743	1.473	0.766
YAMAGUCHI	1.215	0.851	1.307	0.830
TOKUSHIMA	1.222	0.819	1.342	0.831
KAGAWA	1.322	0.802	1.264	0.808
EHIME	1.336	0.808	1.346	0.803
KOHCHI	1.244	0.804	1.239	0.788
FUKUOKA	1.274	0.824	1.225	0.818
SAGA	1.218	0.849	1.208	0.871
NAGASAKI	1.180	0.818	1.340	0.830
KUMAMOTO	1.316	0.836	1.208	0.871
OITA	1.224	0.834	1.218	0.874
MIYAKI	1.060	0.850	1.096	0.875
KAGOSHIMA	1.141	0.838	1.174	0.868

Table 3 Statistics of Parameters

	a	A	alpha
mean value			
1970	0.69937	1.41725	0.81496
1977	0.72065	1.41377	0.81670
coefficient of variation			
1970	3.4923 E−4	1.0662 E−4	3.6419 E−4
1977	3.2303 E−4	9.8481 E−5	3.7087 E−4
F−value(1/90 d.f.)			
	3.99952	1.1352 E−2	1.7322 E−2

Notes. Only at the level of 5% can one reject the hypothesis that the parameter a is the same between 1970 and 1977. Parameters A and alpha are not significantly varied between 1970 and 1977.

III. Garden Preference Parameter and Climate

In this section I report on the results of regression analysis of the garden preference parameter on some variables related to climate. To what extent the regional difference in garden preference parameter ("b") may be explained by the regional differences in climate, as it is often hypothesized that regional climate helps to form the temperament of local citizens. To explain variables which are related to climate, four variables are first chosen: average temperature, sunshine hours, clear days and precipitation (6). Temperature is the most common variable to be employed in connection with attempts to explain regional differences and it varies widely over the year and in regions in Japan. However, it is very difficult to predict a priori how temperature may affect the garden preference parameter. The high level of temperature might be associated with an enhanced level of activities involving garden in winter but may show a negative association in summer and that it is always the case, where it is mild in winter, and it is very hot in summer. I used average temperature (expressed in centigrade) over the year, in which each day's data is given as the mean value of eight observations per day. The average temperature varies from 7.9 centigrade for Hokkaido to 17.2 centigrade for Kagoshima with the mean value of 13.8 centigrade and the standard deviation of 2.05 centigrade.

Sunshine is considered to be an important characteristic of living environment. Where it is very cold in winter and it is very humid in summer, sunshine plays a vital role in the such a way that people live comfortably. Not only does sunshine provide natural light but also it becomes a substitute for energy for heating rooms, if not a direct source of energy. People let in the maximum amount of sunshine so that it will sterilize the room, especially when humidity is so high that germs may find it most comfortable to multiply in the house. It is a common scene that newly washed clothes are dried in the yard under the sun. In any event, sunshine is one of few natural resources which Japan is favored with and has learned to make full use of. As to the effect of sunshine hours on garden preference parameter, it is most likely that the variable is negatively associated with garden preference parameter, that is, the scarcer sunshine is, the greater is the preference for more spacious garden to let in the maximum amount of sunshine without obstacles. Sunshine is measured by total hours per year, with the mean of 2037.6 hours and the standard deviation of 159.6 hours.

Japan is a long archipelago lying northeast to southwest and its climate varies widely. Perhaps the number of clear days per year differs as markedly as any other climatic variables. Regions facing the Pacific Ocean enjoy far more clear days than regions facing the Sea of Japan. Clear days are expressed by the number of clear days per year, with the mean of 44.8 days and the standard deviation of 15.7 days. As outdoor activities are most likely to be performed on clear days, the relationship between the garden preference and clear days may be speculated to exist in positive terms.

The last climatic variable I employed is precipitation. The volume of precipitation may have an influence on the preference for garden. Lower level of precipitation will allow more activities in garden, suggesting a negative relation between them. Precipitation is expressed by mm per year, with the mean of 1680.0 mm and the standard deviation of 442.1 mm.

