

Floor Space Demand in an Aging Society: An Empirical Investigation for Kanto Area in Japan*

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Abstract

We estimate a household floor space demand function for the Kanto area in Japan using a survey questionnaire, and conduct simulation studies to investigate the relationships between family structures, their respective floor space demand, and the objectives of the Basic Program for Housing (National Plan) of the Japanese Government. The results indicate that small families can afford relatively large housing but that most three- or four-person families cannot afford the prescribed level of floor space in the Basic Housing Program.

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1. Introduction

The Japanese Government has since 1966 repeatedly set up five-year plans for housing construction and measures to improve the residential environment. The main purpose of these plans is to supply houses to meet the implicit housing demand. This implicit demand is generated by the people who reside in temporary houses because they lost their homes in air raids during World War II or who returned from Japan's former colonies. Additionally, after World War II, a baby boom developed in Japan and these babies seem to have had a huge demand for housing as they grew up. However, in the early 1980s, an OECD report suggested that most Japanese lived in "rabbit hutches".¹ This report was quoted by many politicians and in mass communications and moved policy makers to increase the prescribed floor space of housing as another important objective of the government. In the 1990s, "from quantity to quality" became an additional slogan because the total amount of housing seemed sufficient and the housing vacancy rate went up a relatively high level. During this period, housing floor space grew steadily (see Figure 1). Furthermore, as the number of persons per household decreased in this period (Figure 2), so the floor space per person also increased rapidly.²

In 2005, the Japanese Government ended the eighth five-year plan and in 2006 it set up the Promotion of the Basic Program for Housing (National Plan). The Plan sets out minimum and guideline levels of floor space and other objectives for improving the residential environment. While the former five-year plans distributed some subsidies for new development of suburban apartments, the new Plan just provides some guidelines. Thus the Plan aims to raise the rate of housing that meets the guideline levels of the floor space in urban area from 37% (in 2003) to 50% by 2015.

In the present paper, we discuss the results of a survey questionnaire and investigate the attainment of the government's guidelines, including the effect of Japan's aging population. Statistics in various sources show that average floor space has continuously expanded and that most Japanese do not reside in "rabbit hutches." However such statistics might reflect the rising numbers of households that consist only of an aged couple or a single aged person. To assess this kind of effect clearly it is important to evaluate the attainment of guideline levels of floor space. If we find that most households consist of single aged persons or aged couples and each of them

¹ Some researchers suggested this was nothing but a kind of political failure. For example, see Eggers (2006).

² Kanemoto (1997) comprehensively analyzed Japanese housing policy issues, including the problem of floor space demand.

lives in a relatively large house because their children have grown up and left home, such social changes do not necessarily imply a real improvement in the housing situation.³ To answer these questions, we need first to estimate the floor space demand function. In Japan and in other countries, there are very few studies that estimate the floor space demand function.⁴

This paper's next sections are as follows. In section 2, we explain our questionnaire survey in brief and estimate the floor space demand function. In section 3, we relate the simulated levels of floor space demand to the minimum and guideline levels and investigate the effects of an aging population. In section 4, we conclude the paper and consider some remaining problems.

2. Estimation of Floor Space Demand Function

Design of Survey Questionnaire

Details of our questionnaire are described in the Appendix. In this section we provide a brief summary of our survey design. We utilized the "Personal Master Samples of the Central Research Service." This was originally a three-strata stratified random sampling of persons over 20 years old from all over the country. The Central Research Service keeps over 60,000 persons as the basis for other surveys. They call this sample the "Master Sample." We utilized this Master Sample in the Kanto area, which includes the Tokyo, Kanagawa, Saitama, Gunma, Tochigi and Chiba prefectures. The Central Research Service keeps 13,218 persons for mail surveys. We obtained 2,000 persons from the Master Sample randomly and sent out the questionnaire. We conducted our mail survey in February 2009 and obtained 1118 returns.

Candidates for Explanatory Variables

We selected the candidate for the explanatory variables in our floor space demand function as follows. The first group has variables that represent housing costs and characteristics. We formed explanatory variables with housing type (Q1), housing rent (SQ6), fixed property taxes (SQ5), ownership of land and house (AQ2) in this group. The second group has variables that represent the characteristics of the household. We form explanatory variables with

³ This problem relates to whether children live with their parents or not. Kotlikoff and Morris (1989) is a classical source and there are many other research papers that deal with this. However, in the present paper, we focus on floor space demand and do not proceed into this choice problem.

⁴ Seko (1990, 1991, 1998, 1999, and 2002) estimated a floor demand function and analyzed it from several points of view but without considering the relationship between the impact of an aging population and floor space demand.

households' total income (SQ4), number of family members for each year group (SQ1 and SQ2)⁵, length of time that the family had lived in the present location (SQ3), and commuting time (Q3 and AQ4-2)⁶. Table 1 shows the list of the variables that we utilized in the empirical analysis, including the dependent variable “floor,” and the generating process. Table 2 shows the summary statistics.

Estimation Strategy and Results

Firstly, we apply linear regression to obtain floor space demand as a function of the candidates of the explanatory variables. This is the “Full Model.” At this step, of course, most of the estimated coefficients are not statistically significant, so we proceed to the model selection process. We remove the variables whose estimated coefficients' p-values are the highest, which means they are statistically insignificant, and re-estimate the regression. We repeat this process until AIC (Akaike's Information Criterion) becomes a minimum or the adjusted R-squared becomes a maximum. The results of the estimation are shown in Table 3. In this estimation process, we pick up the observations for which we can obtain responses from all the related questionnaires, so the available observations are selected from 1118 returns and then the valid number of observations becomes 865.

Estimated Impacts of Explanatory Variables

Before going into the comparison of the guidelines and minimum levels of floor space and estimated results, we examine the structure of the estimation results as a demand function. At first we examine the price effect on floor space demand. In our questionnaire, we did not ask the estate price per square meter of the house or per square meter of floors because we considered that respondents could not answer these questions. However, we asked for the amount of annual fixed property tax and monthly housing rent, so we can investigate the effects of the fixed property tax and housing rent per squared meter on the floor space demand. Figures 3 and 4 show the relationships between floor space demand and fixed property tax and house rent when the other explanatory variables are set at their sample means. Both graphs show the price effects are negative, showing a normal demand function. Seko (1990, 1998, 1999, and 2002) investigated the effects of fixed property tax changes on floor area demand. Of course, when the tax is reduced, the estimated demand function suggests an increase in floor space demand. But we cannot

⁵ This type of approach is similar to Mankiw and Wiel (1989) and Ohtake and Shintani (1996). But, they did not consider other explanatory variables in the estimating demand function. Recently, Iwata and Hattori (2009) pointed out the importance of including other explanatory variables.

⁶ Whether to include commuting cost should be paid attention to, because most of salaried persons in Japan are paid their commuting cost by the employers.

investigate the effects of the fixed property tax reduction on floor space demand exactly because the fixed property tax in the regression analysis (price 1) is a total fixed property tax per square meter of floor space and we cannot identify the changes in fixed property taxes for both land and building. We also cannot conclude that the ownership effect is significant for floor space demand, as Seko (1991) pointed out. We need further investigation to develop the results of the preceding research.

Next, we analyze the income effects on floor space demand. Figure 5 shows the relationships between that and total family income when the other explanatory variables are set at their mean values. This figure shows that the income effect is positive. When the total family income increases by 3 million yen, the floor space demand increases about 20 m². This means that total family income is an important factor in determining floor space demand, so we will consider the effects of total family income for simulated floor space demand in the next section.

