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Targeted Standards for Floor Space in a Government Housing Plan: an Empirical Investigation of the Kanto Area in Japan

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We estimate a demand function for household floor space in the Kanto area in Japan by using a survey questionnaire, and conduct calibrations to investigate whether effective demand is consistent with the prescribed targeted or minimum floor space in Japan's Basic Act for Housing. The results indicate that one- and two-person families can afford relatively large houses, but many three-person families with lower incomes and most four- and five-person families cannot afford housing that meets the Act's targeted housing standards. This result implies that further subsidies are needed to achieve the Act's targets.

Keywords

Housing; Floor space; Housing standards; Japan

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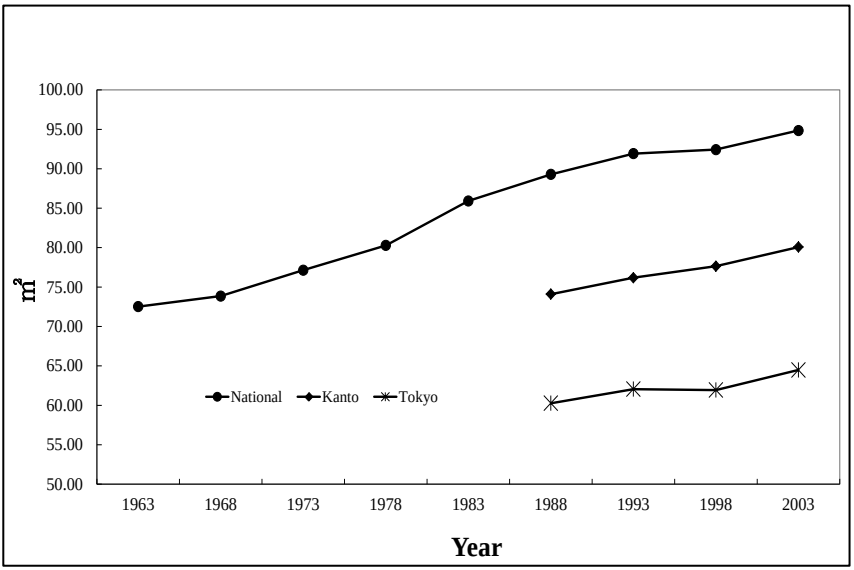
1. Introduction

In 1966, the central government and local authorities in Japan began to establish five-year plans for housing construction and measures to improve residential environments under the Housing Construction Plan Act. The original purpose of these plans was to ensure that the housing supply met the "implicit" housing demand. This implicit demand was generated by people in temporary accommodations who had lost their homes in air raids during World War II or returned from Japan's former colonies. In addition, after World War II, a baby boom was encouraged in Japan, and these babies seemed to have created a huge demand for housing as they grew older. In the early 1980s, an Organisation for Economic Co-operation and Development (OECD) report said that most Japanese lived in "rabbit hutches." Although some researchers, such as Eggers (2006), suggest that this context is nothing but a kind of political failure, many politicians and the mass media quoted the report, thus driving policy makers to increase the floor space for housing. In the 1990s, the new slogan became "from quantity to quality" because the total amount of housing seemed sufficient and the housing vacancy rate had risen to a relatively high level. Because in this period housing floor space steadily grew (see Panel (A) of Figure 1) in parallel with a decrease in the number of members in each household (Panel (B) of Figure 1), floor space per person also rapidly increased.

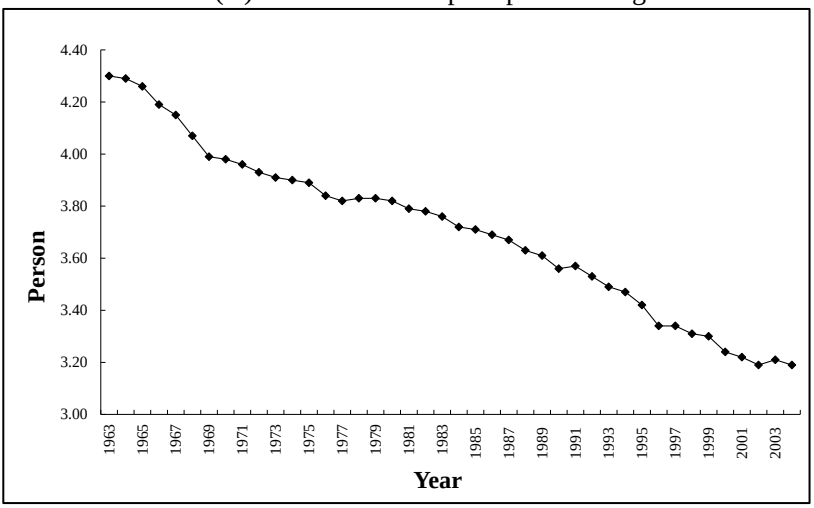
After the final five-year plan for housing construction expired at the end of the 2005 fiscal year, the Japanese Government enacted the Basic Act for Housing following the Housing Construction Plan Act. Under this Act, the central government and local authorities are required to formulate basic plans for housing to ensure a stable supply of housing and improve standards. These plans are required to set out not only space standards for houses, but also criteria for improving the residential environment. For the space standards, the plans provide both minimum and targeted housing standards; for the latter, there are two kinds of standards: one for apartments in urban areas and the other for detached houses based on household size. The aim of these plans is to increase the proportion of houses that meet the targeted housing standards for urban areas from 37% (in 2003) to 50% by 2015. However, the Act only lays down standards and sets targets, whereas the previous five-year plans had included the distribution of subsidies for new development of suburban apartments. In other words, although the Japanese Government enacted the Basic Act for Housing, and thus obliging local authorities to formulate basic plans for housing, it ceased to provide any supporting measures or financing.