In addition to the above four climatic variables, income variable has been included as an economic variable in the regression on garden preference parameter. Inclusion of income variable in the regression is an attempt to see if an economic variable may be relevant in the determination of garden preference (7). The result of the regression is reported in Table 4-a. Except for an average temperature variable and income variable, all the other variables seem to be significant in explaining the dependent variable, garden preference parameter, with expected signs. Temperature variable and income variable do

Table 4-a Regression Anglyais of Garden Preference Parameter

Independent Variables	1970	1977	Pooled
Constant	1.651	−0.529	0.594
	(0.42)	(0.14)	(0.23)
Average Temperature	0.191	0.193	0.192
	(0.93)	(0.99)	(1.39)
Sunshire Hours	−0.811	−0.865	−0.837
	(1.65)	(1.87)	(2.54) *
Clear Days	0.248	0.259	0.253
	(2.56) *	(2.84) *	(3.91) *
Precipitation	−0.241	−0.300	−0.270
	(2.12) *	(2.81) *	(3.55) *
Income	0.173	0.544	0.359
	(0.49)	(1.65)	(1.53)
D=1 if 1977			−0.074
			(2.44) *
R square	0.259	0.368	0.338
F value	2.80	4.67	7.25
Sample Size	46	46	92

Notes. Variables are in natural log form. T values are in parentheses. * shows r-value is significant at 5% level. F values are all significant at a 5% level.

not appear to be very powerful in explaining the dependent variable. As a next step, a regression was run employing only three independent variables which have been proved to be powerful in explaining the dependent variable, sunshine hours, clear days and precipitation. The regression result is shown in Table 4-b. The value of each coefficient in Table 4-b does not differ from that of the previous table, although t-value has been in most cases enhanced. The study of regression has shown that garden preference parameter is most responsive to sunshine hours, and then to clear days and precipitation. The three climatic variables jointly explain about one fourth to one third of the variation in garden preference parameter.

IV. Measurement of Housing

Quantification of housing is usually not distinct and arbitrary. In Japan, for example, it is most frequently done by counting the number of tatami, the unit of floor space. Since residual housing land or garden seems to be an integral part of housing, the failure of the recognition that garden plays a role in the generation of housing service will result in inaccuracy and distortion of housing measurement. What is more, the distortion resulting

Table 4-b Regression Analysis of Garden Preference Parameter

Independent Variables	1970	1977	Pooled
Constant	2.450	3.518	3.021
	(1.10)	(1.63)	(1.98)
Sunshine Hours	−0.706	−0.869	−0.787
	(1.59)	(2.02) *	(2.58) *
Clear Days	0.273	0.297	0.285
	(2.93) *	(3.29) *	(4.46) *
Precipitation	−0.184	−0.255	−0.221
	(2.07) *	(2.96) *	(3.61) *
E=1 if 1977			−0.074
			(2.40) *
R square	0.238	0.308	0.304
F value	4.37	6.23	9.50
Sample Size	46	46	92

Notes. Variables are in natural log form. T values are in parentheses. * shows t-value is significant at 5% level. F values are all significant at 5% level.

from not paying due consideration to garden will grow, as structure is getting substituted for land in the face of asymmetric increases of land values with respect to prices of other housing inputs.

