Agglomeration Economies and House Rent

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SUMMARY: The aim of this paper is to show the quantitative relationship between the urban size and the agglomeration economies in present Japan. This is an approach to measure the urban externalities. The main result is that the agglomeration economies measured by the house rent are proportional to the urban size measured by the number of population(straight line), or increase more gradually than the growth of urban size(upper-wards convex). In the standard rental apartment house, either the rent increases by about 31 yen when the number of population of an area increases by 10 thousand men, or the elasticity of rent to population is about 0.18.

1. Introduction

Since Marshall [4], the externalities have been one of the main theme of economics. Generally speaking, the externalities are important from point of the development of industries. Above all, in the age of service economies, the agglomeration economies of cities are very important among concepts of externalities. We have many theoretical contributions to the agglomeration economies, e.g. Rabenau [7], Rabenau and

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Hanson [8], Dendrinos [1], Papageorgiou [6], Kanemoto [3], Miyao [5] and Hatta [2].

This paper is a quantitative and empirical approach, and complementary to these contributions. This is also a development of previous papers of mine [9], [10], [11], [12], [13], [14] and [15].

2. Region of Cities, Urban Size and Agglomeration Economies

The selection of the region of a city is important, because the urban size and the agglomeration economies vary with the region selected, so the relation of these two factors will also vary with the region. We have some candidates of the region to be selected, e.g. the city, the city area, the economic area, and the prefecture and so on.

The first one, "city", is an administrative district. In Japan in 1994, we have 663 cities and Tokyo-special-ward which consists of 23 special wards in the Tokyo metropolitan area. There are 11 cities with a population of over one million, which include Tokyo-special-ward. The average number of population in all cities is about 150 thousand.

Secondly, "city area" is the region of everyday life, and consists of not only an administrative city just mentioned above but also several towns and villages around the city. There are 1992 towns and 581 villages in Japan. The average population of towns and villages is about 10 thousand.

The third region, "economic area", is the distribution area. And the central city of this area has powerful functions from points of economic or distributive activities as well as points of administration, industries, and culture in the area. It consists of some city areas just mentioned above.

The final one, "prefecture", is a local administrative unit which is in upper level of cities, towns and villages. We have 47 prefectures in Japan which include Tokyo metropolitan area, Osaka metropolitan prefecture, Kyoto metropolitan prefecture, and Hokkaido special prefecture. Its average population is about 2.6 million.

The first and fourth of above regions are administrative units, but the second and third are not, so we have no clear and official definition of the city area and the economic area. However, in the previous paper, we showed about 709 city areas and 110 economic areas in Japan, and furthermore, we showed that the best of four regions was the third one, i.e. the economic area, when we investigated the relation between the urban size and the agglomeration economies in present Japan. (Yoshimura [14]) Therefore we will adopt the economic area as the region in this paper, too.

As concerns the index of urban size, we can think of the number of population, gross or net products, the number of labourer, the number of enterprises, and so on. In the same paper(Yoshimura [14]), it has been shown that the number of population is the most appropriate index among many indices. In this paper we will also adopt the number of population as the index of urban size.

On the other hand, as concerns the index of agglomeration economies of cities, we will adopt a different index in this paper from the previous ones. In my former papers [10] and [11] , I adopted the wage differences among economic areas as the index of agglomeration economies. After that, however, I payed attention to the land which is the immovable factor of production, instead of labour which is mov-

able, and then adopted the land prices in papers [14] and [15].

In this paper, we will select the rent, because the rent is the direct reward to the land as factor of production, although the land price is the indirect refrection of the productivity of land and is derived from the rent. We should also recognize that the differences of land price among regions are still larger than the rent, and that the land price is easily influenced by speculative activities in the economy.

3. Data of the Economic Area, the Population and the Rent

In this paper, we select the economic area as the region of a city, the number of population as the index of urban size, and the house rent as the index of agglomeration economies of cities.

As concerns economic areas, we will use the data in "Power of People" ("Minryoku" in Japanese) [18] published by Asahi Shinbun Ltd. in the same way as my previous papers [14] and [15].

Furthermore, we will use the data of population in "Basic data of Residents" ("Jumin Kihon Daicho" in Japanese) [16] published by the Ministry of Home Affairs.

On the other hand, it is most difficult to obtain the data of rents among three kinds of data which we need in this paper. Although we could have offical data of land prices in my former papers [14] and [15], we have no official data of rents this time, so we must look for suitable data of rents which are comparable each other among economic areas. We could not find data of all the areas which are comparable each other, although we made every effort through visiting or

calling the relevant authorities and organizations in Japan. However, fortunately we were able to find some data of rents through the report [17] ("Business Customs and Actual Conditions of Rental House Agencies") of National Federation of Real Estate Transaction Associations (NFRETA) (Zenkoku Takuchi Tatemono Torihikigyo Kyokai Rengokai).

The outline of the research in this report is as follows. The questionnaires were disributed from January to February in 1985 to the Associations mentioned above which were in 285 cities, each of which had a population of 100 thousand or more. The answers were collected from 283 Associations during the same period. Therefore the ratio of answers collected to all questionnaires distributed is 99.3%. There are many questions in the questionnaires, all of which are concerned with the densest area of rental houses in the city. Among questions, it is the house rent that we use in this paper.