A third point is the effect of commuting time on floor space demand. We consider that people trade off commuting time and floor space. People might want to have a large house when the commuting time is long and might accept a small house when the commuting time is very short. Figure 6 shows the relationships between commuting time and floor space when the other explanatory variables are set at their means. This figure shows that it has the lowest point when the commuting time is about 70 minutes. This results from our inclusion of housing cost in the regression analysis. According to previous research on the relationship between the commuting time and land prices, there is a high correlation between them, so a direct substitution between commuting time and floor space demand cannot be observed. This problem may be related to the discussion in Kwon (2002). We will need further theoretical and empirical research on the relationships between land prices, floor space and commuting time or commuting cost.

3. Preferred and Minimal Level of Housing

Guidelines and Minimum Levels of Floor Spaces

The Promotion of the Basic Program for Housing (National Plan) suggested guidelines and minimum levels of floor space. For the former, there are two levels, one for detached houses and another for apartments in urban areas. Guideline levels for apartments are as follows:

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

and guideline levels 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 over four, we should reduce 5% of the calculated floor space. For example, the guideline level of a detached house for a five-person family is 142.5 m² and that for an apartment is 109.25 m². The minimum levels are calculated as:

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

This level is common to both detached houses and apartments.

Simulation Studies for Different Family Structures

In this paper, we conduct simulation studies on the effects of total family income and family structure on floor space demand. According to Japan's Family Income and Expenditure Survey of 2008, the average annual income for all households is about 5.50 million yen, so we set total family income at three levels, 3.5, 5.5 and 8.5 million yen, in our simulation. Other explanatory variables, except for the number of family members, are set at their mean values. We investigate one-, two-, three-, four- and five-person families and simulate the detached house and apartment cases for each.

For a single-person family, we allow for each age group from 20–30 up to 70 and over. Table 4 shows the results. The results of the simulation show that, in all cases, simulated floor spaces are larger than the guideline levels for detached houses. As for the two-person family, we assume that these two persons is a couple, and we assess age groups from the twenties to seventies and their partner as being in the same age group or only one class below or above. The result is shown in Table 5. Similar to the single-person family, all the outcomes are larger than the guideline levels for a detached house. These results show that one or two person families can afford relatively large houses. The apartment outcomes also show larger floor space than the guideline levels for a detached house.

Table 6 shows the results for three-person families. In this simulation, we consider that families consist of a couple and child or a couple with a single aged parent. As for the cases of a couple with a single parent, in some cases for lower income classes, e.g., 6-1-1 or 6-1-4, families cannot afford houses with large floor spaces. As in the cases of a couple with child, only five cases, 6-2-1, 6-2-3, 6-2-6, 6-2-7, and 6-2-9, cannot afford the guideline levels for an apartment. In

other cases, occupiers of detached houses exceed their guideline levels and occupiers of apartments house also exceed the guideline level except in the former five cases.

As for the four-person families, we can set up numerous cases, but we restrict them to two-couple families. Table 7 shows the results. As for the detached house, there are no cases that can afford the guideline levels of detached house and in 7-2, which are low-income cases, the household cannot afford the guideline levels for the apartment house. None of the apartment cases except for the high-income class can afford the guideline levels for an apartment. In the Kanto area, most two-couple families cannot afford the guideline levels. As for the five-person families (Table 8), similar to the four-person families, none of the detached house and apartment house cases can afford the guideline levels for detached houses and apartments.

To conclude the findings of this section, while the relatively small families can afford larger houses, relatively large families are constrained to smaller houses.

4. Concluding Remarks

In this paper, we estimated a floor space demand function and simulated the floor space demand for several types of family structure. From the simulations, we can conclude that all the families can afford above-minimum prescribed levels of floor space. However, some of the families, relatively low income and relatively large families, cannot afford to meet the guideline levels for floor space. This tendency is common for both detached houses and apartments.

The results of the regression suggest that if housing costs become lower or total family income becomes higher, households increase their floor space demand. However, to reduce the fixed property tax or to provide a general subsidy for housing might lead to raising the price of housing, thereby reducing the intended effect of this type of policy. Our research does not enable us to forecast the total demand for floor space in the Kanto area and we cannot investigate the macro effects of reducing fixed property taxes or increasing housing subsidies. Of course, when the subsidy goes only to the lower income class, the effects of the policy become larger.

From another viewpoint, the simulation results suggest two types of reasons why a relatively large family cannot afford a large house. The first comes from the supply side. Responding to the reducing numbers in most families and the increasing number of nuclear

families, most new housing construction is for single, couple or nuclear families, and houses for relatively large families are in short supply. Another is a problem in guideline levels. According to the estimated floor space demand function, families do not demand floor space proportional to the number of family members. This may be caused by economic factors. But we can also consider that families do not have to demand floor space proportional to the number of family members. If this interpretation is right, the guideline levels become too large even when we reduce 5% of the calculated floor spaces. As these questions cannot be answered at this stage, we need to conduct further research.

Appendix
Summary of “Survey for Residential Environment”

The following is the summary of the questionnaire sheet of our residential environment survey.

Q1. What type of house do you reside in?

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

AQ1-1 (Additional question 1). What kind of possession types apply to your residential land and housing?

1. renting land and house
2. renting land and built a house on it
3. possessing land and house

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

1. under 50 m²
2. 50 m²–100 m²
3. 100 m²–150 m²
4. 150 m²–200 m²
5. 200 m²–250 m²
6. over 300 m²

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

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

1. a condominium
2. a rental apartment

<Omitted>

Please answer all the following questions.

Q2. How wide is the total floor space where you live? Please include occupied compartment, entrance, rest room, and kitchen.

1. under 30 m²
2. 30 m²–50 m²
3. 50 m²–70 m²
4. 70 m²–100 m²
5. 100 m²–150 m²
6. over 150 m²

Q3. How long have you lived in the house where you live now?

1. under 1 year
2. 1–3 years
3. 3–5 years
4. 5–10 years
5. 10–15 years
6. over 15 years

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

1. yes (commuting)
2. house is workplace
3. not commuting

<Omitted>

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

1. within 30 minutes
2. 30–60 minutes
3. 60–90 minutes

4. 90–120 minutes
5. over 120 minutes

<Omitted>

The following are questionnaires about household characteristics for all respondents.

SQ1. Answer the characters of the respondent.

Sex: 1. male 2. female

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

SQ2. Answer the numbers of the following.

Total numbers of family members in your house except you
and answer their composition.

1. under 10 years old ____
2. 10–20 years old
3. 20–30 years old ____
4. 30–40 years old
5. 40–50 years old ____
6. 50–60 years old
7. 60–70 years old ____
8. over 70 years old

<SQ3 is omitted.>

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

1. under 2 million yen
2. 2–4 million yen
3. 4–6 million yen
4. 6–8 million yen
5. 8–10 million yen
6. over 10 million yen

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

1. under 10 thousand yen
2. 10–30 thousand yen
3. 30–50 thousand yen
4. 50–100 thousand yen
5. 100–150 thousand yen
6. over 150 thousand yen
7. we do not pay

SQ6. How much do you pay for renting land and/or house monthly?