When evaluating this policy change by the Japanese government, we should investigate the state of the demand for floor space and the effects of stopping subsidies. Statistics from various sources show that average floor space has been continuously expanding and that most Japanese no longer seem to reside

Figure 1 Trends in Floor Space Per Dwelling and Number of Household Members



(A) Trends in floor space per dwelling



(B) Trends in number of household members

in “rabbit hutches.” However, such statistics may reflect the rising number of households that consist of aged singles or couples. The assessing of this kind of effect requires a more detailed analysis of the attainment of housing floor space standards. A finding that most households consist of aged singles or couples living in relatively large houses because their adult children have left home will indicate that there may still be the need to improve housing quality,

including floor space, for younger families. This problem also relates to whether adult children live with their parents. In the present paper, although we do not directly address whether children live with their parents or not, we estimate the floor space demand function as the first step in examining floor space demand. We have conducted a survey in the Kanto area (Figure 2), which includes the capital Tokyo and Kanagawa, Saitama, Gunma, Tochigi, Ibaraki, and Chiba prefectures, to investigate its housing environment. Because this area is home to approximately one-fourth of Japan's total population and has the highest population density in the country, the problem of insufficient floor space is very serious, and this highly urbanized area provides a setting in which we can observe the status of housing demand.

Figure 2 Location of Tokyo and Kanto Area in Japan

In the next section, we conduct a survey of related research. In Section 3, we briefly explain our questionnaire survey. In Section 4, we estimate the floor space demand function. Then, in Section 5, we compare the calibrated levels

of floor space demand with the targeted standards to discuss the state of housing demand. Finally, we conclude the paper and consider some remaining issues.

2. Literature Review

With regard to the housing problem in Japan, Kanemoto (1997) has comprehensively analyzed Japanese housing policy issues based on international comparison and shows that the average floor space per person or house in Japan was relatively small at that time. He also attributes the small average size of rental housing to the tax advantages of owning land. Vliet and Hirayama (1994) point out that housing conditions in Japan were poor because land prices had grown faster than incomes.

Few studies have estimated the floor demand function in Japan. Seko (1990) proposes a space demand function and analyzes the relationship between floor space demand and housing quality, as indicated by the price of housing floor space. She points out the importance of the role played by the government's Housing Loan Corporation in the five-year plans for housing construction. Seko (1991) estimates a demand function for floor space as well as for housing lots, noting that floor space demand became larger when families inherited land from their parents. Seko (1999) analyzes the effects of property taxation on floor space demand with piecewise-linear budget constraints, and Seko (2002) applies this approach to investigate the effects of subsidized home loans on floor space demand.

In similar studies in Korea, Lim, Follain and Renaud (1984) estimate a simple floor space demand function and statistically find significant effects of income (positive), land price (negative), construction cost (negative), number of household members (positive) and commuting cost (negative). Choi and Ha (2010) investigate floor space demand in the Seoul Metropolitan Region and examine the relationships between the needs of low-income renter households and demographic change. In Hong Kong, Chan, Tang and Wong (2002) and Jayantha and Lau (2008) investigate floor space demand. Lai and Ho (2001) do not directly estimate a floor space demand function, but analyze the choice probabilities for so-called "small houses" in Hong Kong, which may also be relevant to small floor space demand.

More generally, some researchers have examined the relationships between the total demand for housing and changes in the age structure of populations that arise from factors such as baby booms. Mankiw and Weil (1989) take an approach that uses the numbers of household members in each age group as explanatory variables for the total demand for housing. Ohtake and Shintani (1996) estimate a similar demand function by using Japanese data. However, these papers do not consider other explanatory variables in estimating demand functions. Iwata and Hattori (2009) point out the importance of including

other explanatory variables. Hirayama and Ronald (2008) investigate the housing patterns of baby booms and busts, and note the existence of generation-based differences. The problem about the relationships between the number of household members and total demand for housing also relates to whether or not adult children live with their parents. Beginning with Kotilikoff and Morris (1989), many papers have addressed this issue. Ronald and Hirayama (2009) have recently pointed out the individualization of young urban singles. Changing preferences of recent generations affect floor space demand as determined by individual household members.

3. Survey Questionnaire and Candidates for Explanatory Variables

In this section, we briefly summarize our survey design; details of our questionnaire are given in the Appendix. We employed the "Personal Master Samples of the Central Research Service," which is a random sampling of people aged 20 years and over from all over the country divided into three strata. The Central Research Service maintains the "Master Sample," which is collected from more than 60,000 people, as the basis for other surveys. In particular, the Central Research Service keeps records in the Master Sample for 13,218 people, which correspond to the criteria of our study. We obtained records for 2,000 random people from these data; we used only 2,000 records because of budgetary restraints. We sent the questionnaires via mail in February 2009 and obtained 1118 responses.

Next, we selected the candidates for the explanatory variables in our floor space demand function as follows. The candidates can be divided into two broad categories according to items in the questionnaire (see Appendix). The first category contains variables that represent housing costs and the following characteristics: housing type (Q1), housing rent (SQ6), fixed property taxes (SQ5) and ownership of land and house (AQ2).