The items researched are not only the monthly house rent but also the deposit, the recompense and the key money. The latter three items do not always have a unique definition in Japan. However, we are usually able to think that the key money is not returned at the end of contract, on the other hand, the deposit and recompense are returned after deducting compensation for damages which the tenant caused during the term of contract.

The subjects researched are the following six kinds of rental houses.

①newly built wooden rental apartment house

②secondhand wooden rental apartment house

③newly built wooden rental single house

④secondhand wooden rental single house

⑤newly built non-wooden rental apartment house

⑥secondhand non-wooden rental apartment house

We usually use the terms 1DK, 2DK and so on about rental houses. 1DK means one-room-apartment or house with a dining room(D) and a kitchen(K). Similarly 2DK means two-rooms-apartment or house with a dining room and a kitchen.

Now, in ①, ②, ⑤ and ⑥ of six kinds of rental houses, there are four cases in the reseach above mentioned, i.e. 1DK with bath, 1DK without bath, 2DK with bath, and 2DK without bath. And in ③ and ④, we have six cases, i.e. 2DK with bath, 2DK without bath, 3DK with bath, 3DK without bath, 4DK with bath, and 4DK without bath.

Among these cases, we will use the following cases in this paper which are in the highest grade. That is to say, we use the case of 2DK with bath in the rental apartment house of ①, ②, ⑤ and ⑥, and the case of 4DK with bath in the single house of ③ and ④.

There are two points to be noted here. First, we can not have data of all areas, because the cities which have a population of less than 100 thousand are excluded from the research mentioned above, although there are areas whose central city has a population of less than 100 thousand.

Second, the numbers of economic areas whose data we can find in the report mentioned above are not always same among the cases, because there are some respondents who gave answers to questions of some cases, but did not give answers to questions of the other cases.

Therefore, the numbers of areas in six cases that we will investigate are as follows (Table 1).

Table 1. Six Cases and the Numbers of Areas

cases	numbers of areas
①newly built wooden rental apartment house (2DK with bath)	78
②secondhand wooden rental apartment house (2DK with bath)	79
③newly built wooden rental single house (4DK with bath)	78
④secondhand wooden rental single house (4DK with bath)	78
⑤newly built non-wooden rental apartment house (2DK with bath)	80
⑥secondhand non-wooden rental apartment house (2DK with bath)	77

As mentioned above, the rent which is in the report [17] is one in the densest area of the city, so we can regard it as the highest rent in the city. However, there are one or more cities in an area, so we have one or more rents, each of which is the highest in each city, in the area. Among these rents, we will select the highest rent as the rent of the area. Therefore we are able to think the rent we select is the highest one in the area.

Here, we will show the way where the "real" rent is formed. The rent usually means the "nominal" rent which does not include the factors of three items, i.e. the deposit, the recompense and the key money. However, the "real" rent which includes these factors is better than the

nominal rent when we will use the rent as the index of agglomeration economies of cities. Therefore, we use the following formula to caluculate the real rent.

real rent per month = {nominal rent per month} + {(deposit + recompense) × interest rate per year / 12} + {key money / 24}

As concerns the deposit and the recompense, we should add the monthly earnings of these two items to the nominal rent per month to have the real rent, because these two items are returned at the end of the term of contract. We use the prime rate of interest as the inerest rete, which was 4.4% in 1985.

On the otherhand, the key money is not returned, so it should be added directly to the nominal rent. However, it is necessary to convert the key money to the monthly value. Then we add the value of the key money devided by 24 months to the nominal rent, because the average term of contract of rental houses is about two years, according to the same report [17].

4. Urban Size and Agglomeration Economies

Table 2 shows the relations between the population and the real rent of the areas in Japan in 1985, which we can obtain through the data indicated above. Concerns as some of them, we will show figures from Fig.1 to Fig. 8.

Table 2. Relations between the population and the real rent of the areas in Japan in 1985

Y: real rent per month(yen), X: population(men)
$\bar{R}^2$: coefficient of determination adjusted for the degrees of freedom
DF: degree of freedom

Cases	Regression Equations	$\bar{R}^2$ (t-value)	DF	
①newly built wooden rental apartment house (2DK with bath)	$Y=0.003293X + 40889$	0.707(13.7)	76	Fig.1
	$*Y=0.007827X + 37270$	0.310(5.8)	73	Fig.2
	$Y=3714X^{0.182298}$	0.426(7.6)	76	Fig.3
②secondhand wooden rental apartment house (2DK with bath)	$Y=0.002853X + 34464$	0.721(14.3)	77	Fig.4
	$*Y=0.005464X + 32422$	0.216(4.6)	74	
	$Y=4113X^{0.162434}$	0.338(6.4)	77	
③newly built wooden rental single house (4DK with bath)	$Y=0.009818X + 60151$	0.755(15.3)	75	Fig.5
	$*Y=0.025449X + 46895$	0.413(7.2)	72	
	$Y=1018X^{0.309945}$	0.558(9.8)	75	
④secondhand wooden rental single house (4DK with bath)	$Y=0.008568X + 53567$	0.707(18.7)	76	Fig.6
	$*Y=0.022575X + 41721$	0.352(6.4)	73	
	$Y=1181X^{0.290367}$	0.524(9.3)	76	
⑤newly built non-wooden rental apartment house (2DK with bath)	$Y=0.003565X + 49015$	0.565(10.2)	78	Fig.7
	$*Y=0.010168X + 43455$	0.238(4.7)	75	
	$Y=3471X^{0.199343}$	0.387(7.1)	78	
⑥secondhand non-wooden rental apartment house (2DK with bath)	$Y=0.002758X + 44482$	0.511(9.0)	75	Fig.8
	$*Y=0.009594X + 38700$	0.283(5.5)	72	
	$Y=3627X^{0.188117}$	0.384(7.0)	75	