1. under 10 thousand yen
2. 10–30 thousand yen
3. 30–50 thousand yen
4. 50–100 thousand yen
5. 100–150 thousand yen
6. over 150 thousand yen
7. we do not pay

<Omitted below>

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Table 1. Process for explained and explanatory variables

Abbreviation	Definition and process
Floor	<p>Floor space per dwelling</p> <p>Floor = 15 if Q2 = 1</p> <p>Floor = 40 if Q2 = 2</p> <p>Floor = 60 if Q2 = 3</p> <p>Floor = 85 if Q2 = 4</p> <p>Floor = 125 if Q2 = 5</p> <p>Floor = 175 if Q2 = 6</p> <p>Floor = 0 otherwise</p>
Price1	<p>Estate tax per floor space (per 1m²)</p> <p>Price1=Etax/Floor</p> <p>Etax = 0.5 if SQ5 = 1</p> <p>Etax = 2 if SQ5 = 2</p> <p>Etax = 4 if SQ5 = 3</p> <p>Etax = 7.5 if SQ5 = 4</p> <p>Etax = 12.5 if SQ5 = 5</p> <p>Etax = 17.5 if SQ5 = 6</p> <p>Etax = 0 otherwise</p>
Price2	<p>Housing rent per floor space (per 1m²)</p> <p>Price2=Rent*12/Floor</p> <p>Rent = 0.5 if SQ6 = 1</p> <p>Rent = 2 if SQ6 = 2</p> <p>Rent = 4 if SQ6 = 3</p> <p>Rent = 7.5 if SQ6 = 4</p> <p>Rent = 12.5 if SQ6 = 5</p> <p>Rent = 17.5 if SQ6 = 6</p> <p>Rent = 0 otherwise</p>
Price3	<p>Estate tax plus housing rent per floor space (per 1m²)</p> <p>Price3=(Etax+Rent*12)/Floor</p>
Dum2	<p>Dummy variable for renting land and house</p> <p>Dum2 = 1 if Q1 = 3 or AQ2 = 1 or AQ3 = 2</p> <p>Dum2 = 0 otherwise</p>
Dum3	<p>Dummy variable for renting only house or apartment</p> <p>Dum3 = 1 if AQ2 = 2</p> <p>Dum3 = 0 otherwise</p>
House1	<p>Dummy variable for detached house</p> <p>House1 = 1 if Q1 = 1</p> <p>House1 = 0 otherwise</p>
House2	<p>Dummy variable for renting house and land</p> <p>House2 = 1 if Q1 = 2</p> <p>House2 = 0 otherwise</p>

Table 1. Process for explained and explanatory variables: continued

Abbreviation	Definition and process
Income	<p>Ttotal family income</p> <p>Income = 100 if SQ4 = 1</p> <p>Income = 300 if SQ4 = 2</p> <p>Income = 500 if SQ4 = 3</p> <p>Income = 700 if SQ4 = 4</p> <p>Income = 900 if SQ4 = 5</p> <p>Income = 1250 if SQ4 = 6</p> <p>Income = 0 otherwise</p>
CommTime	<p>Commuting time</p> <p>CommTime = 15 if AQ4-2 = 1</p> <p>CommTime = 45 if AQ4-2 = 2</p> <p>CommTime = 75 if AQ4-2 = 3</p> <p>CommTime = 105 if AQ4-2 = 4</p> <p>CommTime = 135 if AQ4-2 = 5</p> <p>CommTime = 0 otherwise</p>
D-Commut	<p>Dummy variable for commuting</p> <p>D-Commut = 1 if Q3 = 2 or 3</p>
Year1	<p>Dummy variable for living over 10 yers under 20 years</p> <p>Year1 = 1 if Q3 = 5</p> <p>Year1 = 0 otherwise</p>
Year2	<p>Dummy variables for living over 20 years</p> <p>Year2 = 1 if Q3 = 6</p> <p>Year1 = 0 otherwise</p>
N0-N7	<p>Number of family member during * years</p> <p>N0 : under 10 years odl</p> <p>N1: 10 – 19 years old</p> <p>N2: 20 – 29 years old</p> <p>N3: 30 – 39 years old</p> <p>N4: 40 – 49 years old</p> <p>N5: 50 – 59 years old</p> <p>N6: 60 – 69 years old</p> <p>N7: over 70 years old</p>
SN6 – SN7	<p>Number of elderly in elderly family</p> <p>SN6: 60-69 years elderlies in elderly household</p> <p>SN7: over 70 years elderlies in elderly household</p>

Table 2. Summary statistics of dependent 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

Table 3. Results of regression equations

	Full model		Max adjusted R ²		Min AIC
	89.151 **		94.063 **		92.680 **
	(9.842)		(15.697)		(16.027)
Price1	-334.727 **		-334.373 **		-334.685 **
	(- 11.922)		(- 12.047)		(- 12.091)
Price1 ²	193.377 **		193.097 **		194.395 **
	(5.354)		(5.409)		(5.460)
Price2	-21.202 **		-20.633 **		-10.593 **
	(- 2.623)		(- 2.589)		(- 3.952)
Price2 ²	1.969 *		1.856		**
	(1.414)		(1.351)		
Price3	-60.010 *		-61.480 **		-36.794 **
	(- 2.458)		(- 2.535)		(- 3.703)
Price3 ²	13.824		14.710		**
	(1.048)		(1.126)		
Dum2	-22.079 *		-22.773 *		-32.492 **
	(- 2.089)		(- 2.193)		(- 4.336)
Dum3	-10.033		-9.970		-14.559 *
	(- 1.282)		(- 1.283)		(- 2.371)
House1	25.827 **		25.488 **		25.697 **
	(7.337)		(7.326)		(7.476)
House2	23.392		22.914		
	(1.033)		(1.018)		
Income	0.046 **		0.031 **		0.029 **
	(2.957)		(8.015)		(7.712)
Income ²	0.000				
	(- 1.036)				
CommTime	-0.225		-0.291 **		-0.282 **
	(- 1.526)		(- 2.922)		(- 2.864)
CommTime ²	0.002		0.002 *		0.002 *
	(1.376)		(2.241)		(2.189)
D-Commut	3.508				
	(0.768)				
Year1	-3.367				
	(- 1.051)				
Year2	-7.562 *		-5.495 *		-5.221 *
	(- 2.319)		(- 2.221)		(- 2.138)

Table 3. Results of regression equations: continued

	Full model		Max adjusted R ²		Min AIC	
N0	7.931 (1.395)		8.225 (1.484)			
N0 ²	-3.512 (- 1.512)		-3.709 (- 1.622)			
N1	1.175 (0.230)		-2.381 (- 1.162)			
N1 ²	0.310 (0.144)					
N2	-2.139 (- 0.403)		-6.339 (- 1.378)			
N2 ²	-0.053 (- 0.021)					
N3	-7.254 (- 1.497)					
N3 ²	4.471 (2.311)	*	4.354 (2.291)	*	2.258 (2.820)	**
N4	-3.176 (- 0.575)					
N4 ²	2.403 (1.036)		1.392 (1.477)		2.064 (2.386)	*
N5	0.188 (0.030)					
N5 ²	2.882 (0.986)		3.029 (2.712)	**	2.948 (2.848)	**
N6	17.788 (2.853)	**	17.429 (3.148)	**	19.650 (3.709)	**
N6 ²	-5.224 (- 1.653)		-5.098 (- 1.815)		-6.869 (- 2.660)	**
N7	10.531 (1.935)		10.939 (2.166)	*	5.811 (3.038)	**
N7 ²	-2.743 (- 1.047)		-2.954 (- 1.216)			

Table 3. Results of regression equations: continued

	Full model		Max adjusted R ²		Min AIC	
SN6	-7.350 (- 0.413)		-3.675 (- 1.288)			
SN6 ²	1.768 (0.201)					
SN7	7.871 (0.472)		4.064 (1.437)		4.024 (1.475)	
SN7 ²	-2.024 (- 0.249)					
adjusted R ²	0.416		0.420		0.419	
AIC	4226.293		4218.147		4215.126	
Log likelihood	-4188.290		-4190.150		-4196.130	
LM hetero	35.150	**	35.975	**	37.261	**
Jarque-Bera	1.508		1.581		1.074	
RESET	4.518	*	4.007	*	3.168	

Note: t-values are in parentheses.