We then categorized housing into three types (AQ1-1): renting land and house, renting land and building a house on it, and owning land and house. Households in the first type usually pay monthly rent to the owner; those in the second type pay monthly rent on the land to the owner and an annual fixed property tax for the house to the local government; those in the third type of housing pay annual fixed property taxes for both land and house to the local government. In our questionnaire, we did not ask respondents the estate price either per square meter of their house or floor space because we considered that respondents would be unable to give a precise answer to these questions. Instead, we asked for their amounts of annual fixed property tax and monthly housing rent to investigate the effects of the fixed property tax and housing rent per square meter on floor space demand. We construct the variables Price1, Price2 and Price3 to represent housing cost per floor space which

corresponds to the three housing types. In addition, to deal with the differences in basic floor demand for each housing type, we introduce two types of dummy variables: Dum2 and Dum3 for housing types (AQ1-1) and House1 and House2 for the type of house construction (Q1).

The second category of explanatory variables contains variables that represent the characteristics of the household: household's total income (SQ4), the number of household members for each age group (SQ1 and SQ2), length of time residing at the current address (SQ3) and commuting time (Q3 and AQ4–2). We directly construct the variable Income from questionnaire item SQ4. We adopt commuting time as an explanatory variable for commuting cost because employers cover the monetary commuting costs for most salaried workers in Japan. We construct CommTime and D-Commut to represent the length of commuting time and differences in basic demand between households with and without commuting. Year1 and Year2 are dummy variables that represent demand for floor space depending on the length of time of residence at the current address. We also capture the variables N0–N7 to represent the effects from the number of household members for each age group, as in Mankiw and Wiel (1989) and Ohtake and Shintani (1996). In addition to these variables, we construct the variables SN6 and SN7 for households that only consist of aged singles or couples who live in relatively large houses because their adult children have left home, to analyze the effects of those who might live in relatively or unnecessarily large houses. Because we use cross-sectional data collected by the questionnaire, we cannot include any macro or policy variables that take the same values at a specific point in time. Table 1 shows the list of candidate variables in our empirical analysis and how they are derived, including the explained variable "Floor." Table 2 shows the summary statistics for explained and explanatory variables. The average income of our survey respondents is 6.37 million yen; in comparison, the average income in the 2009 Family Income and Expenditure Survey for all households is about 5.35 million yen and that for worker households is 6.28 million yen. This difference suggests that our sample has a bias to wealthier people, so simple averages for some subgroups might have an upper income bias; therefore, we need to estimate floor demand function and make calibrations to analyze the affordability of housing for each type of household.

Finally, we should mention the construction of the variables with open-ended categories. In addition to the explained variable Floor, Price1, Price2, Income and CommTime are constructed from categorized variables with open-ended categories. We assume some ideal upper limits and consider the midpoint as representing the value for that category. We assume 200 m^2 as the upper limit for floor space; 200,000 yen as the upper limit for both Price1 and Price2; 150 minutes as the upper limit for CommTime; and 15 million yen as the upper limit for Income. Because these assumptions have some problems, as we will mention later, we try to deal with the measurement errors by including their squared values in the candidates for the explanatory variables in the regression analysis to approximate a flexible functional form.

Table 1 Definitions of Explained and Explanatory Variables

Abbreviation	Definition
Floor	Floor space per dwelling Floor = 15, 40, 60, 85, 125, 175 corresponding to Q2 = 1, 2, 3, 4, 5, 6, otherwise = 0
Price1	Estate tax per floor space (per 1 m^2) = Etax / Floor Etax = 0.5, 2, 4, 7.5, 12.5, 17.5 corresponding to SQ5 = 1, 2, 3, 4, 5, 6, otherwise = 0
Price2	Housing rent per floor space (per 1 m^2) = Rent × 12 / Floor Rent = 0.5,2,4,7.5,12.5,17.5 corresponding to SQ6 = 1, 2, 3, 4, 5, 6, otherwise = 0
Price3	Estate tax plus housing rent per floor space (per 1 m^2) Price3 = (Etax + Rent ´ 12) / Floor
Dum2	Dummy variable for renting land and house Dum2 = 1 if Q1 = 3 or AQ2 = 1 or AQ3 = 2, otherwise = 0
Dum3	Dummy variable for renting only house or apartment Dum3 = 1 if AQ2 = 2, otherwise = 0
House1	Dummy variable for detached house House1 = 1 if Q1 = 1, otherwise = 0
House2	Dummy variable for renting house and land House2 = 1 if Q1 = 2, otherwise = 0
Income	Total family income Income = 100, 300, 500, 700, 900, 1250 corresponding to SQ4 = 1, 2, 3, 4, 5, 6, otherwise = 0
CommTime	Commuting time CommTime = 15, 45, 75, 105, 135 corresponding to AQ4-2 = 1, 2, 3, 4, 5, otherwise = 0
D-Commut	Dummy variable for commuting D-Commut = 1 if Q4 = 2 or 3
Year1	Dummy variable for 10–20 years of residence Year1 = 1 if Q3 = 5, otherwise = 0
Year2	Dummy variables for more than 20 years of residence Year2 = 1 if Q3 = 6, otherwise = 0
N0–N7	Number of family members during * years Ni = 1, i=0 to 7 for under 10, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69 and over 70 years old, otherwise =0
SN6–SN7	Number of older people in elderly family SN6 for 60–69 years and SN7 for elderly persons over 70 years in elderly household

