

## Estimation of Affordable Rental Housing Demands in Yamaguchi Prefecture

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(Received July 11, 1995)

### Abstract

The purpose of this study is to make a model of housing demand estimation, and to simulate the number of affordable rental houses need to supply from 1991 to 2000. In this paper, the framework of the model, the objective living standard and the result of estimation by the model is shown, and we make a discuss about the effect of housing policy of local prefecture's government. Yamaguchi prefecture is selected as an example for the study. If the population become 1,500,000 in 2000, objective households of affordable rental housing are estimated about 52,600. Considering the supply in the market and original housing standard, the number of rental houses need to supply by government is 2,280.

### 1. Introduction

"System of affordable rental housing" materialized in 1993. This system is evaluated with the point that framework of the housing policy is expanded to the promotion of supply of private rental housing for standard families from the conventional public rental housing supply. The main purpose of the system is annulment of lack of rental housing supply for standard families in major metropolitan areas, and it dose not necessarily aime at improvement of level of the rental housing market in local areas. However, rate of owned houses is relatively high in local areas, therefore, the rental housing market does not grow, and generally the housing level is low. The stock of housing for standard families is small, and the need of rental housing supply that utilize system of affordable rental housing is high. On the other hand, the house rent standard in local areas is fairly lower compared with major metropolitan areas, so supply of large size dwelling unit is difficult by management profit. It is a main factor that small size dwelling unit supplies.

System of affordable rental housing is utilized effectively in such rental housing market of local areas. It is an important theme to clear the effect to improve the level.

This study is to construct the demand estimation model of affordable rental housing for Yamaguchi Pref. that is typical prefecture in local areas. It reports the result of estimated demands for 10 years from 1991 to 2000.

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## 2. Basic frame of the demand estimation model

Households in rented house owned privately and number of tatami units of dwelling rooms by household members are estimated in 2000. Original housing standard goal is set up by the viewpoint that improves housing level sets up. To clear this standard, the supply number of affordable rental housing need to supply in 10 years form 1991 to 2000 is estimated. Fig.-1 shows the flow chart of estimation. The estimation is composed of the following 5 steps.

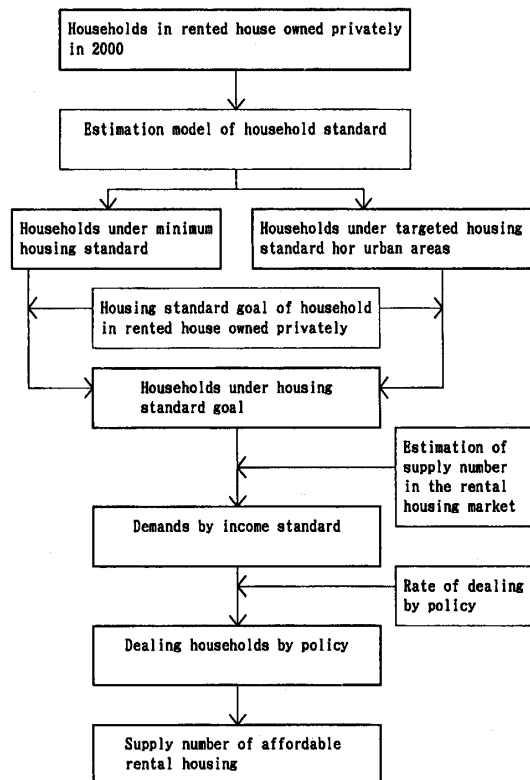


Fig.-1 Flow chart of demands estimation of affordable rental housing

STEP 1 : Households in rented house owned privately in 2000 are estimated by the model of households by housing types considered population fluctuation. Details of this model were reported by references 1)~3). Only basic structure of the model and the result of estimation are shown in this paper.

STEP 2 : Households in rented house owned privately (wooden and non-wooden/facilities used exclusively) in 2000 multiplied by rate of households under minimum housing standard and targeted housing standard for urban areas by estimation model of housing level and make each households. The outline of the model is stated in other manuscript of this report "Estimation of households in the rented houses considering the fluctuation of living level". Accordingly, only the result is shown in this paper.

STEP 3 : Housing standard goal (individual space of dwelling unit by household

members) of the household in rented house owned privately in Yamaguchi Pref. is set up independently, and the households under the housing standard goal are calculated. The reason this original housing standard goal is set up is as follows. The annulment of households under minimum housing standard is natural. However, dwelling unit area of targeted housing standard for urban areas for 4 persons per household is 91 m<sup>2</sup>. The housing supply of such size is very small in rental housing market, and 50 m<sup>2</sup> are lowest standard at the system of affordable rental housing. A realistic standard is set up in each government, and the policy that clear the standard has to be enforced.