** and * mean statistically significant at 1% and 5%.

LM hetero is LM type test for heteroscedasticity.

Jarque-Bera is test for normality.

RESET is Ramsey's RESET test.

Table 4. Simulation for 1 person families

No.	Income	Number of family persons					Average	Detached house		Apartment house		
		20's	30's	40's	50's	60's	70's	Estimated F.S.	2 × sigma	Estimated F.S.	2 × sigma	Estimated F.S.
4-1	350	1					82.16	6.11	86.62	6.36	60.92	7.84
4-2	350		1				84.42	5.65	88.88	5.90	63.18	7.57
4-3	350			1			84.23	5.29	88.68	5.55	62.98	7.33
4-4	350				1		84.28	5.38	88.74	5.64	63.04	7.38
4-5	350					1	86.83	4.78	91.29	5.04	65.59	7.02
4-6	350						85.61	5.26	90.07	5.50	64.37	7.37
4-11	550	1					88.02	5.89	92.47	6.16	66.77	7.64
4-12	550		1				90.27	5.36	94.73	5.63	69.03	7.33
4-13	550			1			90.08	4.95	94.54	5.24	68.84	7.06
4-14	550				1		90.14	5.03	94.59	5.32	68.90	7.10
4-15	550					1	92.68	4.53	97.14	4.82	71.44	6.83
4-16	550						91.46	5.01	95.92	5.27	70.22	7.17
4-21	850	1					96.80	6.28	101.25	6.55	75.56	7.90
4-22	850		1				99.05	5.71	103.51	5.98	77.81	7.55
4-23	850			1			98.86	5.29	103.32	5.56	77.62	7.25
4-24	850				1		98.92	5.35	103.38	5.63	77.68	7.29
4-25	850					1	101.47	5.07	105.92	5.35	80.22	7.16
4-26	850						100.25	5.47	104.70	5.72	79.00	7.46

Note: Estimated F.S. means estimated floor spaces.

2 × sigma is 2 × estimated standard errors.

Bold face number means that the floor space is over the guided level for detached house.

Shaded number means that the floor space is below the guided levels for apartment house.

Other numbers is over the urban level under the general level.

Table 5. Simulation for 2 person families

No.	Income	Number of family persons					Average	Detached house	Apartment house			
		20's	30's	40's	50's	60's	70's	Estimated F.S. $2 \times \sigma$	Estimated F.S. $2 \times \sigma$	Estimated F.S. $2 \times \sigma$		
5-1	350	2					82.16	6.11	86.62	6.36	60.92	7.84
5-2	350	1	1				84.42	5.65	88.88	5.90	63.18	7.57
5-3	350		2				91.19	6.82	95.65	6.97	69.95	8.69
5-4	350		1	1			85.39	5.10	89.85	5.36	64.15	7.23
5-5	350			2			90.42	5.98	94.87	6.13	69.18	8.16
5-6	350			1	1		87.17	4.60	91.63	4.85	65.93	6.99
5-7	350				2		93.95	6.84	98.41	6.95	72.71	8.89
5-8	350				1	1	97.89	5.43	102.35	5.57	76.65	7.80
5-9	350					2	93.98	5.46	98.44	5.59	72.74	7.87
5-10	350					1	80.15	12.95	84.60	13.01	58.90	14.10
5-11	350						97.81	6.01	102.26	6.09	76.57	8.39
5-21	550	2					88.02	5.89	92.47	6.16	66.77	7.64
5-22	550	1	1				90.27	5.36	94.73	5.63	69.03	7.33
5-23	550		2				97.05	6.45	101.50	6.62	75.81	8.39
5-24	550		1	1			91.25	4.72	95.70	5.01	70.00	6.94
5-25	550			2			96.27	5.45	100.73	5.62	75.03	7.75
5-26	550			1	1		93.03	4.04	97.48	4.33	71.79	6.61
5-27	550				2		99.81	6.22	104.26	6.34	78.57	8.40
5-28	550				1	1	103.74	5.11	108.20	5.28	82.50	7.56
5-29	550					2	99.84	5.32	104.29	5.47	78.60	7.74
5-30	550					1	86.00	12.85	90.46	12.91	64.76	13.99
5-31	550						103.66	5.87	108.12	5.96	82.42	8.26
5-41	850	2					96.80	6.28	101.25	6.55	75.56	7.90
5-42	850	1	1				99.05	5.71	103.51	5.98	77.81	7.55
5-43	850		2				105.83	6.56	110.29	6.73	84.59	8.43
5-44	850		1	1			100.03	5.04	104.48	5.32	78.79	7.12
5-45	850			2			105.05	5.41	109.51	5.59	83.81	7.68
5-46	850			1	1		101.81	4.21	106.26	4.50	80.57	6.67
5-47	850				2		108.59	5.94	113.04	6.07	87.35	8.16
5-48	850				1	1	112.52	5.46	116.98	5.62	91.28	7.75
5-49	850					2	108.62	5.90	113.08	6.04	87.38	8.11
5-50	850					1	94.78	13.03	99.24	13.10	73.54	14.14
5-51	850						112.44	6.36	116.90	6.46	91.20	8.58

Notes: See notes on the Table 4.

Table 6. Simulation for 3 person families

No.	Income	Number of family persons					Average		Detached house		Apartment house	
		20's	30's	40's	50's	60's	70's	Estimated F.S.	2 × sigma	Estimated F.S.	2 × sigma	Estimated F.S.
6-1-1	350	2			1		85.11	5.18	89.57	5.44	63.87	7.28
6-1-2	350	1	1			1	97.20	5.27	101.66	5.44	75.96	7.64
6-1-3	350		2			1	103.98	6.84	108.43	6.91	82.73	9.01
6-1-4	350		2			1	97.01	6.82	101.46	6.89	75.76	9.02
6-1-5	350		1	1		1	78.66	12.16	83.11	12.25	57.42	13.28
6-1-6	350		1	1		1	92.63	5.45	97.09	5.51	71.39	8.11
6-1-7	350			2		1	103.20	7.56	107.65	7.61	81.96	9.65
6-1-8	350			2		1	96.23	6.03	100.68	6.08	74.99	8.53
6-1-9	350			1	1	1	92.98	4.42	97.44	4.56	71.74	7.28
6-1-10	350				2	1	99.76	7.16	104.22	7.18	78.52	9.45
6-1-21	550	2			1		90.96	4.78	95.42	5.07	69.72	6.97
6-1-22	550	1	1			1	103.05	5.03	107.51	5.21	81.81	7.45
6-1-23	550		2			1	109.83	6.53	114.29	6.61	88.59	8.75
6-1-24	550		2			1	102.86	6.43	107.32	6.51	81.62	8.70
6-1-25	550		1	1		1	84.51	12.01	88.97	12.11	63.27	13.13
6-1-26	550		1	1		1	98.49	4.86	102.94	4.93	77.25	7.70
6-1-27	550			2		1	109.05	7.20	113.51	7.25	87.81	9.35
6-1-28	550			2		1	102.08	5.47	106.54	5.53	80.84	8.12
6-1-29	550			1	1	1	98.84	3.79	103.29	3.96	77.60	6.88
6-1-30	550				2	1	105.62	6.55	110.07	6.58	84.38	8.97
6-1-41	850	2			1		99.74	5.06	104.20	5.34	78.50	7.11
6-1-42	850	1	1			1	111.84	5.49	116.29	5.67	90.59	7.73
6-1-43	850		2			1	118.61	6.71	123.07	6.80	97.37	8.85
6-1-44	850		2			1	111.64	6.50	116.10	6.59	90.40	8.72
6-1-45	850		1	1		1	93.29	12.14	97.75	12.24	72.05	13.23
6-1-46	850		1	1		1	107.27	4.81	111.72	4.90	86.03	7.63
6-1-47	850			2		1	117.83	7.23	122.29	7.29	96.59	9.34
6-1-48	850			2		1	110.86	5.38	115.32	5.45	89.62	8.02
6-1-49	850			1	1	1	107.62	3.91	112.07	4.08	86.38	6.90
6-1-50	850				2	1	114.40	6.24	118.85	6.28	93.16	8.71