Table 2 Summary Statistics of Explained and Explanatory Variables

Abbreviation	Mean	Standard deviation	Minimum	Maximum
Floor	104.0462	41.0332	15	175
Price1	0.0921	0.0835	0	1.167
Price2	0.1898	0.7130	0	6
Price3	0.0306	0.1507	0	2.3
Dum2	0.0936	0.2915	0	1
Dum3	0.0775	0.2675	0	1
House1	0.8266	0.3788	0	1
House2	0.0023	0.0481	0	1
Income	637.4567	332.4492	100	1250
CommTime	31.1619	34.9099	0	135
D-Commut	0.3746	0.4843	0	1
Year1	0.3017	0.4593	0	1
Year2	0.4474	0.4975	0	1
N0	0.2890	0.6682	0	3
N1	0.3607	0.7197	0	3
N2	0.2913	0.6072	0	3
N3	0.3988	0.7000	0	4
N4	0.5133	0.7699	0	3
N5	0.4567	0.7158	0	3
N6	0.5480	0.7670	0	3
N7	0.4983	0.7533	0	3
SN6	0.1445	0.5148	0	3
SN7	0.1376	0.5007	0	3

4. Empirical Analysis

Next, we apply a regression analysis to obtain floor space demand as a function of all the candidate explanatory variables, by using their squared values as additional explanatory variables. We do not adopt the squared values of dummy variables, because they take the same values for the squared values. We adopt the squared values as explanatory variables for two reasons. The first is to capture any nonlinear relationships between the explanatory and explained variables. The second is the constructed nature of some of the explanatory and explained variables. We constructed some variables from the categorized data by replacing their midpoints or specific values based on certain assumptions for open-ended categories. By using squared values, we try to approximate their relationships with a flexible functional form, which we call the “full model.” In this step, of course, because most of the estimated coefficients are not statistically significant, we proceed to the model selection process. We remove from the list of the explanatory variables the variable that has an estimated coefficient with the highest P-value, and reestimate the

regression equation. We repeat this process until Akaike's Information Criterion (AIC) takes its minimum value. The results of the estimation are shown in Table 3. In this estimation process, we choose the observations for which we can obtain responses from all related questionnaires; this gives us 865 available observations from the 1118 returned questionnaires. In the present paper, because we focus on the calibrated levels of floor space demand on average, we do not separate the samples by ownership and housing type.

Table 3 Estimation Results

	Full model			Min AIC model		
	Coefficient	t-value		Coefficient	t-value	
Constant	89.151	(9.842)	**	92.680	(16.027)	**
Price1	–334.727	(–11.922)	**	–334.685	(–12.091)	**
Price1^2	193.377	(5.354)	**	194.395	(5.460)	**
Price2	–21.202	(–2.623)	**	–10.593	(–3.952)	**
Price2^2	1.969	(1.414)	*			
Price3	–60.010	(–2.458)	*	–36.794	(–3.703)	**
Price3^2	13.824	(1.048)				
Dum2	–22.079	(–2.089)	*	–32.492	(–4.336)	**
Dum3	–10.033	(–1.282)		–14.559	(–2.371)	*
House1	25.827	(7.337)	**	25.697	(7.476)	**
House2	23.392	(1.033)				
Income	0.046	(2.957)	**	0.029	(7.712)	**
Income^2	0.000	(–1.036)				
CommTime	–0.225	(–1.526)		–0.282	(–2.864)	**
CommTime^2	0.002	(1.376)		0.002	(2.189)	*
D-Commut	3.508	(0.768)				
Year1	–3.367	(–1.051)				
Year2	–7.562	(–2.319)	*	–5.221	(–2.138)	*
N0	7.931	(1.395)				
N0^2	–3.512	(–1.512)				
N1	1.175	(0.230)				
N1^2	0.310	(0.144)				
N2	–2.139	(–0.403)				
N2^2	–0.053	(–0.021)				
N3	–7.254	(–1.497)				
N3^2	4.471	(2.311)	*	2.258	(2.820)	**
N4	–3.176	(–0.575)				
N4^2	2.403	(1.036)		2.064	(2.386)	*

(Continued…)

(Table 3 Continued…)

	Full model			Min AIC model		
	Coefficient	t-value		Coefficient	t-value	
N5	0.188	(0.030)				
$N5^2$	2.882	(0.986)		2.948	(2.848)	**
N6	17.788	(2.853)	**	19.650	(3.709)	**
$N6^2$	–5.224	(–1.653)		–6.869	(–2.660)	**
N7	10.531	(1.935)		5.811	(3.038)	**
$N7^2$	–2.743	(–1.047)				
SN6	–7.350	(–0.413)				
$SN6^2$	1.768	(0.201)				
SN7	7.871	(0.472)		4.024	(1.475)	
$SN7^2$	–2.024	(–0.249)				
Adjusted R^2	0.416			0.419		
Log	–4188.290			–4196.130		
LM hetero	35.150		**	37.261		**
Jarque–Bera	1.508			1.074		
RESET	4.518		*	3.168		

Note: * and ** mean statistically significant at 5% and 1%, respectively.

Before comparing the floor space standard and the calibrated values, we examine the structure of the estimation results as a demand function. First, we focus on the price effect on floor space demand. The estimated results show that the price effects of both fixed property tax and house rent on floor space demand are negative. These results are similar to those of Seko (1990, 1999, 2002), who has shown that a lower fixed property tax means higher demand in floor space. However, we cannot clarify the effects of the fixed property tax on floor space demand because we cannot identify changes in fixed property taxes on both land and buildings. The explanatory variable denoted by "Price1" indicates a total fixed property tax per square meter of floor space. We cannot conclude that the ownership effect is significant for floor space demand, as Seko (1991) suggests. The coefficient for the income effect on floor space demand is found to be positive and statistically significant.