STEP 4 : The supply number of rented house owned privately by the dwelling unit area considered actual supply in the housing market is estimated. Objective households subtract estimated supplies from households under housing standard goal. Next, income standard (25~80%) to move in affordable rental housing is set up by model of probability density function. Objective households by policy are estimated by this model.

STEP 5 : Objective households by policy multiplied by rate of dealing by policy and make necessary supplies of affordable rental housing.

### **3. Estimation of households in rented house owned privately and housing standard**

#### **(1) Estimation of households in rented house owned privately**

Population of men and women in Yamaguchi Pref. in 2000 is estimated by Cohort method. The principal households by age of main earner are estimated by multiplying the rate of principal household incorporated time fluctuation to the population. Households in rented house owned privately are estimated by multiplying the disubtributed ratio of housing types to the households. The result of estimation is shown in table -1. Households of wooden facilities used exclusively are about 61,300, wooden facilities used jointly are about 5,200 and non-wooden are about 76,600. If objective household of affordable rental housing is defined as the household members 2 persons or more and age of main earner under 60, they are each 27,100, 240, and 25,300. In the following, households of wooden facilities used jointly are eliminated from estimation, as they are small.

#### **(2) Estimation of households under standard in 2000**

The form of housing standard in Housing Survey of Japan is not unified, and targeted housing standard for urban areas is introduced from 5th Housing Construction Planning in 1986. Therefore, it is difficult to estimate the fluctuation of households under minimum housing standard and under targeted housing standard for urban areas by the result of Housing Survey of Japan. Accordingly, distribution of number of tatami units of dwelling rooms by household members of rented house owned privately (wooden facilities used exclusively/ non-wooden) is estimated by probability density function (logarithmic normal distribution).

First of all, the households under minimum housing standard and under targeted housing standard for urban areas, and their rate by household members are estimated on the basis of number of tatami units of dwelling rooms of households in rented house owned privately (2 persons or more) in 2000. The result of estimation is shown in table

Table-1 Households in Rental housing in 2000

Wooden facilities used exclusively						
Persons	1	2	3	4	5 or more	Total
Age						
L0~24	3490	1024	582	125	0	5221
25~29	1251	1115	1222	702	154	4444
30~39	1054	1152	1564	2907	1139	7816
40~49	1756	2196	2513	3752	1812	12029
50~59	2405	2824	1791	1090	476	8586
60~HI	11084	8776	2300	707	304	23171
Total	21040	17087	9972	9283	3885	61267

□ = 27140 households

Non-Wooden						
Persons	1	2	3	4	5 or more	Total
Age						
L0~24	32734	4699	1306	0	0	38739
25~29	5396	3028	2628	1020	0	12072
30~39	1795	1444	1488	1937	540	7204
40~49	2351	1335	1388	1822	360	7206
50~59	1695	1140	680	436	49	4000
60~HI	4245	2980	129	0	0	7354
Total	48216	14626	7569	5215	949	76575

□ = 25250 households

Wooden facilities used jointly						
Persons	1	2	3	4	5 or more	Total
Age						
L0~24	4141	109	0	0	0	4250
25~29	34	2	2	2	0	38
30~39	18	1	1	1	0	22
40~49	129	34	13	13	0	189
50~59	198	40	10	10	0	258
60~HI	423	56	0	0	0	479
合計	4943	242	26	25	0	5236

□ = 237 households

-2. Households under minimum housing standard are 11,000 and the rate is 16.0% as high as before. Households under targeted housing standard for urban areas are 35,000 and the rate become 51.3%, and it is close to the proportion of standard goal. Objective households of affordable rental housing are estimated by multiplying the rate to the households. The result of estimation is shown in table-3. Households under minimum housing standard are 86,000 and decrease about 1,300 in comparison with 1988. Also households under targeted housing standard for urban areas are 36,000 and do not change much from 1988. Yet, it is different that proportion of households of non-wooden rise conspicuously. The reason is new supply shifts from wooden detached houses to non-wooden apartments in the market.