Although I can not exactly highlight the divergence in the measurement of housing between the two yardsticks because of the JHLC data I used which still do not reflect the latest trend of residential land being very intensively substituted for structure (8), measurement of housing will be shown below with two yardsticks, space yardstick, structure and garden yardstick and their difference will be noted. First housing growth over seven years from 1970 to 1977 is presented, together with the growth of housing expenditure, as in Table 5. The first column shows the growth of housing expenditure by prefecture over the seven years after inflation adjustment (9). The second column displays housing growth measured only in terms of floor space and the third column shows housing growth measured in terms of both structure and garden calibrated from [1) using parameters presented above. Although housing growth in either measurement has in most prefectures failed to catch up with housing expenditure growth, it is apparent that the two yardsticks produced a big difference in the measurement of housing growth: housing growth measured in terms of both structure and garden seems to have registered much higher rates of growth, indicating that the general level of housing has considerably improved than when one compares only floor space of the two periods. Next, in order to see the growth of housing price in the two yardsticks, the growth rates of housing price are given in Table 6. The first column shows the unit floor price of 1977 divided by that of 1970, while the

Table 5 HOUSING GROWTH

PREFECTURE	Y_{77}/Y_{70}	F_{77}/F_{70}	H_{77}/H_{70}
HOKKAIDO	1.744	1.335	1.730
AOMORI	1.621	1.363	1.598
IWATE	1.538	1.328	1.504
MIYAGI	1.635	1.289	1.461
AKITA	1.671	1.349	1.618
YAMAGATA	1.552	1.344	1.719
FUKUSHIMA	1.633	1.323	1.591
TOCHIGI	1.847	1.331	1.480
GUNMA	1.459	1.318	1.460
NIIGATA	1.378	1.335	1.653
NAGANO	1.568	1.299	1.494
TOKYO	1.554	1.389	1.473
IBARAKI	1.578	1.320	1.396
SAITAMA	1.702	1.342	1.432
CHIBA	1.532	1.330	1.398
KANAGAWA	1.634	1.302	1.354
YAMANASHI	1.430	1.332	1.477
SHIZUOKA	1.485	1.327	1.509
GIFU	1.373	1.272	1.490
AICHI	1.639	1.308	1.403
MIE	1.570	1.280	1.522
TOYAMA	1.526	1.220	1.474
ISHIKAWA	1.359	1.205	1.471
FUKUI	1.599	1.286	1.501
SHIGA	1.557	1.210	1.406
KYOTO	1.381	1.243	1.515
OSAKA	1.537	1.224	1.357
HYOGO	1.494	1.182	1.379
NARA	1.714	1.263	1.328
WAKAYAMA	1.561	1.225	1.452
TOTTORI	1.512	1.230	1.481
SHIMANE	1.544	1.257	1.574
OKAYAMA	1.462	1.239	1.461
HIROSHIMA	1.458	1.207	1.554
YAMAGUCHI	1.702	1.246	1.541
TOKUSHIMA	1.491	1.253	1.450
KAGAWA	1.537	1.262	1.503
EHIME	1.574	1.208	1.497
KOHCHI	1.548	1.219	1.523
FUKUOKA	1.626	1.273	1.524
SAGA	1.488	1.275	1.625
NAGASAKI	1.511	1.292	1.580
KUMAMOTO	1.462	1.293	1.578
OITA	1.426	1.265	1.602
MIYAZAKI	1.490	1.311	1.599
KAGASHIMA	1.426	1.276	1.614