Our results suggest that people trade off commuting time and floor space. That is, people may want a large house if their commuting time is long and accept a small house if their commuting time is very short. Figure 3 shows the relationships between commuting time and floor space when other explanatory variables are fixed at their means in the full model and the minimum AIC model. This figure shows that floor space demand is lowest if the commuting time is about 70 minutes. Although Lim, Follain and Renaud (1984) have found a high correlation, we have found a nonlinear relationship. This nonmonotonic relationship between floor space and commuting time is interesting. A theoretical investigation for rent-commuting cost and rent distance by Kwon (2002) shows that they have a monotonic relationship, but

the present study implies a nonmonotonic relationship with a minimum point for floor space demand. Of course, the relationship between floor space demand and rent might not be monotonic, so the result from our research does not necessarily contradict Kwon's analysis. However, to clarify the relationship between Kwon's results and ours, we need further theoretical and empirical research on the relationships between land prices, floor space and commuting time or cost.

We next discuss the results of the diagnostic statistics for the specification of the equation. The adjusted R^2 is relatively high in such a cross-section analysis. The Lagrange multiplier (LM) test statistic for heteroskedasticity (LM hetero) is statistically significant, but we assume regularity conditions for ordinary least squares regressions, so this problem does not affect the consistency of the coefficients' estimation. Furthermore, the Jarque–Bera test statistics for nonnormality of the error terms and RESET test for the specification error are not statistically significant. By judging from these results of the diagnostic tests, we consider that the estimated coefficients in the regression equation can be used for calibrating the respective floor space demand by various kinds of household.

5. Standards and Minimum Levels for Floor Space and Calibration

As we noted above, the Basic Act for Housing provides minimum and targeted housing standards for floor space with two standards for the latter, one for apartments in urban areas and another for detached houses based on household size. The dwelling floor space targets for residential use of apartments are as follows[1]:

Single-person family	40 m^2
Two or more persons in family	20 m^2 × (number of persons) + 15 m^2,

and the targeted housing standards for detached houses are:

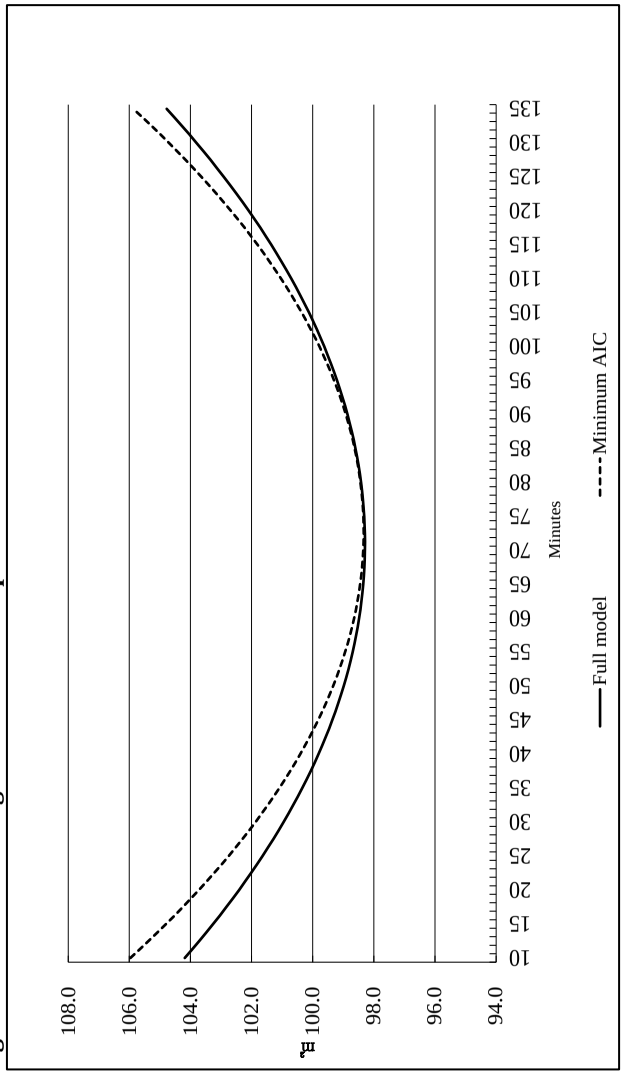
Single-person family	55 m^2
Two or more persons in family	25 m^2 × (number of persons) + 25 m^2.

When the number of family members is greater than four, the standard is reduced by 5% of the calculated floor space. For example, the targeted housing standard for apartments for a five-person family is 109.25 m^2 (= (20 m^2 × 5 + 15 m^2) × 0.95) and that for detached houses for a five-person family is 142.5 m^2 (= (25 m^2 × 5 + 25 m^2) × 0.95). The minimum standards are calculated as:

Single-person family	25 m^2
Two or more persons in family	10 m^2 × (number of persons) + 10 m^2.

[1] The floor space is measured from the centerline of a wall.

Figure 3 Commuting Time and Floor Space Demand



These standards are the same for both detached houses and apartments, and provided as a national minimum for all of Japan. We also note that the Basic Act for Housing contains neither a specific housing construction scheme nor a subsidization plan.

Next, we conduct calibrations to investigate the effects of total family income and family structure on floor space demand in the cases of a detached house and an apartment. According to the 2008 Family Income and Expenditure Survey, the average annual income for all households is about 5.5 million yen and the boundaries between the first and second income quintile groups and between the fourth and fifth income quintile groups for annual incomes of worker households are about 3.5 million yen and 8.5 million yen, respectively. Therefore, in our calibration, we divided total family income into three classes: 3.5, 5.5 and 8.5 million yen. Other explanatory variables, except for the number of family members, are set at their mean values. We investigate one- to five-person families and calibrate detached house and apartment cases for each. Moreover, we consider six age groups from the 20s to 70s and over. Selected results of the calibrations are shown in Table 4.