#### 4. Setting of housing standard goal and estimation of objective households

##### (1) Setting of housing standard goal

Table-4 shows the objective households of affordable rental housing (household members 2 persons or more and age of main earner under 60) in rented house owned privately in 1988 by the result of Housing Survey of Japan. Households under minimum housing standard are 7,881 (under ratio 20%) at wooden facilities used exclusively, 225 (under ratio 78%) at wooden facilities used jointly and 1,996 (under ratio 12%) at non-wooden. This number means that there are still a lot households that necessitate urgent improvement of housing level. Targeted housing standard for urban areas is a little high (For example, individual space of dwelling unit for standard 4 persons per household is 91 m<sup>2</sup>), so households under the standard are 24,367 (under ratio 62%) at wooden facilities used exclusively, 54 (under ratio 12%) at wooden facilities used jointly and 11,319 (under ratio 68%) at non-wooden. Also dwelling unit of large space

Table-2 Rate of households under housing standard of rental housing in 2000

Households in rented house owned privately						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		17087	9972	9282	3885	40226
Non-wooden		14625	7569	5215	949	28359
<b>Total</b>		<b>31712</b>	<b>17541</b>	<b>14498</b>	<b>4833</b>	<b>68584</b>
Under minimum housing standard						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		315	1096	2273	678	4362
Non-wooden		1571	2220	2488	344	6622
<b>Total</b>		<b>1887</b>	<b>3316</b>	<b>4760</b>	<b>1022</b>	<b>10985</b>
		( 5.9)	(18.9)	(32.8)	(21.1)	(16.0)
Under targeted housing standard for urban areas						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		6449	5803	5861	2820	20933
Non-wooden		7360	3983	2382	549	14275
<b>Total</b>		<b>13810</b>	<b>9785</b>	<b>8243</b>	<b>3370</b>	<b>35207</b>
		(43.5)	(55.8)	(56.9)	(69.7)	(51.3)

Appendix: ( )=households by housing standard/all households

Table-3 Result of estimation of households under housing standard

Under minimum housing standard						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		153	843	2100	625	3052
Non-wooden		1251	2182	2487	344	5897
<b>Total</b>		<b>1187</b>	<b>2857</b>	<b>4528</b>	<b>958</b>	<b>8551</b>
Under targeted housing standard for urban areas						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		1404	3026	4587	969	8551
Non-wooden		8998	8379	7797	3149	27408
<b>Total</b>		<b>10402</b>	<b>11405</b>	<b>12384</b>	<b>4118</b>	<b>35959</b>

Table-4 Rate under housing standard of objective household of affordable rental housing in 1988

Objective households of affordable rental housing						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		10822	10256	13241	5093	39412
Non-wooden		5859	4575	4797	1358	16590
<b>Total</b>		<b>16681</b>	<b>14831</b>	<b>18038</b>	<b>6451</b>	<b>56002</b>
Under minimum housing standard						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		1255	1531	2966	2129	7881
Non-wooden		473	465	688	370	1996
<b>Total</b>		<b>1728</b>	<b>1996</b>	<b>3654</b>	<b>2499</b>	<b>9877</b>
		(10.4)	(13.5)	(20.3)	(38.7)	(17.6)
Under targeted housing standard for urban areas						
Housing types	Persons	2	3	4	5 or more	Total
Wooden facilities used exclusively		5864	6719	9158	2627	24367
Non-wooden		3176	3391	3886	865	11319
<b>Total</b>		<b>9040</b>	<b>10110</b>	<b>13044</b>	<b>3492</b>	<b>35686</b>
		(54.2)	(68.2)	(72.3)	(54.1)	(63.7)

Appendix: ( )=households by housing standard/objective households of affordable rental housing

for standard families is small in the rental housing market.

Accordingly, it is necessary to be set up the following standard goal. Firstly it is aimed at annulment of households under minimum housing standard. Secondly it is aimed at improvement of households under targeted housing standard for urban areas. However, it is difficult to annul households under targeted housing standard for urban areas, at present situation in the rental housing market. Thereupon, middle standard between minimum housing standard and targeted housing standard for urban areas are set up as an immediate goal. Concrete standard goal is shown by every household members.

Household members	Number of tatami units of dwelling rooms	Individual space of a dwelling unit
2	15~20 mats	40~50 m <sup>2</sup>
3	20~24 mats	55~65 m <sup>2</sup>
4	24~28 mats	65~75 m <sup>2</sup>
5 or more	28~36 mats	75~90 m <sup>2</sup>

This standard goal exceeds 10~20 m<sup>2</sup> at 2 persons per households, 15~25 m<sup>2</sup> at 3,4 persons and 20~35 m<sup>2</sup> at 5 persons or more than minimum housing standard (fig.-2).