Notes: See notes on the Table 4.

Table 6. Simulation for 3 person families: continued

No.	Income	Number of family persons					Average		Detached house		Apartment house	
		20's	30's	40's	50's	60's	70's	Estimated F.S.	2 × sigma	Estimated F.S.	2 × sigma	Estimated F.S.
6-2-1	350	1				2	93.98	5.46	98.44	5.59	72.74	7.87
6-2-2	350	1				1	100.75	5.57	105.21	5.65	79.51	8.12
6-2-3	350	1				2	93.78	7.43	98.24	7.48	72.54	9.51
6-2-4	350		1			2	96.24	5.33	100.70	5.45	75.00	7.86
6-2-5	350		1			1	103.01	5.35	107.47	5.40	81.77	8.05
6-2-6	350		1			2	96.04	7.26	100.50	7.29	74.80	9.45
6-2-7	350			1		2	96.05	5.51	100.50	5.61	74.81	8.00
6-2-8	350			1		1	102.82	5.48	107.27	5.53	81.58	8.16
6-2-9	350			1		2	95.85	7.00	100.30	7.03	74.61	9.27
6-2-10	350				1	2	96.73	7.06	101.19	7.08	75.49	9.34
6-2-21	550	1				2	99.84	5.32	104.29	5.47	78.60	7.74
6-2-22	550	1				1	106.61	5.36	111.06	5.45	85.37	7.96
6-2-23	550	1				2	99.64	7.21	104.09	7.27	78.40	9.32
6-2-24	550		1			2	102.10	5.14	106.55	5.26	80.86	7.70
6-2-25	550		1			1	108.86	5.07	113.32	5.14	87.62	7.84
6-2-26	550		1			2	101.89	6.99	106.35	7.03	80.65	9.22
6-2-27	550			1		2	101.90	5.29	106.36	5.40	80.66	7.83
6-2-28	550			1		1	108.67	5.18	113.13	5.24	87.43	7.94
6-2-29	550			1		2	101.70	6.70	106.16	6.73	80.46	9.02
6-2-30	550				1	2	102.58	6.72	107.04	6.75	81.34	9.06
6-2-41	850	1				2	108.62	5.90	113.08	6.04	87.38	8.11
6-2-42	850	1				1	115.39	5.83	119.84	5.92	94.15	8.24
6-2-43	850	1				2	108.42	7.46	112.87	7.53	87.18	9.48
6-2-44	850		1			2	110.88	5.66	115.33	5.78	89.64	8.02
6-2-45	850		1			1	117.65	5.49	122.10	5.56	96.40	8.08
6-2-46	850		1			2	110.68	7.19	115.13	7.24	89.43	9.34
6-2-47	850			1		2	110.68	5.75	115.14	5.87	89.44	8.11
6-2-48	850			1		1	117.45	5.55	121.91	5.61	96.21	8.14
6-2-49	850			1		2	110.48	6.87	114.94	6.92	89.24	9.12
6-2-50	850				1	2	111.37	6.84	115.82	6.89	90.12	9.12

Notes: See notes on the Table 4.

Table 7. Simulation for 4 person families

No.	Income	Number of family persons					Average		Detached house		Apartment house	
		20's	30's	40's	50's	60's	70's	Estimated F.S.	2 × sigma	Estimated F.S.	2 × sigma	Estimated F.S.
7-1	350	2	2				91.19	6.82	95.65	6.97	69.95	8.69
7-2	350	2		2			90.42	5.98	94.87	6.13	69.18	8.16
7-3	350	2			2		93.95	6.84	98.41	6.95	72.71	8.89
7-4	350	2				2	93.98	5.46	98.44	5.59	72.74	7.87
7-5	350		2		2		102.99	9.60	107.44	9.62	81.75	11.38
7-6	350		2			2	103.02	7.42	107.47	7.45	81.78	9.61
7-7	350		2			2	102.82	8.71	107.27	8.70	81.58	10.78
7-8	350			2		2	102.24	8.24	106.70	8.24	81.00	10.32
7-9	350			2		2	102.04	8.13	106.49	8.10	80.80	10.40
7-10	350				2	2	105.57	9.22	110.03	9.17	84.33	11.34
7-11	550	2	2				97.05	6.45	101.50	6.62	75.81	8.39
7-12	550	2		2			96.27	5.45	100.73	5.62	75.03	7.75
7-13	550	2			2		99.81	6.22	104.26	6.34	78.57	8.40
7-14	550	2				2	99.84	5.32	104.29	5.47	78.60	7.74
7-15	550		2		2		108.84	9.05	113.30	9.08	87.60	10.90
7-16	550		2			2	108.87	7.17	113.33	7.20	87.63	9.39
7-17	550		2			2	108.67	8.39	113.13	8.38	87.43	10.51
7-18	550			2		2	108.09	7.93	112.55	7.94	86.85	10.06
7-19	550			2		2	107.89	7.71	112.35	7.67	86.65	10.05
7-20	550				2	2	111.43	8.74	115.88	8.69	90.19	10.93
7-21	850	2	2				105.83	6.56	110.29	6.73	84.59	8.43
7-22	850	2		2			105.05	5.41	109.51	5.59	83.81	7.68
7-23	850	2			2		108.59	5.94	113.04	6.07	87.35	8.16
7-24	850	2				2	108.62	5.90	113.08	6.04	87.38	8.11
7-25	850		2		2		117.62	8.67	122.08	8.70	96.38	10.56
7-26	850		2			2	117.65	7.38	122.11	7.42	96.41	9.52
7-27	850		2			2	117.45	8.41	121.91	8.41	96.21	10.49
7-28	850			2		2	116.87	8.01	121.33	8.03	95.63	10.09
7-29	850			2		2	116.67	7.61	121.13	7.59	95.43	9.94
7-30	850				2	2	120.21	8.48	124.67	8.43	98.97	10.69

Notes: See notes on the Table 4.