For single-person families, the results of the calibration show that calibrated floor spaces are larger than the targeted standards for detached houses in all combinations of age groups and income classes. For two-person families, we assume that these two people are a couple in the same age group. As with single-person families, all the calibrated levels of floor space are larger than the targeted standards for detached houses. These results show that one- or two-person families can afford relatively large houses. The apartment outcomes also show that all families have larger floor space than the targeted standards for apartments. For the three-person families, we only consider that these families consist of a couple with a child because this type of family will become the major pattern in an aging society with many three-person families. Some families in lower-income classes cannot afford houses that exceed the targeted standards for detached houses (two cases) and apartments (five cases). All families except these seven, however, are expected to have houses that exceed the targeted standards.

We restrict four-person families to two-couple families, which mean that two generations of couples live together in the same house. No four-person families can afford a house that exceeds the targeted standards for detached houses, and no four-person families living in an apartment can afford one that meets the targeted standards for apartments except for some families in the high-income class. This implies that in the Kanto area, which is a densely populated urban area, most two-couple families cannot afford to meet the targeted standards. The situation is similar for five-person families. None of the five-person families living in a detached house or in an apartment can afford any of the targeted standards except for one family in the high-income class.

Table 4 Calibration Results

Income	Number of family members						Average		Detached house		Apartment	
	20's	30's	40's	50's	60's	70's+	Floor space	2×sigma	Floor space	2×sigma	Floor space	2×sigma
< One person family >												
350	1						**82.16**	6.11	**86.62**	6.36	**60.92**	7.84
350		1					**84.42**	5.65	**88.88**	5.90	**63.18**	7.57
350			1				**84.23**	5.29	**88.68**	5.55	**62.98**	7.33
350				1			**84.28**	5.38	**88.74**	5.64	**63.04**	7.38
350					1		**86.83**	4.78	**91.29**	5.04	**65.59**	7.02
350						1	**85.61**	5.26	**90.07**	5.50	**64.37**	7.37
550	1						**88.02**	5.89	**92.47**	6.16	**66.77**	7.64
550		1					**90.27**	5.36	**94.73**	5.63	**69.03**	7.33
550			1				**90.08**	4.95	**94.54**	5.24	**68.84**	7.06
550				1			**90.14**	5.03	**94.59**	5.32	**68.90**	7.10
550					1		**92.68**	4.53	**97.14**	4.82	**71.44**	6.83
550						1	**91.46**	5.01	**95.92**	5.27	**70.22**	7.17
850	1						**96.80**	6.28	**101.25**	6.55	**75.56**	7.90
850		1					**99.05**	5.71	**103.51**	5.98	**77.81**	7.55
850			1				**98.86**	5.29	**103.32**	5.56	**77.62**	7.25
850				1			**98.92**	5.35	**103.38**	5.63	**77.68**	7.29
850					1		**101.47**	5.07	**105.92**	5.35	**80.22**	7.16
850						1	**100.25**	5.47	**104.70**	5.72	**79.00**	7.46
< Two person family >												
350	2						**82.16**	6.11	**86.62**	6.36	**60.92**	7.84
350		2					**91.19**	6.82	**95.65**	6.97	**69.95**	8.69
350			2				**90.42**	5.98	**94.87**	6.13	**69.18**	8.16
350				2			**93.95**	6.84	**98.41**	6.95	**72.71**	8.89
350					2		**93.98**	5.46	**98.44**	5.59	**72.74**	7.87
350						2	**97.81**	6.01	**102.26**	6.09	**76.57**	8.39
550	2						**88.02**	5.89	**92.47**	6.16	**66.77**	7.64
550		2					**97.05**	6.45	**101.50**	6.62	**75.81**	8.39
550			2				**96.27**	5.45	**100.73**	5.62	**75.03**	7.75
550				2			**99.81**	6.22	**104.26**	6.34	**78.57**	8.40
550					2		**99.84**	5.32	**104.29**	5.47	**78.60**	7.74
550						2	**103.66**	5.87	**108.12**	5.96	**82.42**	8.26
850	2						**96.80**	6.28	**101.25**	6.55	**75.56**	7.90
850		2					**105.83**	6.56	**110.29**	6.73	**84.59**	8.43
850			2				**105.05**	5.41	**109.51**	5.59	**83.81**	7.68
850				2			**108.59**	5.94	**113.04**	6.07	**87.35**	8.16
850					2		**108.62**	5.90	**113.08**	6.04	**87.38**	8.11
850						2	**112.44**	6.36	**116.90**	6.46	**91.20**	8.58
< Three person family >												
350	1				2		93.98	5.46	98.44	5.59	72.74	7.87
350	1					2	93.78	7.43	98.24	7.48	72.54	9.51
350		1			2		96.24	5.33	**100.70**	5.45	75.00	7.86
350		1				2	96.04	7.26	**100.50**	7.29	74.80	9.45
350			1		2		96.05	5.51	**100.50**	5.61	74.81	8.00
350			1			2	95.85	7.00	**100.30**	7.03	74.61	9.27
350				1		2	96.73	7.06	**101.19**	7.08	75.49	9.34
550	1				2		99.84	5.32	**104.29**	5.47	78.60	7.74
550	1					2	99.64	7.21	**104.09**	7.27	78.40	9.32
550		1			2		**102.10**	5.14	**106.55**	5.26	80.86	7.70
550		1				2	**101.89**	6.99	**106.35**	7.03	80.65	9.22
550			1		2		**101.90**	5.29	**106.36**	5.40	80.66	7.83
550			1			2	**101.70**	6.70	**106.16**	6.73	80.46	9.02
550				1		2	**102.58**	6.72	**107.04**	6.75	81.34	9.06
850	1				2		**108.62**	5.90	**113.08**	6.04	87.38	8.11
850	1					2	**108.42**	7.46	**112.87**	7.53	87.18	9.48
850		1			2		**110.88**	5.66	**115.33**	5.78	89.64	8.02
850		1				2	**110.68**	7.19	**115.13**	7.24	89.43	9.34
850			1		2		**110.68**	5.75	**115.14**	5.87	89.44	8.11
850			1			2	**110.48**	6.87	**114.94**	6.92	89.24	9.12
850				1		2	**111.37**	6.84	**115.82**	6.89	90.12	9.12