#### (2) Calculation of objective households

Households under minimum housing standard are considered all. Also households under targeted housing standard for urban areas replace to households under original standard goal. To estimate the households, number of tatami units of dwelling rooms by household members is calculated. A Frame in table-5 shows households under housing standard goal, and the households inside this frame are defined as objective

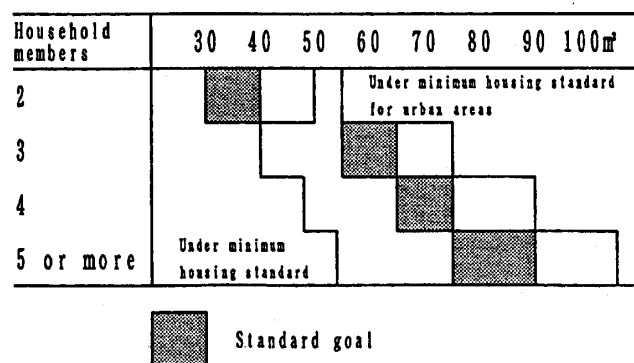


Fig.2 Standard goal of individual space of dwelling unit

households of policy. The total is about 24,000 and proportion of number of tatami units of dwelling rooms 10~15 mats at 2 and 3 persons, 15~20 mats at 3 and 4 persons and 20~28 mats households at 4 persons are high. Households of wooden facilities used

exclusively are about 11,000 and non-wooden are about 13,000. As for the former proportion of 20~28 mats at 4 persons per household is high, latter proportion of 10~15 mats at 2 persons per household is high.

Table-5 Result of estimation of households under housing standard goal

Wooden facilities used exclusively									
Household members	L0-	5-	10-	15-	20-	28-	36-	42-	Total
	5	10	15	20	28	36	42	HI	
2	0	153	1125	2012	2799	1391	450	381	8311
3	0	72	771	1715	2749	1477	487	401	7672
4	0	18	457	1625	3415	2000	629	432	8576
5 or more	0	5	125	496	1287	954	378	356	3581

Wooden facilities used exclusively+non-wooden									
Household members	L0-	5-	10-	15-	20-	28-	36-	42-	Total
	5	10	15	20	28	36	42	HI	
2	34	1371	4101	4896	5539	2508	799	708	19957
3	7	572	2448	3631	4747	2322	750	635	15112
4	0	167	1379	3041	5092	2705	829	577	13791
5 or more	0	20	239	710	1585	1126	438	412	4530

Non-wooden									
Household members	L0-	5-	10-	15-	20-	28-	36-	42-	Total
	5	10	15	20	28	36	42	HI	
2	34	1218	2977	2884	2741	1117	949	327	11646
3	7	500	1676	1916	1998	846	263	234	7440
4	0	149	921	1416	1667	705	200	145	5215
5 or more	0	15	114	214	318	172	60	56	949

Objective households of affordable rental housing  
 Clear line of under targeted housing standard for urban areas (by number of tatami units (mats))

## 5. Estimation of supply number in the market

Supplies per year by dwelling unit size are calculated from supplies of rented house owned privately for past 5 years. Supplies in the rental housing market for 10 years are estimated by multiplying 10 times of the number. Table-6 shows supplies by individual space of dwelling unit in main cities and towns of Yamaguchi Pre. for 5 years (1989~1993). Total supplies are 18,400 for 5 years and supplies per year are about 3,700. However, the units under 50 m<sup>2</sup> occupy 70% over and supplies for standard families are small. The units of 50~64 m<sup>2</sup> corresponding to standard goal of dwelling unit size for 3 persons per household are about 20% and they are a little many, but 65~74 m<sup>2</sup> corresponding to dwelling unit size for 4 persons are just 7%.

Supplies for 10 years from 1991 to 2000 are estimated by multiplying 10 times of supply per year in the market from 1989 to 1993. Supplies of 40~49 m<sup>2</sup> corresponding to standard goal for 2 persons per households are distributed according to the space from supplies of 25~49 m<sup>2</sup> in table-6. However, it is necessary to improve the method simply estimating supplies for 10 years by real supplies for 5 years.