1) The symbol * means the case where three big areas (Tokyo, Osaka, and Nagoya areas) are excluded from the just above case.

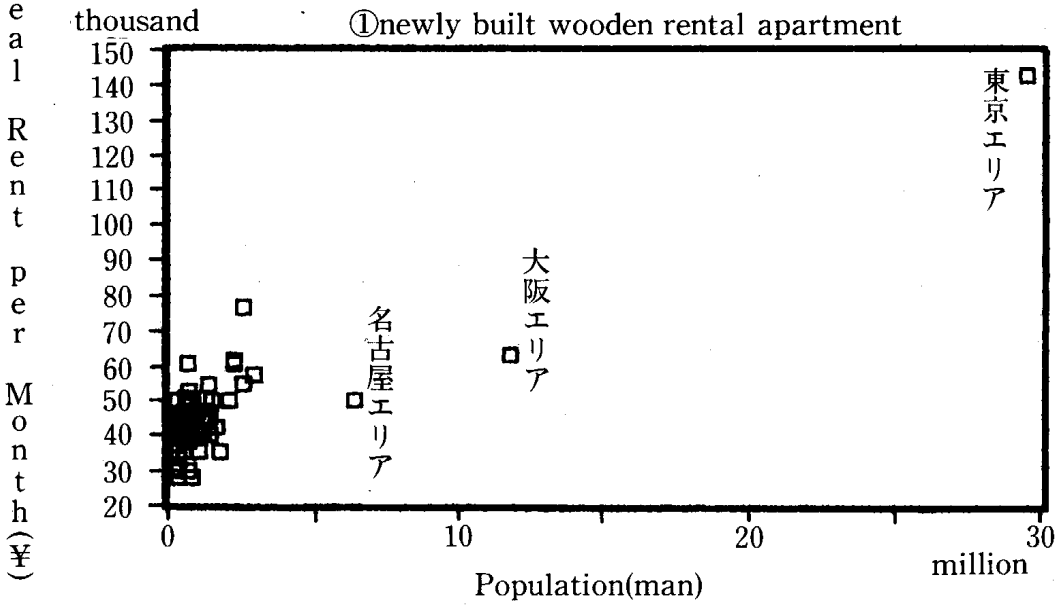
2) real rent per month = {nominal rent per month} + {(deposit + recompense) × interest rate per year / 12} + {key money / 24}

The first and second equations of each case in Table 2 are ones of a linear type, and the third is one of a log-linear type.

The first equation in each case in Table 2 is concerned with all areas in each case in the Table 1. In the second equation, three big areas (Tokyo, Osaka, and Nagoya areas) are excluded from the areas which are used in the first equation. In the third equation, we use all the same areas as in the first one.

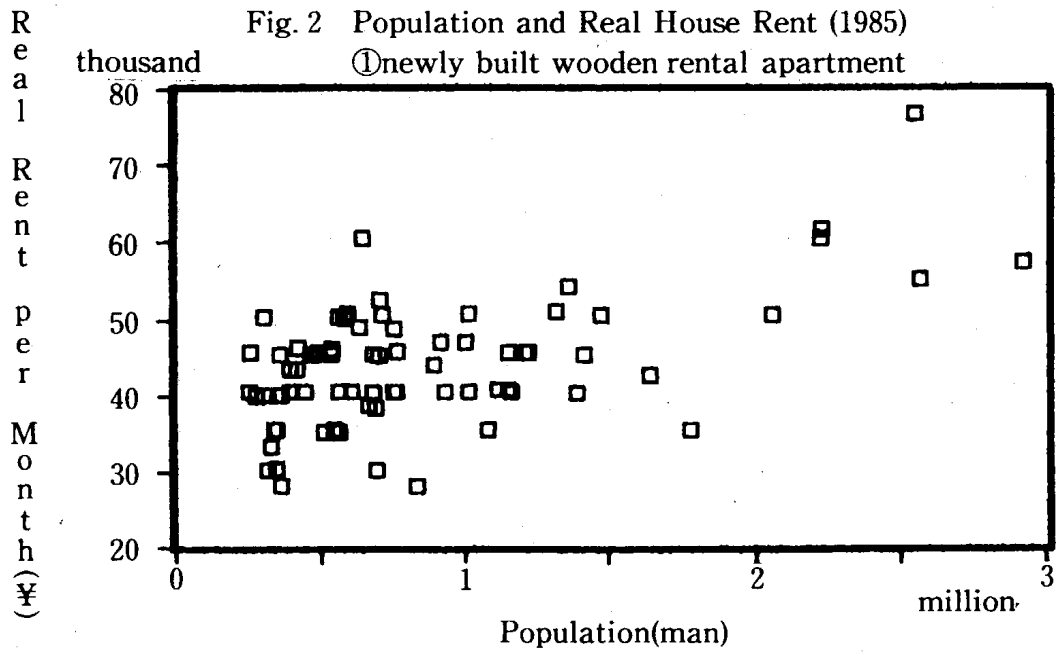
In the case ①(newly built wooden rental apartment house(2DK with bath)), the coefficient($\bar{R}^2$) of determination adjusted for the degrees of freedom is 0.707, and the t-value is 13.7, so the fitness is good, and the real rent is explained to the extent of 70 % by the population in the cities. Because the coefficient of X is 0.003293, the rent of the newly built wooden rental apartment house(2DK with bath) increases by 32.9 yen, when the population of the area increases by 10 thousand men. This case ① is showed in Fig. 1.