(Continued…)

(Table 4 Continued…)

Income	Number of family members						Average		Detached house		Apartment	
	20's	30's	40's	50's	60's	70's+	Floor space	2×sigma	Floor space	2×sigma	Floor space	2×sigma
< Four person family >												
350	2	2					91.19	6.82	95.65	6.97	69.95	8.69
350	2		2				90.42	5.98	94.87	6.13	69.18	8.16
350	2			2			93.95	6.84	98.41	6.95	72.71	8.89
350	2				2		93.98	5.46	98.44	5.59	72.74	7.87
350		2		2			102.99	9.60	107.44	9.62	81.75	11.38
350		2			2		103.02	7.42	107.47	7.45	81.78	9.61
350		2				2	102.82	8.71	107.27	8.70	81.58	10.78
350			2		2		102.24	8.24	106.70	8.24	81.00	10.32
350			2			2	102.04	8.13	106.49	8.10	80.80	10.40
350				2		2	105.57	9.22	110.03	9.17	84.33	11.34
550	2	2					97.05	6.45	101.50	6.62	75.81	8.39
550	2		2				96.27	5.45	100.73	5.62	75.03	7.75
550	2			2			99.81	6.22	104.26	6.34	78.57	8.40
550	2				2		99.84	5.32	104.29	5.47	78.60	7.74
550		2		2			108.84	9.05	113.30	9.08	87.60	10.90
550		2			2		108.87	7.17	113.33	7.20	87.63	9.39
550		2				2	108.67	8.39	113.13	8.38	87.43	10.51
550			2		2		108.09	7.93	112.55	7.94	86.85	10.06
550			2			2	107.89	7.71	112.35	7.67	86.65	10.05
550				2		2	111.43	8.74	115.88	8.69	90.19	10.93
850	2	2					105.83	6.56	110.29	6.73	84.59	8.43
850	2		2				105.05	5.41	109.51	5.59	83.81	7.68
850	2			2			108.59	5.94	113.04	6.07	87.35	8.16
850	2				2		108.62	5.90	113.08	6.04	87.38	8.11
850		2		2			117.62	8.67	122.08	8.70	96.38	10.56
850		2			2		117.65	7.38	122.11	7.42	96.41	9.52
850		2				2	117.45	8.41	121.91	8.41	96.21	10.49
850			2		2		116.87	8.01	121.33	8.03	95.63	10.09
850			2			2	116.67	7.61	121.13	7.59	95.43	9.94
850				2		2	120.21	8.48	124.67	8.43	98.97	10.69
< Five person family >												
350	3	2					91.19	6.82	95.65	6.97	69.95	8.69
350	3		2				90.42	5.98	94.87	6.13	69.18	8.16
350		3		2			114.28	16.26	118.73	16.23	93.04	17.55
350		3			2		114.31	14.22	118.77	14.19	93.07	15.67
350			3		2		112.56	15.81	117.01	15.76	91.32	17.24
350			3			2	112.36	14.64	116.81	14.56	91.12	16.27
350				3		2	120.31	17.76	124.77	17.67	99.07	19.21
550	3	2					97.05	6.45	101.50	6.62	75.81	8.39
550	3		2				96.27	5.45	100.73	5.62	75.03	7.75
550		3		2			120.13	15.85	124.59	15.83	98.89	17.16
550		3			2		120.16	13.99	124.62	13.96	98.92	15.45
550			3		2		118.41	15.52	122.87	15.46	97.17	16.95
550			3			2	118.21	14.26	122.67	14.18	96.97	15.91
550				3		2	126.17	17.31	130.62	17.23	104.93	18.79
850	3	2					105.83	6.56	110.29	6.73	84.59	8.43
850	3		2				105.05	5.41	109.51	5.59	83.81	7.68
850		3		2			128.91	15.50	133.37	15.48	107.67	16.82
850		3			2		128.94	13.95	133.40	13.92	107.70	15.39
850			3		2		127.19	15.34	131.65	15.30	105.95	16.78
850			3			2	126.99	13.98	131.45	13.90	105.75	15.64
850				3		2	134.95	16.88	139.41	16.80	113.71	18.38

Note: Floor space means estimated floor space in m^2 and 2×sigma is 2×estimated standard errors. Boldface indicates that the floor space exceeds the targeted standards for detached houses. Shading indicates that the floor space is below the targeted standards for apartments.

Overall, although this calibration study is not fully comprehensive, we can capture the contemporary situation of floor space demand in the Kanto area. We conclude that most of the relatively large families (those with four or more members) are constrained to live in houses that are smaller than the targeted standard set in the Basic Act for Housing, while smaller families (those with one or two members) can afford houses significantly larger than the Act's prescribed minima. Three-person families are the boundary cases. In the case of both detached houses and apartments, this study shows that some families whose annual income is lower than 3.5 million yen cannot afford houses larger than the targeted standard, whereas in other cases, including all the families with an annual income of more than 5.5 million yen, the families can afford the targeted standard levels.