Estimated supplies in the market are shown in the left columns of table-12. The units of 40~50 m<sup>2</sup> and 50~65 m<sup>2</sup> corresponding to the individual space of the dwelling unit of standard goal for 2 and 3 persons per households are estimated about 5,600 and 7,300. On the other hand, dwelling units of 65~75 m<sup>2</sup> are about 2,600, and supplies of 75~90 m<sup>2</sup> decreases to 700. The individual space of a dwelling unit is from 65 m<sup>2</sup> to 120 m<sup>2</sup> at the system of affordable rental housing in Yamaguchi Pref.. The stated trend of supply shows that the standard of space agrees to cover the small supply for standard families in the market.

Table-6 Supply number of rental housing in main cities and towns for 5 years

Cities and towns	10-25 ㎡	25-49 ㎡	50-64 ㎡	65-74 ㎡	75-91 ㎡	Total
Shimonoseki	1671	1852	612	171	124	4430
Ube	859	1070	334	236	12	2511
Yamaguchi	1334	1018	406	228	119	3097
Hagi	56	88	182	30	0	356
Tokuyama	1042	549	399	262	28	2280
Hofu	331	396	674	105	21	1527
Kudamatu	77	210	180	23	0	490
Iwakuni	410	784	411	18	2	1625
Onoda	156	146	76	30	2	410
Hikari	28	201	100	16	4	349
Nagato	26	37	26	10	0	99
Yanai	35	81	75	0	15	186
Shinnanyo	54	176	84	78	0	392
Ogoori	58	200	92	76	14	440
Sanyo	14	179	4	4	0	201
Waki	0	14	16	10	2	42
<b>Total</b>	<b>6151</b>	<b>6981</b>	<b>3665</b>	<b>1295</b>	<b>343</b>	<b>18435</b>
<b>%</b>	<b>33.4</b>	<b>37.9</b>	<b>19.9</b>	<b>7.0</b>	<b>1.9</b>	<b>100.0</b>

## 6 . Estimation of demands of political supply

Demands that should deal by policy to annul households under housing standard goal are made by subtracting the objective households under housing standard goal from supplies in the market. Namely,

Demands=Objective households-Supplies in the market

The result of estimation of demands by household members are shown in the left columns of table-12. The units below 65 m<sup>2</sup> for 2,3 persons per household need not to deal by policy, because supplies in the market exceed objective households, but demands of units of 65~75 m<sup>2</sup> are most frequent with 7,100. Also units of 75~90 m<sup>2</sup> are about 1,700. It is expected that rental housing supply for standard families (4 persons or more) will lack with only supply in the market substantially. Therefore, rental housing of large dwelling unit space need to be supplied in Yamaguchi Pref..

## 7 . Calculation of disdistributed ratio by income standard and rate of demands

(1) calculation of disdistributed ratio by income standard

The income standard of objective household of affordable rental housing is 25~80%. Therefore, it needs to classify in 3 layers 80% over, 25~80%, and under 25% to estimate demands of affordable rental housing. It is necessary to calculate the disdistributed ratio by classified income standard. The disdistributed ratio by income standard is defined as the ratio of households by the income standard of objective household of affordable rental housing in Housing Survey of Japan, and it supposes that ratio does not change also in 2000.

Table-7 shows the income standard by the household members by rough estimation of Housing Survey of Japan. The objective households of affordable rental housing in Yamaguchi Pref. is calculated by household members on the basis of the income standard. A question of the annual income of Housing Survey of Japan is selected from 9 categories of less than 1 million yen, 1~2, 2~3, 3~4, 4~5, 5~7, 7~10, 10~15, 15 million and over. It can not to calculate the corresponding households by the result.



Table-7 Annual income by income standard in 1993 (Japan)

Income standard	2 persons	3 persons	4 persons	5 persons or more
25 %	1,887,160	2,772,199	3,468,186	3,544,243
50	3,024,432	4,141,807	4,885,326	4,974,587
60	3,606,885	4,756,169	5,596,634	5,789,353
70	4,227,783	5,646,610	6,411,199	6,616,499
80	5,269,638	6,718,726	7,539,696	7,972,275

Thereupon, it supposes that distribution of annual income is applicable to logarithmic normal distribution, and the households are estimated by the function. A probability density function of logarithmic normal distribution is shown.

$$f(x) = \frac{1}{\sqrt{2\pi} \xi x} \exp\left[-\frac{1}{2} \left(\frac{\ln x - \lambda}{\xi}\right)^2\right]$$

First of all average and variance of annual income is calculated by household members. Parameter  $\lambda$ ,  $\xi$  are calculated by average and variance. A distribution function  $f(x)$  is calculated by these parameters. Estimated parameter ( $\lambda$ ,  $\xi$ ) is (5.61, 0.58) at 2 persons per households, (5.73, 0.54) at 3 persons, (5.94, 0.45) at 4 persons and (5.94, 0.50) at 5 persons or more. Fig.-3 shows the real rate of objective households by annual income and the estimated rate calculated from the function. Next households by income standard are estimated by the function, the result of estimation is shown in table-8. The total households of income standard 25~80% corresponding to standard of moving in affordable rental housing are 29,800. 2 persons per households are most high proportion with 60.8%, and 3~5 persons are about 50%.