Table 8. Simulation for 5 person families

No.	Income	Number of family persons					Average		Detached house		Apartment house	
		20's	30's	40's	50's	60's	70's	Estimated F.S.	2 × sigma	Estimated F.S.	2 × sigma	Estimated F.S.
8-1	350	3	2				91.19	6.82	95.65	6.97	69.95	8.69
8-2	350	3		2			90.42	5.98	94.87	6.13	69.18	8.16
8-3	350	3			2		93.95	6.84	98.41	6.95	72.71	8.89
8-4	350	3				2	93.98	5.46	98.44	5.59	72.74	7.87
8-5	350		3		2		114.28	16.26	118.73	16.23	93.04	17.55
8-6	350		3			2	114.31	14.22	118.77	14.19	93.07	15.67
8-7	350		3			2	114.11	14.74	118.56	14.68	92.87	16.25
8-8	350			3		2	112.56	15.81	117.01	15.76	91.32	17.24
8-9	350			3		2	112.36	14.64	116.81	14.56	91.12	16.27
8-10	350				3	2	120.31	17.76	124.77	17.67	99.07	19.21
8-11	550	3	2				97.05	6.45	101.50	6.62	75.81	8.39
8-12	550	3		2			96.27	5.45	100.73	5.62	75.03	7.75
8-13	550	3			2		99.81	6.22	104.26	6.34	78.57	8.40
8-14	550	3				2	99.84	5.32	104.29	5.47	78.60	7.74
8-15	550		3		2		120.13	15.85	124.59	15.83	98.89	17.16
8-16	550		3			2	120.16	13.99	124.62	13.96	98.92	15.45
8-17	550		3			2	119.96	14.45	124.42	14.40	98.72	15.97
8-18	550			3		2	118.41	15.52	122.87	15.46	97.17	16.95
8-19	550			3		2	118.21	14.26	122.67	14.18	96.97	15.91
8-20	550				3	2	126.17	17.31	130.62	17.23	104.93	18.79
8-21	850	3	2				105.83	6.56	110.29	6.73	84.59	8.43
8-22	850	3		2			105.05	5.41	109.51	5.59	83.81	7.68
8-23	850	3			2		108.59	5.94	113.04	6.07	87.35	8.16
8-24	850	3				2	108.62	5.90	113.08	6.04	87.38	8.11
8-25	850		3		2		128.91	15.50	133.37	15.48	107.67	16.82
8-26	850		3			2	128.94	13.95	133.40	13.92	107.70	15.39
8-27	850		3			2	128.74	14.32	133.20	14.27	107.50	15.84
8-28	850			3		2	127.19	15.34	131.65	15.30	105.95	16.78
8-29	850			3		2	126.99	13.98	131.45	13.90	105.75	15.64
8-30	850				3	2	134.95	16.88	139.41	16.80	113.71	18.38

Notes: See notes on the Table 4.