6. Conclusion

In this paper, we have estimated a floor space demand function, and calibrated floor space demand for several types of family structures. From the calibration studies, we conclude that most of the relatively large families are constrained to live in houses smaller than the targeted standard whereas smaller families can afford significantly larger houses. Boundary cases are three-person families, some of which with low incomes cannot afford a house larger than the targeted standard levels. This tendency is common to both detached houses and apartments.

The results of the regression also suggest that lower housing costs or higher total family income means higher demand for household floor space. That is, floor space demand is expected to increase if the fixed property tax is reduced or a housing allowance is provided. Because it is impossible to use our research findings to forecast total demand for floor space in the Kanto area, we cannot investigate the macro effects of reducing fixed property taxes or increasing housing subsidies. However, from the empirical evidence in this paper, we can forecast that offering subsidies or lowering fixed property taxes would increase floor space demand.

We need to consider the trends in the average number and size of households to assess the feasibility of the policy target, which is to raise the proportion of houses that meet the targeted housing standards in urban areas to 50% by 2015. As we mentioned in the Introduction, Panel B of Figure 1 shows that the average number of household members approaches three. This is the boundary case as to whether households can afford the targeted level of housing in the calibration study. However, the results of the calibration tell us that when the annual income remains at around 5.5 million yen, households can afford the targeted level of housing standard. Therefore, the policy target might be attainable even though the government has stopped subsidies. Of course, if subsidies are offered to lower-income classes, the attainability of the policy target becomes more realistic.

Finally, in considering these calibration results from other viewpoints, we have two possible explanations for why a relatively large family cannot afford a large house. The first comes from the supply side. In line with the trend toward smaller family sizes and an increased number of nuclear families, the floor space per house of most new housing constructions is smaller, in order to suit these relatively small families. This makes it difficult for relatively large families to find an appropriate residence. The other explanation arises from the setting of the targeted standards provided in the Basic Act for Housing. According to the estimated floor space demand function, we might conclude that families need not demand as much floor space as that set in the targeted standard. If we consider that this interpretation is correct, the housing standards provided in the Basic Act for Housing exceed the actual demand even when we reduce calculated floor spaces by 5%. Because these interpretations cannot be confirmed at this stage, we need to conduct further research to investigate the ideal demand levels for floor space when families do not face budgetary constraints.

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Appendix
Summary of "Residential Environment Survey"

The following is a summary of the questionnaire used in our residential environment survey.

Q1. What type of house do you reside in?

1. detached house
2. tenement house
3. rental apartment built of wood
4. apartment or condominium

AQ1-1 (Additional question 1). What kind of ownership structure applies to your residential land and housing?

1. rent land and house
2. rent land and built a house on it
3. own land and house

AQ1-2. How large is the residential area where you live?

1. less than 50 m^2
2. between 50 m^2 and 100 m^2
3. between 100 m^2 and 150 m^2
4. between 150 m^2 and 200 m^2
5. between 200 m^2 and 250 m^2
6. more than 250 m^2

If you did not choose 3, please proceed to Q2.

AQ1-3. What type of apartment do you live in?

1. condominium
2. rental apartment

<Omitted>

Please answer all the following questions.

Q2. How large is the total floor space where you live? Please include occupied rooms, entrances, bathrooms and kitchen.

1. less than 30 m^2
2. between 30 m^2 and 50 m^2
3. between 50 m^2 and 70 m^2
4. between 70 m^2 and 100 m^2
5. between 100 m^2 and 150 m^2
6. more than 150 m^2

Q3. How long have you lived in your present house?

1. less than 1 year
2. between 1 and 3 years
3. between 3 and 5 years
4. between 5 and 10 years
5. between 10 and 15 years
6. more than 15 years

Q4. Does the head of household commute from home now?

1. yes (commuting)
2. working at home
3. not commuting

<Omitted>

AQ4-2. How long does it take to commute from your house to the workplace?

1. less than 30 minutes
2. between 30 and 60 minutes
3. between 60 and 90 minutes
4. between 90 and 120 minutes
5. more than 120 minutes

<Omitted>

The following are questionnaires about household characteristics for all respondents.

SQ1. Identify the characteristics of the respondent.

Sex: 1. male 2. female
Age: 1. 20s 2. 30s 3. 40s 4. 50s 5. 60s 6. 70 or over

SQ2. Provide the following numbers.
Number of family members in your house except yourself
In each of the following age groups.

1. less than 10 years old
2. between 10 and 20 years old
3. between 20 and 30 years old
4. between 30 and 40 years old
5. between 40 and 50 years old
6. between 50 and 60 years old
7. between 60 and 70 years old
8. over 70 years old

<SQ3 is omitted.>

SQ4. How much is your total annual family income, including annuities and taxes?

1. less than 2 million yen
2. between 2 and 4 million yen
3. between 4 and 6 million yen
4. between 6 and 8 million yen
5. between 8 and 10 million yen
6. more than 10 million yen

SQ5. How much fixed property tax do you pay annually?

1. less than 10,000 yen
2.between 10,000 and 30,000 yen
3.between 30,000 and 50,000 yen
4.between 50,000and100,000 yen
5.between100,000and150,000yen
6. more than 150,000 yen
7.we do not pay it

SQ6. How much do you pay to rent land and/or a house monthly?

1.less than 10,000 yen
2.between 10,000 and 30,000 yen
3.between 30,000and50,000 yen
4.between 50,000and100,000 yen
5.between100,000and150,000yen
6.more than 150,000 yen
7.we do not pay rent

<Omitted below>