## (2) Hypothesis of Rate of demands of affordable rental housing

In "vision of housing policy for Yamaguchi Pref.", goal of stock of rental houses in 2000 is dwelling unit 55 m<sup>2</sup> space). It is examined how many demands of affordable rental housing for necessary households of dealing by policy, to achieve this standard goal.

Households in rented house owned by privately by number of tatami units of dwelling rooms by household members in 1988 are calculated. It is supposed that the rate will not change even in 2000. Households by number of tatami units of dwelling rooms by household members is estimated by multiplying the rate to the estimated households in 2000. The result of estimation in 1988 and 2000 are shown in table-9.

Rate of households of space under 20 mats in 1988 exceeds 50% with 66.8%. 2 persons or more per households almost clear standard goal with 50.8%. However the estimation in 2000, rate of whole households of space under 20 mats rises 72.3%, even 2 persons or more per households rise 53.3%. It is expected that the standard of dwelling unit size of rented house owned privately will decrease, as the reason it is pointed out that the constitution of households rather shifts to single and 2 persons in 2000. As a result, households in the small size dwelling unit increase substantially. Therefore, it

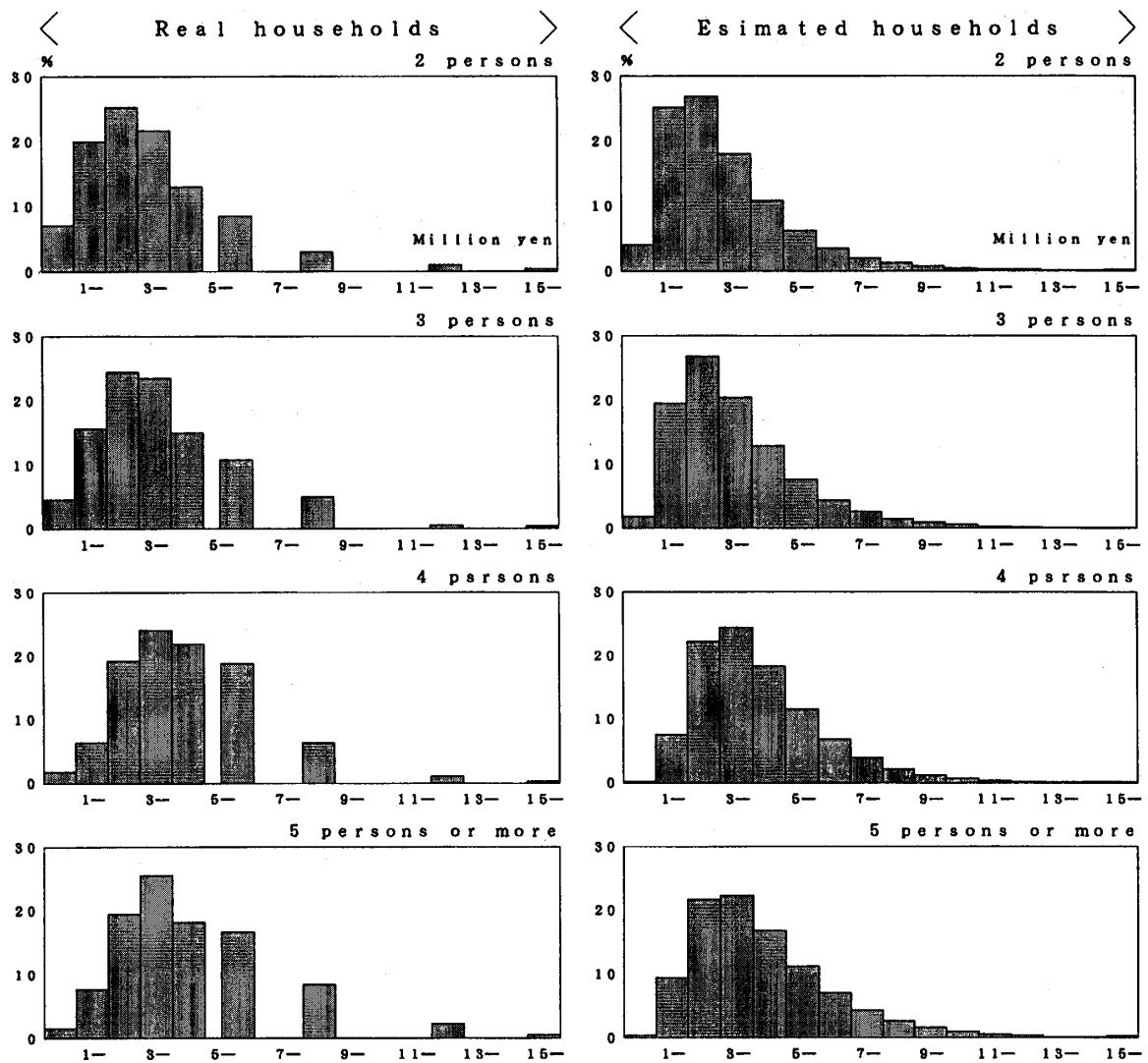


Fig.-3 Real and estimated households by income standard

Table-8 Result of estimation of households by income standard

Income standard	2 persons	3 persons	4 persons	5 persons or more
below 25 %	4295 (26.2)	6335 (42.7)	7624 (42.1)	2863 (44.2)
25-80%	9962 (60.8)	7397 (49.8)	9299 (51.4)	3164 (48.8)
80 % and over	2118 (12.9)	1111 (7.5)	1179 (6.5)	453 (7.0)
Total	16375 (100.0)	14843 (100.0)	18102 (100.0)	6480 (100.0)

has to say that the achievement of the standard goal in the vision of housing policy is extremely difficult, if it change just as present condition.