Table 6 PRICE INCREASE

PREFECTURE	$(P_{77}/P_{70})F$	$(P_{77}/P_{70})H$	PREFECTURE	$(P_{77}/P_{70})F$	$(P_{77}/P_{70})H$
HOKKAIDO	1.307	1.009	FUKUI	1.244	1.065
AOMORI	1.190	1.015	SHIGA	1.287	1.108
IWATE	1.158	1.023	KYOTO	1.111	0.911
MIYAGI	1.269	1.119	OSAKA	1.255	1.133
AKITA	1.239	1.032	HYOGO	1.265	1.084
YAMAGATA	1.155	0.903	NARA	1.358	1.291
FUKUSHIMA	1.234	1.026	WAKAYAMA	1.275	1.075
TOCHIGI	1.388	1.248	TOTTORI	1.229	1.021
GUNMA	1.107	0.999	SHIMANE	1.228	0.981
NIIGATA	1.032	0.834	OKAYAMA	1.180	1.000
NAGANO	1.207	1.049	HIROSHIMA	1.208	0.939
TOKYO	1.119	1.055	YAMAGUCHI	1.366	1.104
IBARAKI	1.196	1.130	TOKUSHIMA	1.190	1.028
SAITAMA	1.268	1.189	KAGAWA	1.218	1.022
CHIBA	1.152	1.096	EHIME	1.303	1.052
KANAGAWA	1.255	1.207	KOHCHI	1.270	1.017
YAMANASHI	1.073	0.968	FUKUOKA	1.277	1.067
SHIZUOKA	1.119	0.984	SAGA	1.166	0.916
GIFU	1.080	0.921	NAGASAKI	1.170	0.956
AICHI	1.253	1.168	KUMAMOTO	1.131	0.927
MIE	1.227	1.031	OITA	1.128	0.890
TOYAMA	1.251	1.036	MIYAZAKI	1.136	0.932
ISHIKAWA	1.128	0.924	KAGOSHIMA	1.118	0.884

second column displays the price of the unit housing service generated by both structure and garden of 1977 divided by that of 1970. Table 6 reveals, what a scan of Table 5 hinted. Although the floor price of housing underwent a considerable inflation during the period from 1970 to 1977,the price of housing service generated by both structure and garden did not necessarily show a rise (10).

The difference in housing growth and price increases which is shown by two different yardsticks may be explained as follows. First floor space yardstick does not take into account the quality of floor space, while structure and garden yardstick does. Second, structure and garden yardstick take into consideration substitutions which must have resulted from asymmetric price increases of the factors of production. In other words, one can tell under what circumstances the difference between the two yardsticks generate a great difference. Structure and garden yardstick will be more responsive to the change in housing than floor space yardstick when the change in quality of floor space is great and substitutions among factor inputs are substantial. Or, one may say the floor space yardstick is valid only when the change of floor space quality is minimum and substitutions among factor inputs are not significant.

Although housing growth measured in terms of structure and garden in all cases exceeded that measured in terms of floor space in Table 5, this is not always so, because the case is attributable to the following facts which may not be sustained for long when the size of residential lots for single family housing did not shrink according to the JHLC data during the study period, in spite of the fact that the residential land space per housing has markedly shrunk recently. I am sure that the two yardsticks will diverge more dramatically if I can make use of data which takes into account the latest housing trend of highly intensive substitution of structure for land.

Regional variation of housing is an interesting topic as it is generally admitted that there exists a big gap in the level of housing between big cities and rural regions in favour of the latter. To improve housing situation in big cities has been a major concern of government as may be known from a series of legislation enacted with a view to easing housing problems in big cities (11). Now I will show how regional variation of housing has changed over the period according to the two yardsticks. In Table 7, regional variation of housing is shown in terms of the coefficient of variation by the two yardsticks, together with regional housing price variation. The table indicates that regional variation in housing shrank over the period with either yardstick, and that regional housing variation is much smaller than that of housing price. According to the structure and garden yardstick, there is even a sign that the regional variation of housing price may even grow bigger, perhaps reflecting growing regional variation of land price.

Table 7 Regional variation of Housing

	Coefficients of Variation	
	1970	1977
Floor Space Yardstick	0.0614	0.0495
	(83.16)	(106.47)
Structure - Garden Yardstick	0.0706	0.0698
	(240.25)	(361.57)
Price per Unit Floor (s. m)	0.2778	0.2721
	(5915)	(7124)
Price per Structure - Garden Unit	0.2707	0.3098
	(2043)	(2113)

Notes: Coefficient of variation is the standard deviation divided by the mean value. Figures in parenthesis indicate mean value. Price is shown in yen.