Fig. 1　Population and Real House Rent (1985)
①newly built wooden rental apartment



We can see in Fig.1 that three big areas (Tokyo, Osaka, and Nagoya areas) are located in the position detached from the other. So we will show Fig.2 and the second equation in the case① of Table 2, where three big areas are excluded. In this case, the coefficient($\bar{R}^2$) of determination adjusted for the degrees of freedom is 0.310, so the degree of fitness is weaker than the above Fig. 1 case. However, we can find that the coefficient of X is 0.007827 in this case Fig. 2 , and that it is larger than the coefficient in the case Fig. 1 where all areas are included. The coefficient of X of the second equation is 2.3 times as large as the first one. Therefore, we are able to think that the slope of regression line is still steeper in the range of small size of population, and that the slope in the range of population with more than 3 million people becomes gentler. Such a situation is showed in the Fig. 9.

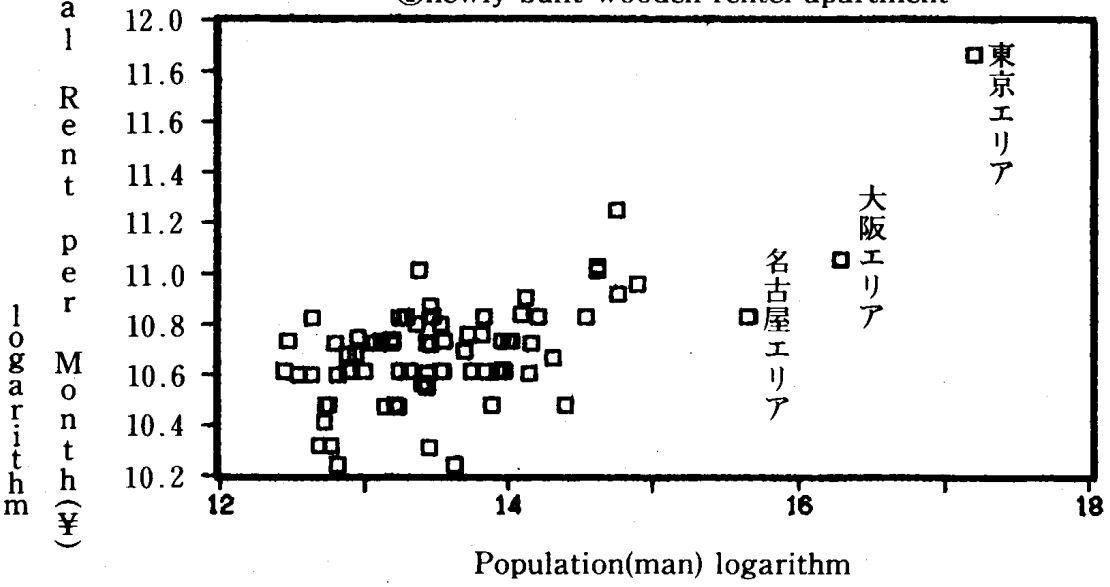
Fig. 2 Population and Real House Rent (1985)
①newly built wooden rental apartment



We will be able to expect that the relation between the rent and the population in this case① may fit in well with the regression line of log -linear type. Therefore, we have Fig.3 and the third equation of the

case① in Table 2. In this case(Fig. 3) with the log-linear type regression line, the coefficient($\bar{R}^2$) of determination adjusted for the degrees of freedom is 0.426, so the fitness is better than in the second equation(Fig. 2), but is worse than in the first(Fig. 1). Because the coefficient of X means the elasticity of rent to population, and the value is 0.182298, then the rent increases by 0.18% when the size of population increases by 1%.

Fig. 3　Population and Real House Rent (1985)
①newly built wooden rentel apartment



The situation is almost the same in the cases of②, ③, ④, ⑤ and ⑥ as in the case ① showed above. These cases are showed in Fig.4～8.