Accordingly, it is simulated how many housing level of rented house owned private-

Table-9 Result of estimation of number of tatami units of dwelling rooms by household members

Housing Survey of Japan (1988)									
Household members	10-5	5-10	10-15	15-20	20-28	28-36	36-42	42-HI	Total
1	2097	15788	12835	9175	3653	512	169	124	44353
	4.7	35.6	28.9	20.7	8.2	1.2	0.4	0.3	
2	16	1049	5195	7615	6329	1332	566	362	22464
	0.1	4.7	23.1	33.9	28.2	5.9	2.5	1.6	
3	0	193	2625	5751	5330	1442	443	411	16195
	0.0	1.2	16.2	35.5	32.9	8.9	2.7	2.5	
4	0	116	1960	5667	7027	2436	730	515	18451
	0.0	0.6	10.6	30.7	38.1	13.2	4.0	2.8	
5 or more	0	46	645	1525	2333	1143	444	552	6688
	0.0	0.7	9.6	22.8	34.9	17.1	6.6	8.3	
Total	2113	17192	23260	29733	24672	6865	2352	1964	108151
	2.0	15.9	21.5	27.5	22.8	6.3	2.2	1.8	
Whole		72298	66.8		35853	33.2			108151
2 persons or more		32403	50.8		31395	49.2			63798

Estimation in 2000									
Household members	10-5	5-10	10-15	15-20	20-28	28-36	36-42	42-HI	Total
1	3508	26412	21472	15349	6111	857	283	207	74199
2	23	1492	7390	10832	9003	1895	805	515	31955
3	0	209	2847	6238	5782	1564	481	446	17567
4	0	91	1543	4461	5531	1917	575	405	14523
5 or more	0	33	466	1102	1686	826	321	399	4834
Total	3531	28238	33718	37982	28113	7059	2464	1973	143078
	2.5	19.7	23.6	26.5	19.6	4.9	1.7	1.4	
Whole		103470	72.3		38608	27.7			143078
2 persons or more		36728	53.3		32151	46.7			68879

Table-10 Simulation of annuled all of households

Household members	10-5	5-10	10-15	15-20	20-28	28-36	36-42	42-HI	合計
1	3508	26412	21472	15349	6111	857	283	207	74199
2	4	682	2813	16228	9003	1895	805	515	31955
3	0	47	360	714	13954	1564	481	446	17567
4	0	11	77	177	11360	1917	575	405	14523
5 or more	0	1	31	52	82	3947	321	399	4834
Total	3512	27164	24753	32521	40511	10180	2464	1973	143078
	2.5	19.0	17.3	22.7	28.3	7.1	1.7	1.4	
Whole		87950	61.5		55128	38.5			143078
2 persons or more		21209	30.8		47670	69.2			68879