V. Income and Price Elasticities of Housing

Income and price elasticities of housing are important parameters from the policy point of view. Although there are various studies on the subject in America and Britain (12), there is not any literature on the subject in Japan except for Yamada et al (1976). I will now show two cases of housing demand parameters estimated by using the above data. It will be noted that I can avoid the specification errors which might be created by omitting the price term, since the price of housing in my case is explicitly known from the data. The first one uses floor space (F) as dependent variable and explaining variables are its price (P), the consumer's income (Y) and a dummy variable(D) to distinguish 1970's data from that of 1977. The result is as follows (13):

$$F = 3.624 - 0.127P + 0.142Y + 0.243D$$
$$(7.04) - (5.83) \quad (1.96) \quad (13.8)$$
$$R\ \text{square} = 0.8784 \qquad F\ \text{value} = 211.82.$$

The price elasticity and income elasticity of the estimation are very low, but they are consistent with what Yamada et al found in their study (14). Great value of the dummy variable, especially in comparison with other coefficient values, indicates that housing demand in Japan is very responsive to a trend factor. Now the second regression was run with structure and garden housing service unit (H) as dependent variable and with its price (P_H).

$$H = 4.182 - 0.155P_H + 0.196Y + 0.373D$$
$$(6.32) \quad (5.65) \quad (2.11) \quad (16.5)$$
$$R\ \text{square} = 0.9212 \qquad F\ \text{value} = 342.72$$

Except the values of parameters are slightly higher and that explaining ability of the independent variables has been enhanced in the second estimation, there is no fundamental change in the two estimations. The fact that the parameter values are slightly greater in the second estimation may perhaps be explained by the nature of variable to reflect the demand preference of the consumer more directly.

(Notes)

(1) Other data sources are Housing Survey of 1968 and 1978, the Construction Statistics, 1970 and 1977, and the Japan Statistical Year Book, 1970 and 1977.
(2) Data is from the Japan Housing Loans Corporation, Annual Report, 1975 and the Construction Statistics, 1975.
(3) The ratio of money spent on construction capital (including labour) is $iK/y = a\alpha$. This ratio became 59% in 1977 as can be known from Table 3.
(4) The data is from Bureau of Statistics, Office of Prime Minister, National Survey of Prices, 1970 and 1977.
(5) In other words, the left hand side of structure production function is the total amount of capital spent on structure, or iK. iK of 1977 is deflated by the factor of 1.839, which is the construction costs inflation rate from 1970 to 1977.
(6) Data is from Meteorology Agency, Annual Report of Meteorology, 1976.
(7) For income variable, land price variable has been also substituted in another regression, but the land price variable is less powerful in explainig the dependent variable than income variable.
(8) Recently the size of residential land has markedly shrunk. For example, the mean lot size for those houses built between 1961 and 1965 was 214 square meters, but it dropped to 171 square meters for those built in 1973. However, the JHLC data I used has not reflected

the trend yet. The mean lot size for JHLC data was 263 square meters for 1970 and 264 square meters for 1977. This is due to these facts: (1) the JHLC data covers only quality housing because of the high standard set by JHLC and (2) JHLC usually extends loans to those who have already obtained residential land, making its data less responsive to the immediate change in land price.

(9) Housing expenditure (y) for 1977 is deflated by the factor of 2.036, an inflation rate of the consumer price index between 1970 and 1977. In calculating H_{77}, iK of 1977 is deflated by 1.839 to take into account construction cost inflation between the same period.

(10) This is because the quality of floor space has improved 1.41 times over the period. The quality of floor space is calculated by dividing iK (the amount of money spent on structure) by the floor space.

(11) The most notable examples will be the Residential Rehabilitation Act (Zayutaku Chiku Kairyo Hou), 1960 and the Urban Renewal Act (Toshi Saikaihatsu Hou), 1969.

(12) Examples are Muth (1969), DeLeeuw (1971) and Byatt et al(1973).

(13) All variables are in natural log forms.

(14) Yamada et al (1976) found that income elasticity is 0.1566 and price elasticity 0.2274 for wooden single family housing, which may be most likely to correspond to the types of housing covered in the JHLC data.

(References)

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