Figure 1. Trends in floor space per dwelling

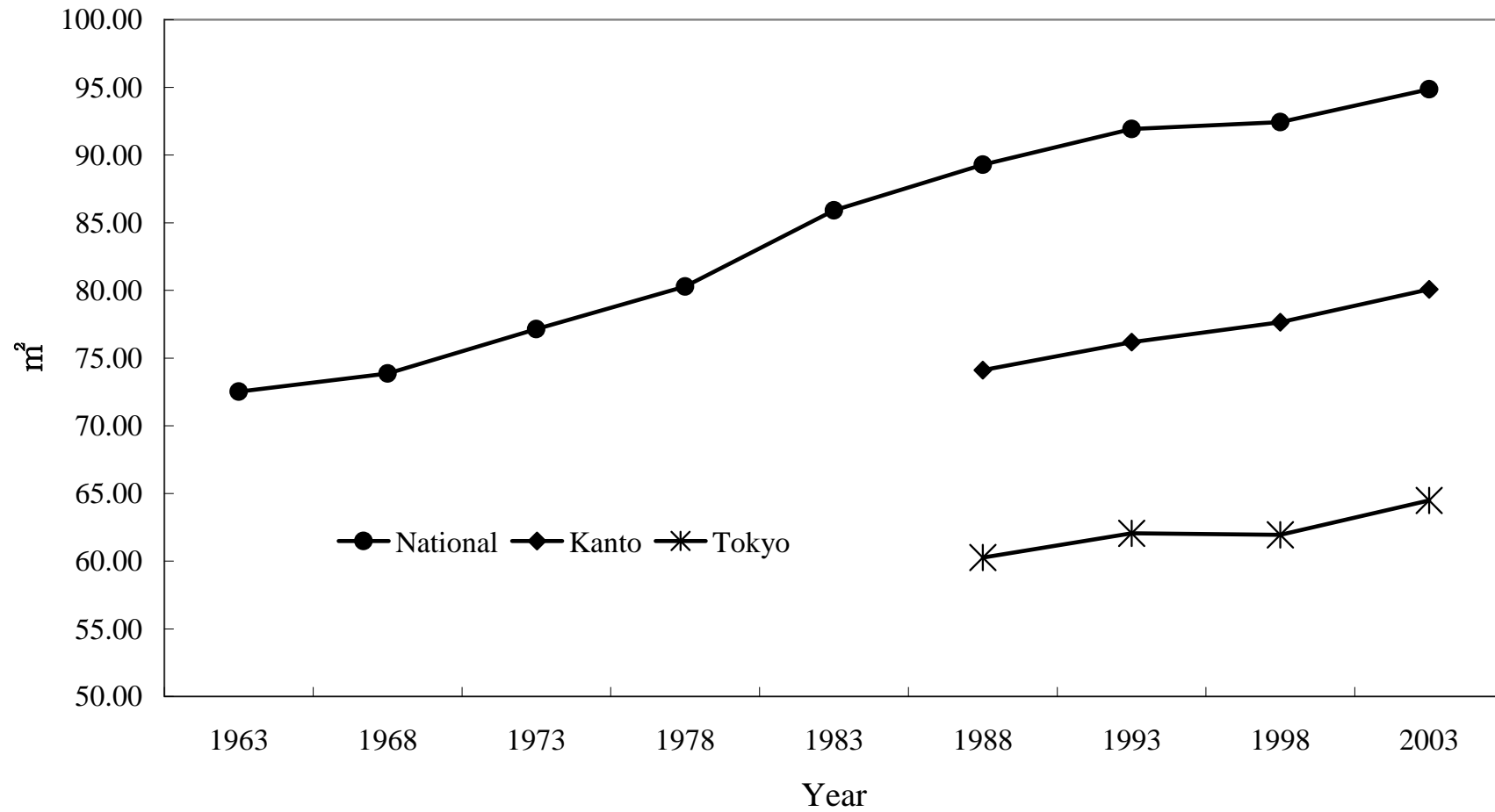


Figure 2. Trends in persons per household

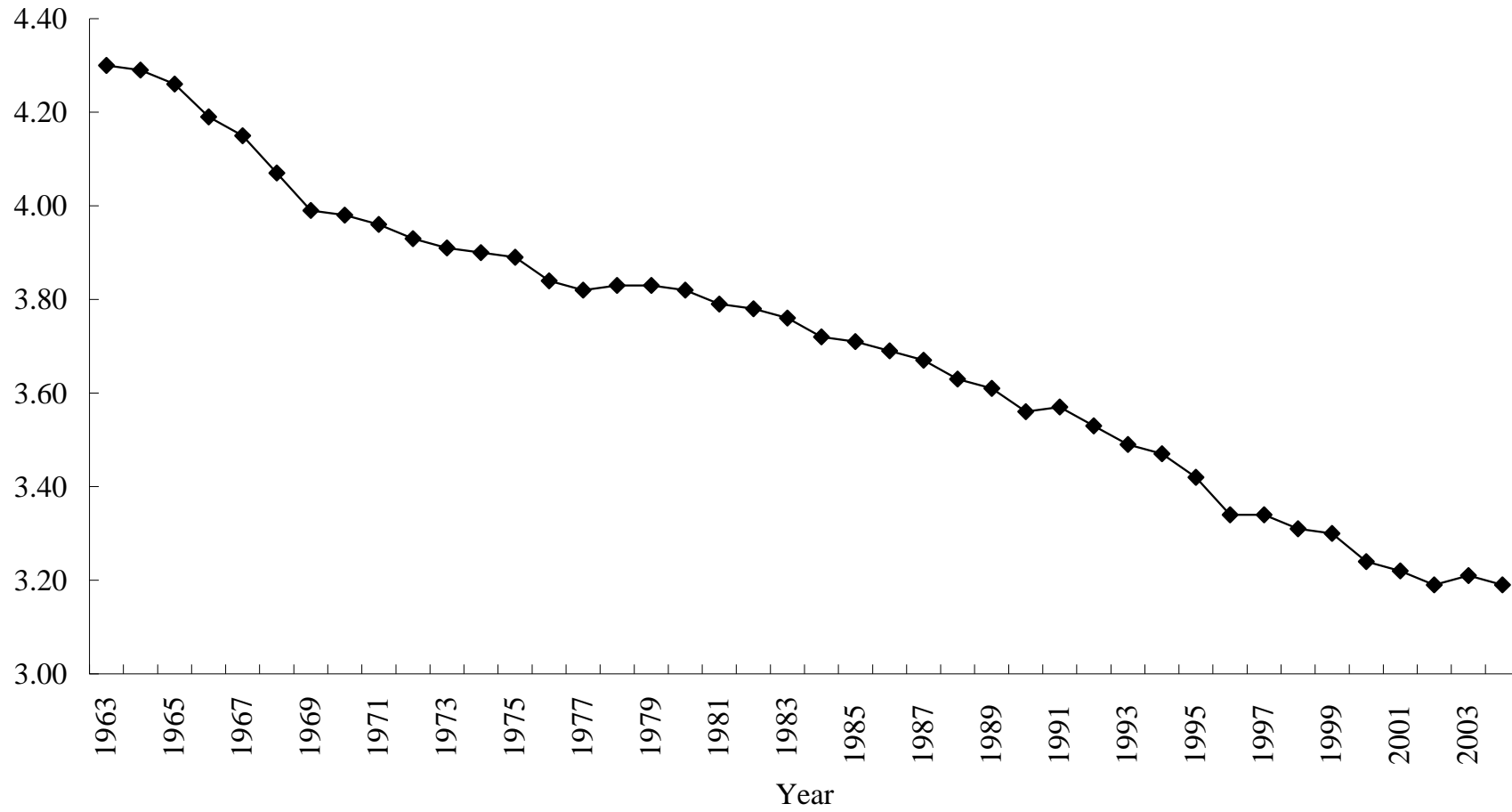


Figure 3. Estate tax and floor space demand

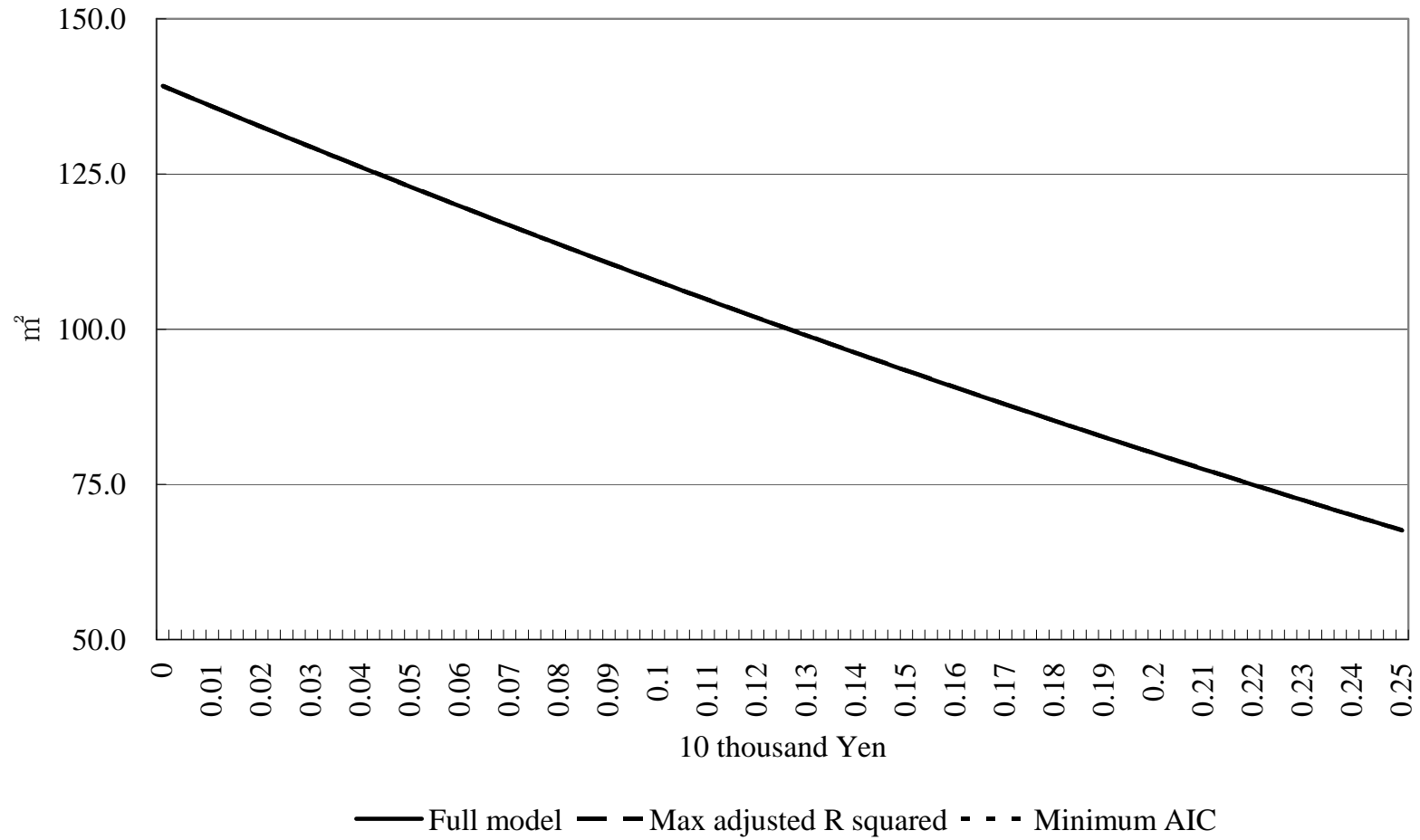