Table-11 Simulation of annuled half of households

Household members	10-5	5-10	10-15	15-20	20-28	28-36	36-42	42-HI	合計
1	3508	26412	21472	15349	6111	857	283	207	74199
2	13	1092	5101	13530	9003	1895	805	515	31955
3	0	128	1604	3476	9868	1564	481	446	17567
4	0	51	810	2319	8446	1917	575	405	14523
5 or more	0	17	249	577	884	2387	321	399	4834
Total	3521	27701	29236	35252	34312	8620	2464	1973	143078
	2.5	19.4	20.4	24.6	24.0	6.0	1.7	1.4	
Whole		95710	66.9		47368	33.1			143078
2 persons or more		28969	42.1		39910	57.9			68879

ly changes by increase of number of tatami units of dwelling rooms, when the all or half of necessary households clear standard goal. Table-10,11 show the result. When all of objective households clear standard goal, as a whole rate of households under 20 mats decreases to 61.5%, objective households of affordable rental housing (2 persons or over per household) become 30.8%. Standard goal is cleared sufficiently at 2 persons or more per household. Also, when half of objective households clear standard goal, as a whole rate of households under 20 mats decreases to 66.9%, 2 persons or over per household become 42.1%, so standard goal is cleared at 2 persons or more. It is possible to achieve the goal of "vision of housing policy for Yamaguchi Pref.". Therefore, the rate of demand of affordable rental housing supply is defined as 1/2.

Table-12 Result of demands estimation of affordable rental housing

Standard goal		Objective households (A)			Number of supply in the market (B)	Demands (C) = (A) - (B)	Demands by income standard			Number of dealing supply by policy (C) × 1/2				
Household members	Individual space of dwelling unit	Under minimum housing standard (mats)	Under targeted housing standard (mats)	Total			LO-25%	25-80%	80-HI%	Public rental housing	Affordable rental housing	Public financing		
2	40-50 m <sup>2</sup>	1405	-10.0	4101	-15.0	5506	5580	0	0	0	0	0	0	0
3	50-65 m <sup>2</sup>	3027	-15.0	3631	-20.0	6658	7330	0	0	0	0	0	0	0
4	65-75 m <sup>2</sup>	4587	-20.0	5092	-28.0	9679	2590	7089	2985	3644	461	1492	1822	230
5 or more	75-90 m <sup>2</sup>	969	-20.0	1585	-28.0	2554	690	1864	824	910	130	412	455	65
Total		9989		14409		24398	16190	8953	3809	4554	591	1904	2277	296

## 8. Result of estimation

By the aforementioned method, demands of affordable rental housing for 10 years from 1991 to 2000 are estimated. Table-12 show the estimated number of demand, dealing supplies by policy and supplies of affordable rental housing, to achieve the housing standard goal.

If population become 1,500,000, objective households are 24,700, especially proportion of 3,4 persons per households is high. However, the dwelling unit size 40~64 m<sup>2</sup> corresponding to 2,3 persons per household are supplied enough in the market. Therefore demands are small with 873. On the other hand, supplies are 2,590 in the market, in spite of objective households 8,455 at 4 persons per household. Therefore demands are most with 5,865. This demands are distributed by income standard. Next the demands are multiplied by rate of dealing by policy (1/2) and make supplies of affordable rental housing, and the number is 2,280.

## 9. conclusion

The result of examination is summarized as follows.

- 1) Objective Households of affordable rental housing are estimated about 52,600 in 2000. Households under minimum housing standard are estimated about 8,600 and households under targeted housing standard for urban areas are estimated about 36,000.
- 2) An original housing standard goal is set up, and households under this standard goal are estimated. As a result, objective households are about 24,000. Necessary households of dealing by policy are estimated by subtracting the rental houses in the market from households under standard. The households that any public policy is necessary are about 9,000.
- 3) Necessary households of dealing by policy are distributed by income standard. Distributed households are multiplied by rate of dealing by policy (1/2) and make dealing supplies by policy. As a result, necessary supplies of

affordable rental housing are about 2,300 for 10 years, and it is necessary to supply 230 for a year.

- 4) From the result of estimation, it is pointed out as an important theme for housing policy in prefecture that the utilization of system of affordable rental housing is necessary, to achieve the goal of "vision of housing policy" in Yamaguchi Pref. And the rental housing supply for standard families is advanced actively.

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