If we must find something to say, there are three points. First, in the cases ⑤ and ⑥ (newly built or secondhand non-wooden rental apartment house (2DK with bath)), the coefficients($\bar{R}^2$) of determination adjusted for the degrees of freedom are smaller than in the other. Even in these cases, the coefficients($\bar{R}^2$) of determination of first equaion are larger than 0.5.

Second, in the cases of ③ and ④ (newly built or secondhand wooden

Fig. 4 Population and Real House Rent (1985)
②secondhand wooden rental apartment

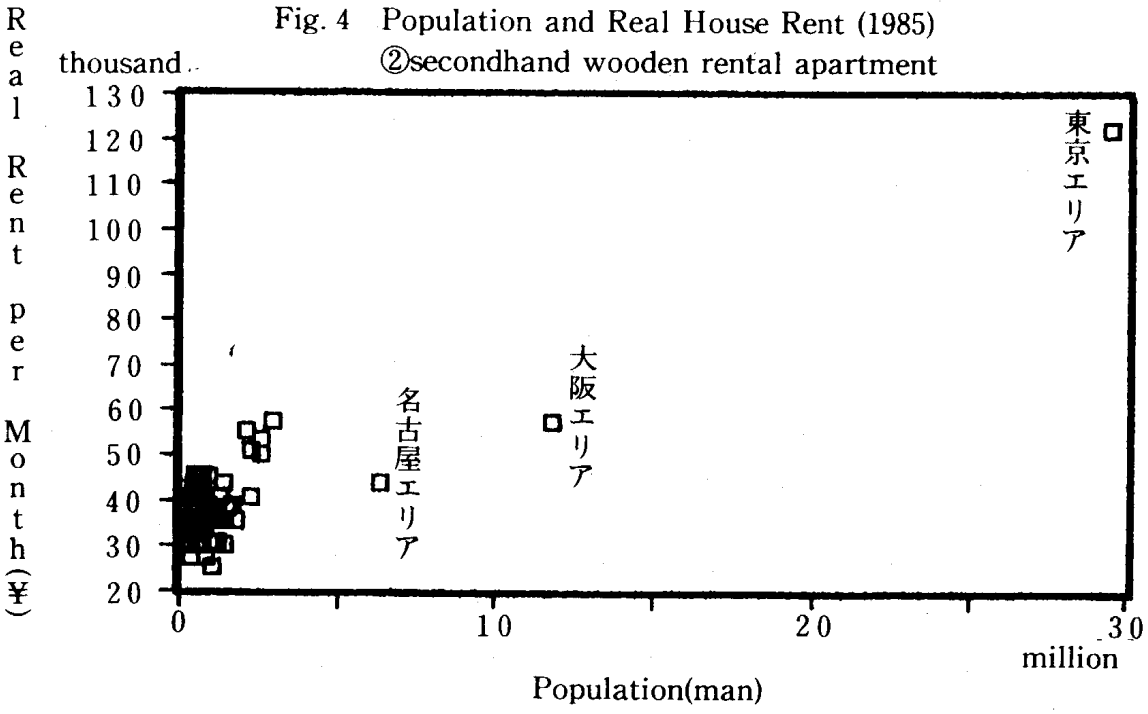


Fig. 5 Population and Real House Rent (1985)
③newly built wooden rental house

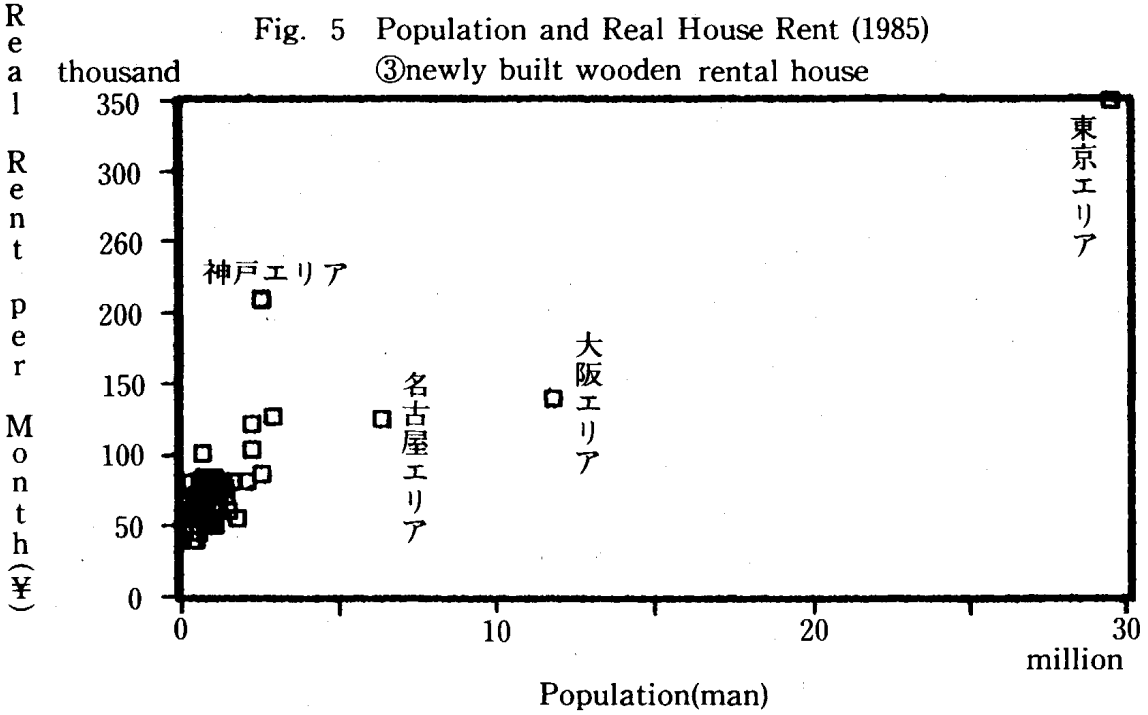


Fig. 6　Population and Real House Rent (1985)
④secondhand wooden rental house

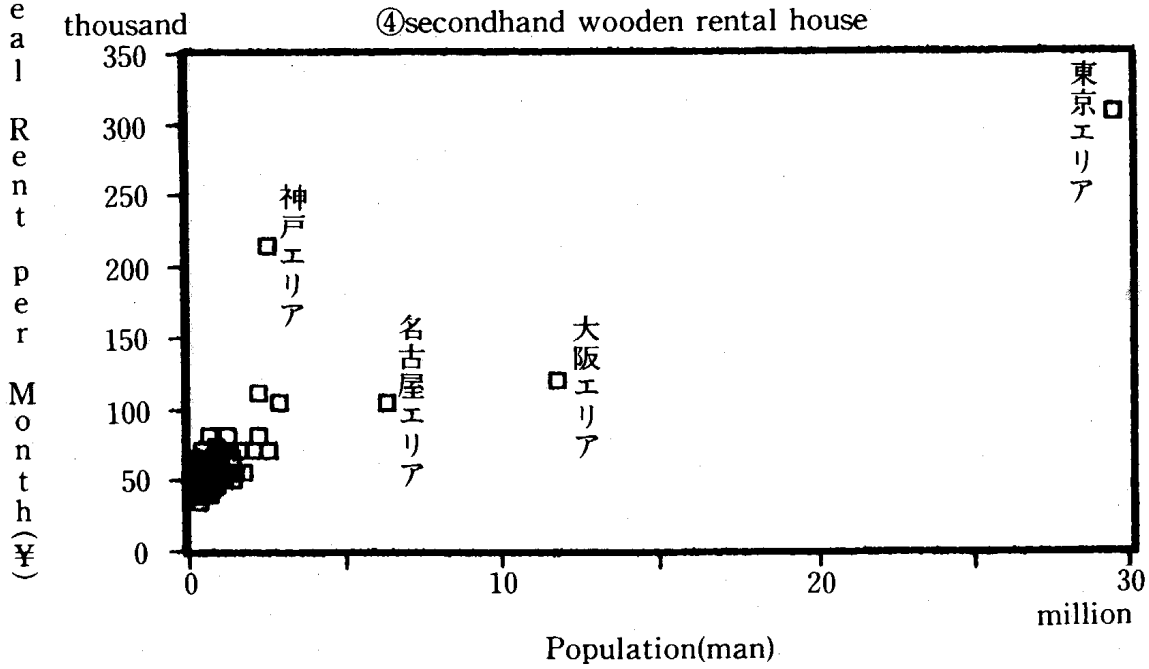


Fig. 7　Population and Real House Rent (1985)
⑤newly built non-wooden rental apartment