Figure 4. Housing rent and floor space demand

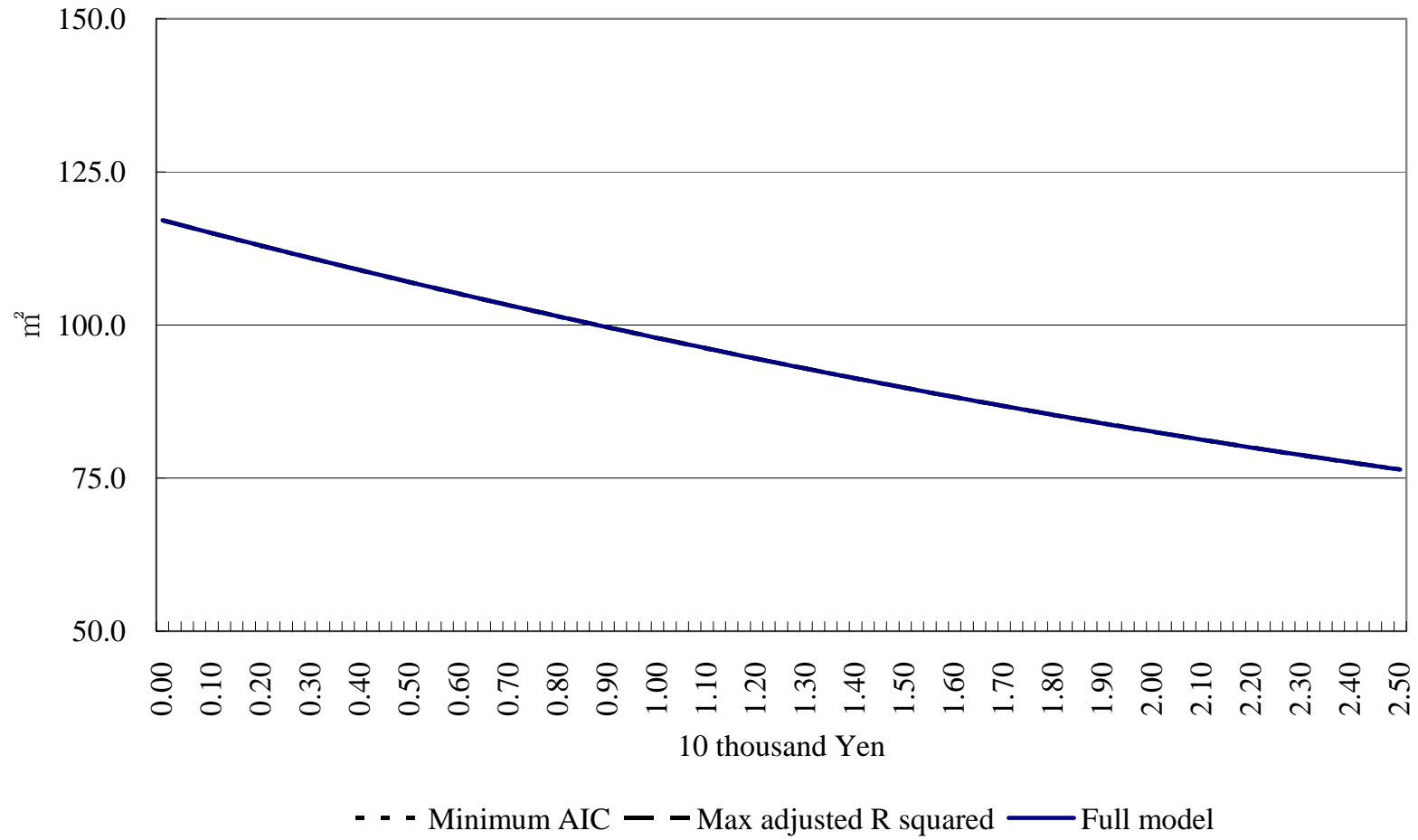


Figure 5. Family income and floor space demand

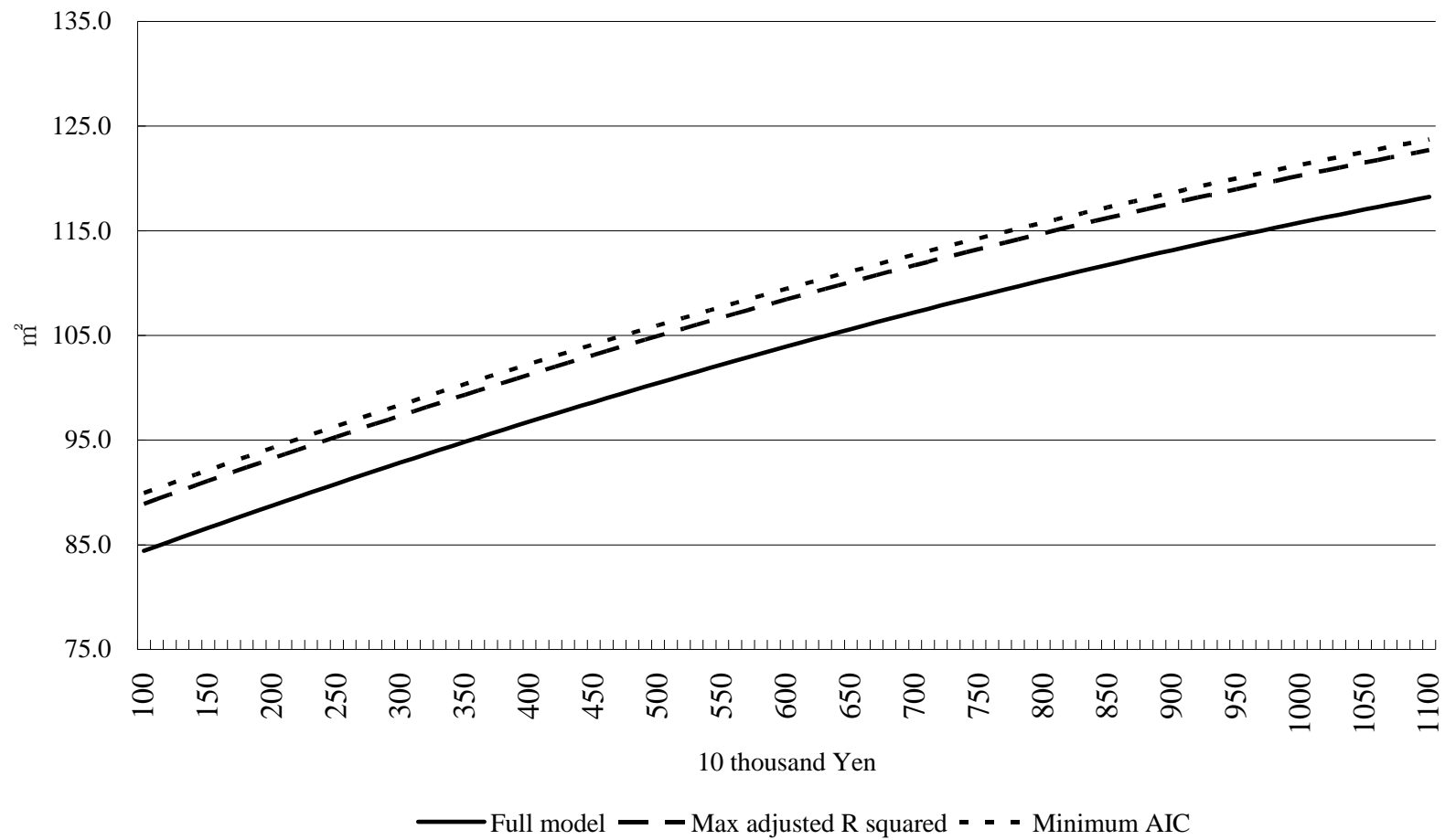


Figure 6. Commuting time and floor space demand