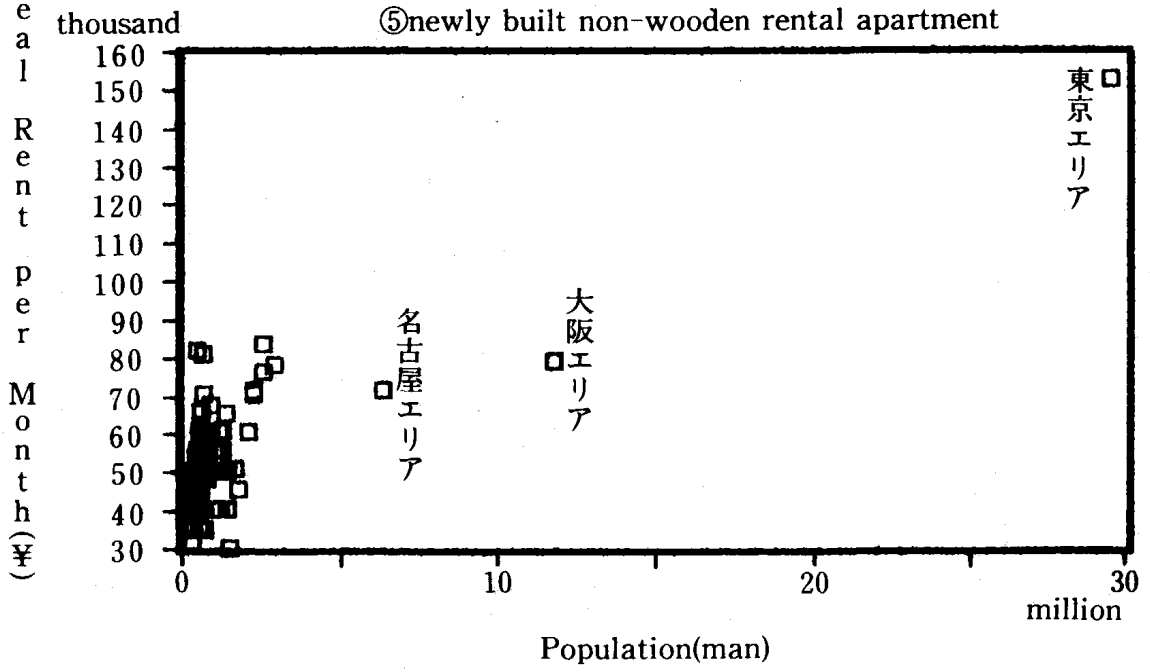
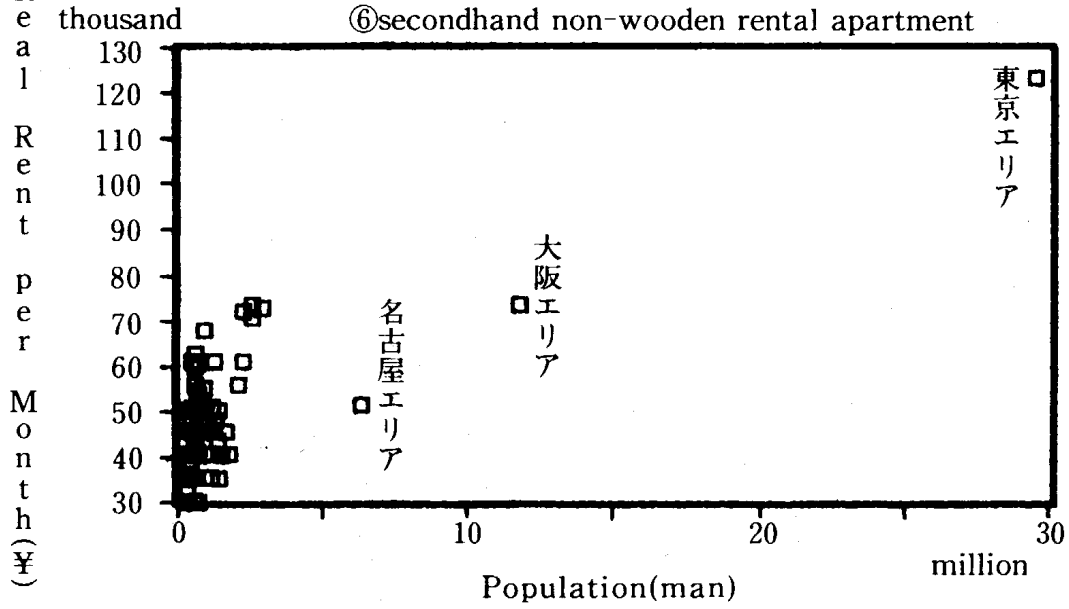


Fig. 8 Population and Real House Rent (1985)
⑥secondhand non-wooden rental apartment



rental single house (4DK with bath)), the coefficients of X are bigger than in the other. That is to say, as concerns the first equaion in each case, the average value of coefficients of X in the cases of ①, ②, ⑤ and ⑥ is 0.003117, and, the average value in the cases ③ and ④ is 0.009193. The latter is about 2.9 times as large as the former. In the second equation, the average value of coefficients of X in the cases of ①, ②, ⑤ and ⑥ is 0.008263, and the average value in the cases ③ and ④ is 0. 024012. The latter is about 2.9 times as large as the former, and this is the same value as the first equation. And in the third equation that is a log-linear type, the average value of coefficients of X in the cases of ①, ②, ⑤ and ⑥ is 0.183048, and the average value in the cases ③ and ④ is 0.300156. The latter is about 1.6 times as large as the former.

The reason for the second point is that the rents themselves are larger in the cases ③ and ④ than in the other, therefore, the difference of rents is also larger when there is a difference of size in population.

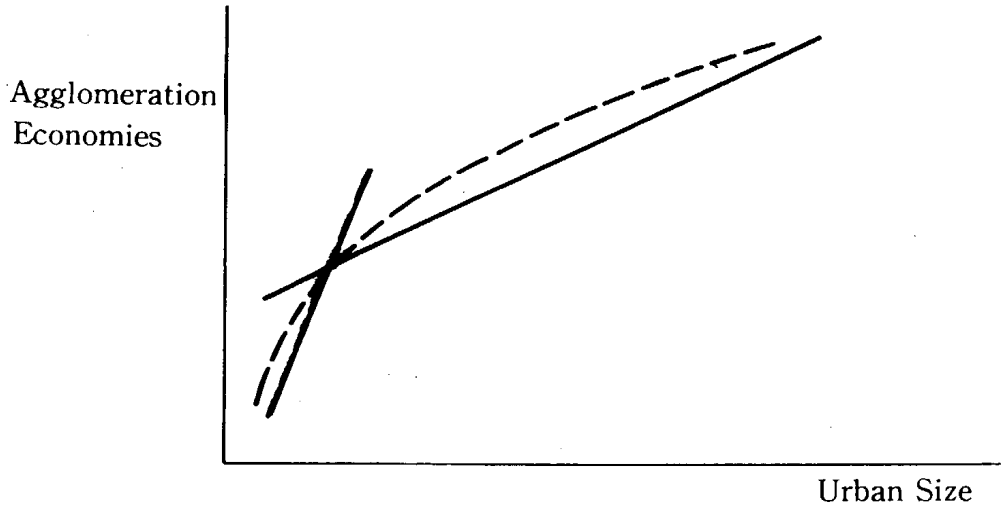
Third, there are two exceptional areas, i.e. Nagoya area and Kobe area. The rent of Nagoya area is low in ⑥ especially, and, on the other

hand, the rent of Kobe area is high in ③ and ④ especially, as compared with the size of population respectively. If we exclude these two exceptions, the coefficients($\bar{R}^2$) of determination will become larger in all the above cases.

From the above analysis, we can summarize as follows.

1. We can find the close relation beetween the rent and the population in the areas. When the size of population in areas increases, the rent increases proportionally(straight line), or increases more gradually than the growth of population(upper-wards convex), as in Fig.9.

Fig. 9 Urban Size and Agglomeration Economies



2. As concerns the rental apartment house which is a 2DK type with bath, whether it is newly built or secondhand, or, whether it is wooden or non-wooden, the rent increases by about 31 yen, when the number of population of a area increases by 10 thousand men. On the other hand, as concerns the wooden rental single house which is a 4DK type with bath, whether it is newly built or secondhand, the rent increases by

about 92 yen, when the number of population in a area increases by 10 thousand men.

3. If the areas are restricted to the range where the number of population is smaller than 3 million, the rent is more sensitive to the difference of size of population. That is to say, as concerns the rental apartment house which is a 2DK type with bath, the rent increases by about 83 yen, (although it is 31 yen in the case with no restriction as showed just above), when the number of population of a area increases by 10 thousand men. On the other hand, as concerns the wooden rental single house which is a 4DK type with bath, the rent increases by about 240 yen, (although it is 92 yen in the case with no restriction as showed just above), when the number of population in a area increases by 10 thousand men.

4. The elasticity of rent to population is about 0.18 in the case of rental apartment house which is a 2DK type with bath, whether it is newly built or secondhand, or, whether it is wooden or non-wooden. Then the rent increases by aboout 0.18% when the size of population increases by 1%. On the other hand, in the case of the wooden rental single house which is a 4DK type with bath, the elasticity is about 0.30.

5. All regression equations are significant at 0.5% level.

5. Comparison with the Case of Land Price

We will show the comparison with the case of land prices in my paper [14]. We have the relations between the residential land prices and the size of population in Table 3.

Table 3. Relations between the population and the residential land prices of the areas in Japan in 1985

Y: residential land price(yen),　X: population(men)

$\bar{R}^2$: coefficient of determination adjusted for the degrees of freedom

DF: degree of freedom

Regression Equations	$\bar{R}^2$ (t-value)	DF
$Y=0.063085X + 77550$	0.912(33.6)	108
$*Y=0.090305X + 61942$	0.536(11.1)	105
$Y=4.544X^{0.536077}$	0.629(13.6)	108

1) The first and third equations are concerned with all of 110 areas.

2) The symbol * means the case where three big areas (Tokyo, Osaka, and Nagoya areas) are excluded.

Reference: Yoshimura [14]

Comparing equations in Table 2 and Table 3, we can see that the coefficients($\bar{R}^2$) of determination adjusted for the degrees of freedom are larger in the land prices(Table 3) than in the rents(Table 2) in all the equations. That is to say, the size of population fits in better with the land price than the rent in these cases.

However, we can not always say that this is true in general, because the areas, the central cities of which have a population of less than 100 thousand, are excluded in Table 2(rent), although all areas are included in Table 3(land price). In other words, if we are able to have data of all 110 areas in Table 2 as in Table 3, we may expect that the fitness

in Table 2 is as good as in Table 3.

Nevertheless, it is true in both cases of the rent and the land price that the agglomeration economies measured by the rent or land price is proportional to the size of population(straight line), or increase more gradually than the growth of population(upper-wards convex), as in Fig. 9. It is easy to expect that this is true, because the relations between the residential land price and the real rent of the areas are close, as showed in Table 4.

Table 4. Relations between the residential land price and the real rent of the areas in Japan in 1985

Y: real rent per month(yen), X: residential land price(yen)
$\bar{R}^2$: coefficient of determination adjusted for the degrees of freedom
DF: degree of freedom

Cases	Regression Equations	$\bar{R}^2$ (t-value)	DF
①	Y=0.052721X + 36615	0.746(15.0)	76
②	Y=0.044136X + 31028	0.709(13.8)	77
③	Y=0.155660X + 47757	0.781(16.5)	75
④	Y=0.137608X + 42099	0.747(15.3)	76
⑤	Y=0.057714X + 44205	0.610(11.2)	78
⑥	Y=0.044040X + 40909	0.535(9.4)	75

Cases①~⑥ are the same as Table 2.

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